Program

SNL 2022

October 6-8, 2022

Philadelphia, Pennsylvania

SOCIETY FOR THE NEUROBIOLOGY OF LANGUAGE

National Institutes of Health

Neurobiology of Language

Brain & Language

Language, Cognition and Neuroscience

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Welcome to SNL 2022

I would have been delighted to welcome you to any non-virtual city for our annual meeting this year, the first we have held in person since 2019. But I am especially delighted to welcome you to the city that I have called home for 26 years. Philadelphia hosted the First Continental Congress in 1774, and now it is hosting the Fourteenth Annual Meeting of the Society for the Neurobiology of Language. On behalf of all of the residents of the city of brotherly love and sisterly affection, I thank you for coming—whether it is your first or fortieth time—and I encourage you to explore and enjoy this fantastic city.

I also encourage you to explore and enjoy our fantastic scientific program. Each day of the program features one invited symposium in which a group of stellar scientists will present their latest findings on the themes of “Plasticity in a language-ready brain: complementary evidence from developmental deafness, blindness, and varied language experience across modalities” (organized by Marina Bedny and Qi Cheng); “Imaging the functional reorganization of the language network in recovery from aphasia” (organized by Stephen Wilson); and “How does the neural mechanism of language processing develop in children?” (organized by Jin Wang).

The program features three keynote speakers by scientists who together reflect the broad range of interests among our members: Ina Bornkessel-Schlesewsky will discuss variability in predictive language processing; Kara Federmeier will speak about the role of electrophysiology in understanding language comprehension; and Asifa Majid will review neurocognitive and cultural biases in language. We will also have the opportunity to hear talks by our Distinguished Career Award winner (Cathy Price); our Early Career Award winner (Michael Artur Skeide); and our Dissertation Award winner (Jin Wang).

For students and postdoctoral fellows, be sure to attend the social hour over lunch on Saturday; thank you to Suhail Matar, our current student and postdoctoral representative, for planning this activity.

And to everyone, please join us for the opening reception on Thursday evening and for a social hour during the poster session on Friday evening. Attendees are also encouraged to attend the SNL Business Meeting right before lunch on Saturday. The program concludes at the end of the day on Saturday, when I will hand the reins over to our next Chair, Liina Pylkkänen of New York University.

This meeting would not be possible without the generous support of our sponsors: National Institutes of Health (Major Sponsor); Neurobiology of Language (The MIT Press) (Gold Sponsor); Brain & Language (Elsevier) (Awards Sponsor); Language, Cognition & Neuroscience (Routledge) (Awards Sponsor); Rogue Research Inc. (Silver Sponsor); ANT Neuro (Bronze Sponsor); Brain Vision LLC (Bronze Sponsor). Please visit these sponsors during our meeting.

I would like to thank the program committee for all of the thought, energy, and, of course, the many, many hours that they put into planning an exciting scientific program: Ingrid Johnsrude, Suhail Matar, Carolyn McGettigan, Liina Pylkkänen, Stephen Wilson, and Patrick Wong, with a special thanks to Michele Diaz, the Chair of the Program Committee. Thank you to all who took time to review and provide feedback for the abstract submissions. And last but by no means least, a huge round of applause for Shauney Wilson, Shawna Lampkin, and their team for remembering how to run an in-person meeting and for doing it so well.

On behalf of all of these people, I would like to thank you for your active participation in SNL and welcome you to our annual meeting in Philadelphia. Have a wonderful time and don’t forget to tag us on social media @SNLmtg during the meeting!

Sharon Thompson-Schill
Chair, Society for the Neurobiology of Language

Schedule of Events

*All times are in **Philadelphia, Pennsylvania** time (**EDT** timezone).*

Thursday, October 6, 2022		
7:00 am - 5:45 pm	Registration Open	Regency Foyer
8:00 - 9:00 am	Continental Breakfast	Regency Foyer
8:00 am - 5:00 pm	Exhibits Open	Regency Foyer
8:50 - 9:00 am	Opening Remarks	Regency Ballroom
9:00 - 10:00 am	Keynote Lecture: Asifa Majid	Regency Ballroom
10:00 - 10:15 am	Poster Slam A	Regency Ballroom
10:15 - 10:45 am	Coffee Break	Millennium Foyer
10:15 am - 12:00 pm	Poster Session A	Millennium Hall
12:00 - 1:30 pm	Lunch Break	On your own
12:00 - 1:30 pm	Meet with NSF Representative Simon Fischer-Baum	Regency Foyer
1:30 - 3:00 pm	Slide Session A: Language Production	Regency Ballroom
3:00 - 3:30 pm	Coffee Break	Regency Foyer
3:30 - 5:30 pm	Symposium: Plasticity in a language-ready brain: complementary evidence from developmental deafness, blindness, and varied language experience across modalities	Regency Ballroom
5:30 - 6:15 pm	Distinguished Career Award (DCA): Cathy Price	Regency Ballroom
6:15 - 6:30 pm	Poster Slam B	Regency Ballroom
6:30 - 8:30 pm	Poster Session B and Reception	Millennium Hall

Friday, October 7, 2022		
7:00 am - 7:00 pm	Registration Open	Regency Foyer
7:30 - 8:30 am	Continental Breakfast	Regency Foyer
8:00 - 10:00 am	Symposium: Imaging the functional reorganization of the language network in recovery from aphasia	Regency Ballroom
8:00 am - 5:30 pm	Exhibits Open	Regency Foyer
10:00 - 10:15 am	Poster Slam C	Regency Ballroom
10:15 - 10:45 am	Coffee Break	Millennium Foyer
10:15 am - 12:00 pm	Poster Session C	Millennium Hall
12:00 - 1:30 pm	Lunch Break	On your own
1:30 - 3:00 pm	Slide Session B: Perception	Regency Ballroom
3:00 - 3:45 pm	Dissertation Award: Jin Wang	Regency Ballroom
3:00 - 3:45 pm	Early Career Award: Michael Skeide	Regency Ballroom
3:45 - 4:15 pm	Coffee Break	Regency Foyer

4:15 - 5:15 pm	Keynote Lecture: Ina Bornkessel-Schlesewsky	Regency Ballroom
5:15 - 5:30 pm	Poster Slam D	Regency Ballroom
5:30 - 7:15 pm	Poster Session D with Social Hour	Millennium Hall

Saturday, October 8, 2022

7:30 - 8:30 am	Continental Breakfast	Regency Foyer
7:30 am - 6:00 pm	Registration Open	Regency Foyer
8:00 - 10:00 am	Symposium: How does the neural mechanism of language processing develop in children?	Regency Ballroom
8:00 am - 3:00 pm	Exhibits Open	Regency Foyer
10:00 - 10:30 am	Coffee Break	Regency Foyer
10:30 am - 12:00 pm	Slide Session C: Disorders	Regency Ballroom
12:00 - 12:30 pm	Business Meeting	Regency Ballroom
12:30 - 2:00 pm	Lunch Break	On your own
12:30 - 2:00 pm	Student Social Hour with Lunch	Commonwealth
12:30 - 2:00 pm	Meet with NSF Representative Simon Fischer-Baum	Regency Foyer
2:00 - 3:00 pm	Keynote: Kara D. Federmeier	Regency Ballroom
3:00 - 3:15 pm	Poster Slam E	Regency Ballroom
3:15 - 3:45 pm	Coffee Break	Millennium Foyer
3:15 - 5:00 pm	Poster Session E	Millennium Hall
5:00 - 5:30 pm	Closing Remarks and Outlook to SNL 2023	Regency Ballroom

Asifa Majid

The limits of language: Teasing apart neurocognitive and cultural biases

Thursday, October 6, 2022, 9:00 - 10:00 am EDT, Regency Ballroom

Chair: Tamara Swaab, University of California, Davis
Speaker: Asifa Majid, University of Oxford

Why are some things relatively easy to express in language (e.g., geometric shapes) but others hard (e.g., odors)? Different proposals abound. Perhaps differential expressibility reveals something about the cognitive architecture of our mind~brains. The difficulty of naming odors, for example, has been attributed to the way olfactory and language areas of the brain are connected: it has been suggested that the primary olfactory cortex interfaces with language regions of the brain while olfactory representations remain coarse and unprocessed at the point of lexical–semantic integration. On the other hand, there may be something specific about the properties of language itself that make some sensations easier or harder to express: that is, universal design features of semantics and syntax may restrict expressibility of particular percepts. Based on fieldwork and laboratory studies, I will show that differential expressibility in language reflects cultural, not just cognitive or linguistic biases. Things that elude description in English are nevertheless easily conveyed in other languages, highlighting the role culture and experience play in understanding the nature and limits of language.

About Asifa Majid

Asifa Majid is Professor of Cognitive Science at the University of Oxford and incoming William Bentinck-Smith Fellow at the Harvard Radcliffe Institute. An alum of the University of Glasgow and University of Edinburgh in Scotland, Professor Majid worked at the Max Planck Institute for Psycholinguistics and then at Radboud University in the Netherlands, before returning to the UK. Her research tackles the relationship between language and thought, and has overturned various dogmas about human olfactory abilities. She has led several large-scale cross-cultural projects with a global network of collaborators, as well as conducting primary fieldwork in the Malay Peninsula. She was awarded a prestigious personal grant of €1.5 million from the Dutch Research Council (NWO VICI Grant) to study olfactory language and cognition across cultures. Professor Majid was Chair of the Cognitive Science Society (2019–2020) and currently serves on the Board of Reviewing Editors at Science.

Ina Bornkessel-Schlesewsky

Variability in predictive language processing

Friday, October 7, 2022, 4:15 - 5:15 pm EDT, Regency Ballroom

Chair: Liina Pylkkänen, New York University

Speaker: Ina Bornkessel-Schlesewsky, University of South Australia

Since the inception of the Society for the Neurobiology of Language, the field has made substantial progress in increasing our understanding of how the brain implements language. Applying neurobiological levels of explanation continues to be particularly challenging, however, for higher-order language processing at the level of sentences and above. In this presentation, I will argue that focusing on the variability of language comprehension can provide fruitful insights into the neurobiology of (higher-order) language. To this end, I will discuss variability between different languages, between individuals and across the adult lifespan. The discussion will be couched within an active inference framework, which assumes that the human brain actively generates explanations for its sensory input and strives to minimise the surprise associated with sensory observations. This is accomplished by combining (top-down) predictions generated by an internal model of the world with incoming (bottom-up) sensory input and updating the model in the case of a prediction error. I will show how variability in sentence comprehension arises through shifts in the balance between top-down and bottom-up information during model updating. In addition to reflecting the varying information processing affordances of the language input, this may, in part, be linked to intrinsic differences in neural information processing.

About Ina Bornkessel-Schlesewsky

Ina Bornkessel-Schlesewsky is Professor of Cognitive Neuroscience at the University of South Australia (UniSA) and Head of the Cognitive Neuroscience Laboratory within the Australian Research Centre for Interactive and Virtual Environments (IVE). Professor Bornkessel-Schlesewsky joined UniSA in 2014 from the University of Marburg, Germany. Prior to her appointment as Professor of Neurolinguistics in Marburg, she headed the Max Planck Research Group "Neurotypology" at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany. In her work, Professor Bornkessel-Schlesewsky has long championed the perspective that, in order to truly understand how the human brain processes language, we need to take into account the full diversity of the world's 7000 languages. Further research interests include inter-individual differences in language processing and human information processing in complex and dynamic environments. Professor Bornkessel-Schlesewsky is a former recipient of an Australian Research Council Future Fellowship and of the Heinz Maier-Leibnitz Prize (awarded by the German Research Foundation and German Federal Ministry of Education and Research).

Kara D. Federmeier

Time will tell: What electrophysiology reveals about language comprehension across adulthood

Saturday, October 8, 2022, 2:00 - 3:00 pm EDT, Regency Ballroom

Chair: Michele T. Diaz, The Pennsylvania State University

Speaker: Kara D. Federmeier, University of Illinois at Urbana-Champaign

Humans have the remarkable ability to link perceptual stimuli with long-term memory – i.e., to glean the meaning of those stimuli – in a manner that is persistent and rapid but also flexible and goal-oriented. Work in my laboratory has revealed that in a relatively invariant time window, uncovered through studies using the N400 component of the event-related potential, incoming sensory information naturally induces a graded landscape of activation across semantic memory, creating what might be called "proto-concepts". This process of *connecting* affords the continuous infusion of meaning into human perception. Connecting can be, but is not always, followed by a process of further *considering* those activations through a set of more attentionally-demanding comprehension mechanisms that permit selection, augmentation, and transformation of the initial semantic representations. The result is a limited set of more stable bindings that can be arranged in time or space, revised as needed, and brought to awareness. The use of these "active" comprehension processes, however, varies across task contexts and across people, including as a function of age, changing how information accrues over time, how context is used to shape word processing, and what people later remember about what they have experienced. Collectively, these findings reveal how the brain uses multiple mechanisms – and takes advantage of time – to provide us with the ability to understand one another and world, across the lifespan.

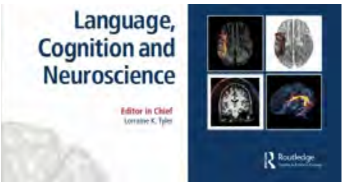
About Kara D. Federmeier

Kara D. Federmeier, received her Ph.D. in Cognitive Science from the University of California, San Diego. She is a Professor in the Department of Psychology and the Neuroscience Program at the University of Illinois and a full-time faculty member at the Beckman Institute for Advanced Science and Technology, where she co-leads the Illinois Language and Literacy Initiative and heads the Cognition and Brain Lab. She also recently served as the President of the Society for Psychophysiological Research. Her research, supported by the National Institute on Aging, examines meaning comprehension and memory across adulthood, using human electrophysiological techniques in combination with behavioral, eyetracking, and other functional imaging and psychophysiological methods.

Distinguished Career Award

Cathy Price

The Society for the Neurobiology of Language is pleased to announce the 2022 Distinguished Career Award recipient: Cathy Price



The Distinguished Career Award is generously sponsored by Language, Cognition and Neuroscience.

Probing the neurobiology of language for three decades

Thursday, October 6, 2022, 5:30 - 6:15 pm EDT, Regency Ballroom

Chair: Matt Lambon Ralph, University of Cambridge

Speaker: Cathy Price, UCL Queen Square Institute of Neurology

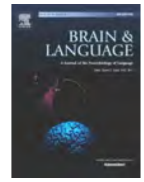
The neurobiology of language, and its many forms, have engaged me on a daily basis for more than 30 years. The types of questions I have investigated include: Which parts of the human brain allow us to meaningfully exchange words and messages and how do the findings vary across individuals? What other functions use the “language” areas and what does this tell us about how language is acquired? How does the neurobiology of language vary with the language spoken and how do bilinguals distinguish and control which language is in use? What changes in our brain when we learn to read and why do some healthy looking brains struggle to read when others find it so easy? Can we predict how language will change if neurological disorders damage the brain regions that typically support language? And how does the brain learn to speak again after it has suffered such damage? When I started thinking about these questions, I assumed that non-invasive functional neuroimaging would provide all the answers. Neuroimaging has indeed transformed our understanding of language but the answers have often been contrary to expectation from other sources of knowledge – and the lessons learnt have not necessarily been related to the questions asked but more about how the questions need to be asked again, in different ways.

About Cathy Price

Cathy Price is a ground-breaking international leader in our field and a professor of Cognitive Neuroscience at University College London. Alongside her neuropsychological studies, she was an early pioneer of functional neuroimaging, and was the only woman amongst the first Principal Investigators at the Functional Imaging Laboratory at UCL, when it was founded. She has made numerous notable contributions, including: (a) developing innovative methods and analytics to investigate cognition with fMRI; (b) establishing language-related fMRI as a field; (c) determining the cognitive and neural bases of language across healthy participants and patients. In addition to her substantial body of internationally recognized contributions to cognitive fMRI, she leads the largest-ever study of post-stroke aphasia (https://www.ucl.ac.uk/ploras/) which continues to generate important new insights about, and prediction of, recovery of language functions in aphasia.

In addition to her cutting-edge research, Professor Price makes many other substantial contributions. She has been the Director of the Wellcome Centre for Human Neuroimaging since 2015. She is a Scientific Advisory Board member for numerous internationally-leading language and neuroimaging research centers. She has been the handling editor for several world-leading journals, served as Secretary for the Organisation of Human Brain Mapping (OHBM), and chaired the nominating committee for SNL. Moreover, professor Price has always promoted the careers of other people. This was formally recognized in the 5th Suffrage award for Life Sciences (2018) and a very high proportion of her past students and postdocs are now world-recognized scientists themselves including Drs. Mummery (UCLH), Gorno-Tempini (UCSF), Phillips (KCL); McCrory (UCL), Mechelli (IoP), and Noppeney (Donders).

Jin Wang



The Society for the Neurobiology of Language is pleased to announce the 2022 Dissertation Award recipient: Jin Wang

The Dissertation Award is generously sponsored by *Brain and Language*.

The longitudinal relation between the neural basis of phonological awareness and reading skill in developing children

Friday, October 7, 2022, 3:00 - 3:45 pm EDT, Regency Ballroom

Chair: Sharon Thompson-Schill, University of Pennsylvania
Speaker: Jin Wang, Department of Psychology and Human Development, Vanderbilt University; Graduate School of Education, Harvard University

Reading is an essential skill for daily life and academic success. According to the connectionist model of reading, word recognition involves orthographic, phonological, and semantic processing, as well as the interactions among them. Language skill such as phonological processing, develops earlier than reading acquisition, and thus likely serves as a foundation for later reading development. We refer to this hypothesis as the scaffolding hypothesis. In addition, based on the connectionist model, the experience of learning to read changes the nature of spoken language processes, which we refer to as the sculpting hypothesis. The overarching goal of my dissertation was to use a language skill, phonological awareness, and its longitudinal relation to reading skill, to examine how the processes of scaffolding and sculpting unfold in elementary school children from 5- to 7- to 9-year-olds. The specific aims of my dissertation were to determine whether the development of these processes depend on (1) the grain size of the representations including larger units like rhymes/rimes versus smaller units like phonemes/letters, (2) the mapping from phonology to orthography resulting in automatic orthographic activation during spoken language processing, and (3) the nature of phonological processing involving representations versus access to those representations. As is predicted by the connectionist model that developmental effects should be earlier for smaller compared to larger grain sizes, due to greater computational demands of the latter, we found that the scaffolding effects occurred at small grain sizes in younger children but at larger grain sizes in older children. In addition, we found that in younger children, better reading led to an increase of the mapping from phonology to orthography and that automatic orthographic activation during auditory processing scaffolded later reading acquisition, consistent with the connectionist model. Finally, we found that phonological representation played a role in the scaffolding and sculpting effects earlier than phonological access, suggesting that a critical component is missing in the connectionist model, which only includes phonological representations but no control systems to account for the role of phonological access.

About Jin Wang

Jin Wang completed her PhD in Psychological Sciences at Vanderbilt University in March 2022. She moved in June 2022 to join the Harvard Graduate School of Education as a post-doctoral scholar.

In her dissertation, Jin Wang systematically examined the bidirectional relation between the neural basis of phonological awareness and reading skill in developing children. This work addresses a critical debate in the literature about whether deficits in phonological awareness are the causes or consequences of reading difficulties. By using a cross-lagged panel design, neural measurements, and linked connectionist models of reading, her studies provide convincing evidence supporting a reciprocal relation between the two skills, that evolves and shifts across the developmental time course. In addition to numerous publications related to neural specialization of language development, Dr. Wang has already published five papers from her doctoral studies and more to come in leading journals spanning the field of neuroimaging, developmental cognitive neuroscience and psycholinguistics.

Michael Artur Skeide

The Society for the Neurobiology of Language is pleased to announce the 2022 Early Career Award recipient: Michael Artur Skeide

The Early Career Award is generously sponsored by Brain and Language

Neurodevelopmental origins of human understanding

Friday, October 7, 2022, 3:00 - 3:45 pm EDT, Regency Ballroom

Chair: Sharon Thompson-Schill, University of Pennsylvania
Speaker: Michael Artur Skeide, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

In several core domains of natural intelligence current artificially intelligent systems are hopelessly inferior to the human brain. This becomes obvious while you are reading this text. You have learned to almost effortlessly understand what is written here. Driven by this fascination for *understanding* learning, the two overarching questions I will address in my talk is how the developing brain learns to make sense of the senses (e.g., read words) and to build mental models of the world (e.g., a mental lexicon). In addition to potentially universal principles of learning, I will also focus on individual and cross-cultural differences in learning.

About Michael Artur Skeide

Michael Artur Skeide received his PhD from the University of Leipzig in 2012 and, after less than six years of postdoctoral research in Leipzig and Stanford, he was awarded his Habilitation in Psychology from the Humboldt University of Berlin in 2018. He was made a Research Group Leader at the Max Planck Institute for Human Cognitive and Brain Sciences in 2020.

Dr. Skeide's research focuses on various aspects of the neurocognitive milestones of language acquisition from prenatal to adulthood. In his PhD, he showed that, beyond general cognitive capacities, such as working memory, children's language comprehension abilities are uniquely associated with the connectivity of a fronto-temporal brain network which increases only gradually towards adulthood. In his postdoctoral studies, Skeide discovered a novel link between the anatomical architecture of brain regions needed for visual word recognition and DNA variation in NRSN1, a gene known to modulate the developmental differentiation of nerve cells. Based on these multimodal data, Dr. Skeide and his group were able to prove the feasibility of reliably forecasting later written language skills in school beyond intelligence and parental education levels. He and his group have also conducted cutting-edge, cross-cultural work in non-western-educated industrialized-rich-democratic (WEIRD) individuals in rural northern India. In this population, he discovered that written language learning induces neuroplastic reorganization in evolutionarily old deep brain nuclei associated with oculomotor control and visuospatial attention that have not been identified before in WEIRD populations learning alphabetic scripts.

Meet with NSF Representative Simon Fischer-Baum

Thursday, October 6, 2022, 12:00 - 1:30 pm EDT, Regency Foyer

Saturday, October 8, 2022, 12:30 - 2:00 pm EDT, Regency Foyer

The Perception, Action, and Cognition (PAC) program at the National Science Foundation supports empirically grounded, theoretically engaged and methodologically sophisticated research in a wide range of topic areas related to human perceptual, motor, and cognitive processes and their interactions. The program funds a variety of projects involved in understanding the human capacity for language. Simon Fischer-Baum, program director for the PAC program will be available during the lunch breaks on Thursday and Saturday to meet one-on-one with interested scientists to discuss the PAC program specifically or NSF funding more generally.

Student and Postdoc Social Hour with Lunch

Saturday, October 8, 2022, 12:30 - 2:00 pm EDT, Commonwealth

To celebrate the return of in-person SNL meetings, join us for a student and postdoc social hour — a gamified space guaranteed to help trainees make new connections, get reacquainted with colleagues, meet people they've only ever met via zoom, and mingle with old friends. Our current student and postdoctoral representative, Suhail Matar, has planned activities that will encourage participants to get to know each other on a personal and professional level. Lunch will be provided.

Pre-registration has closed for this event. Check with the onsite Registration Desk for availability.

Plasticity in a language-ready brain: complementary evidence from developmental deafness, blindness, and varied language experience across modalities

Thursday, October 6, 3:30 - 5:30 pm EDT, Regency Ballroom

Organizers: Marina Bedny[1], Qi Cheng[2]; [1]Johns Hopkins University, [2]University of Washington

Chair: Marina Bedny, Johns Hopkins University

Presenters: Rain Bosworth, Qi Cheng, Karen Emmorey, Katarzyna Jednoróg, Marina Bedny

The neural basis of language is similar across spoken and signed languages, suggesting a 'language-ready' brain. How does experience modify language networks and their interactions with other systems? This symposium brings together research with individuals who are born blind or deaf, combining insights into plasticity from complementary methods. Dr. Bosworth presents insights from eye-tracking into how infants identify modality-invariant language patterns, prior to sign language experience, and how experience changes these abilities. Dr. Cheng combines diffusion tensor imaging and behavioral measures to investigate effects of early delays in language access on language network development. Dr. Emmorey uses time-sensitive ERP data to show how sign and spoken language experience shapes reading networks. Dr. Jednoróg and Dr. Bedny present novel fMRI data revealing effects of congenital blindness and Braille expertise on spoken and written language networks. The discussion will highlight novel insights into language-network plasticity of interest to the broad SNL community.

Presentations

The impact of early auditory or visual language experience on infants' eye gaze behavior for linguistic patterns

Rain Bosworth[1], So-One Hwang[2], David P. Corina[3]; [1]National Technical Institute for the Deaf, Rochester Institute of Technology, [2]Center for Research in Language, University of California, San Diego, [3]Center for Mind and Brain, University of California, Davis, California

Infants accomplish language acquisition with ease, first identifying novel sensory patterns relevant for learning language, aided by heuristics that propel them toward socially relevant communicative signals. This is true for infants exposed to spoken or signed language from birth. New evidence unveils how infants are able to distinguish signed linguistic patterns from non-linguistic ones. We present evidence from a series of eye tracking studies showing 6-month-olds-despite never seeing sign language-can discriminate well-formed from ill-formed signed patterns and signs from gestures, which suggest early language sensitivity transcends sensory modality of communication. Without exposure to visual language, however, this sensitivity wanes by 1-year of age. Finally, home language experience – signed vs. spoken – alters infants' overt attention for linguistic vs. non-linguistic patterns very early. We conclude with understanding the amodal perceptual cues that are relevant for language learning, the linguistic specialization over time, and the emerging awareness of communicative gestural acts.

Processing and anatomical outcomes when early language input is insufficient: evidence from deaf individuals with early language deprivation

Qi Cheng[1]; [1]University of Washington

Deaf individuals are more likely to have restricted early language environment due to the inaccessibility of spoken languages and the unavailability of a sign language. In this talk, I will discuss the processing and anatomical outcomes of lacking early language input. Deaf individuals who had severely delayed sign language onset relied more on world knowledge over American Sign Language (ASL) word order. Chinese deaf individuals with limited early language also showed less robust reliance on morpho-syntactic cues and more processing difficulties in written Chinese. Using diffusion tensor imaging (DTI), we found reduced white matter connectivity in left arcuate fasciculus among three deaf individuals with severely delayed ASL onset. Also, surface-based morphometry revealed negative correlations between age of ASL onset and cortical measurements in several bilateral frontal and posterior language regions among deaf individuals with ASL onset between birth to 14 years of age.

The neural circuit for reading in deaf adults reflects experience-specific adaptations

Karen Emmorey[1], Katherine Midgley[1], Phillip Holcomb[1]; [1]San Diego State University

Skilled deaf readers provide a novel model for probing how the neural circuitry for reading adapts to distinct sensory and linguistic experiences. Early deafness alters the distribution of visual attention which can impact visual word processing, and weak phonological skills (due to reduced access to sound) can impact reading by increasing reliance on orthographic and semantic information. ERP data indicate early visual responses to words differ for skilled deaf vs. hearing readers (reduced P1 amplitude, reversed visual complexity effects, earlier frequency effects, more bilateral N170 component). Reading skill also modulates these components differently (N170 and P1 amplitudes are differently correlated with reading abilities for deaf and hearing readers). Further, deaf readers exhibit more pronounced concreteness effects and N400 effects for sentential violations than skill-matched hearing readers. These findings highlight the plasticity of the reading system and illuminate the neurocognitive adaptations that occur when deaf adults achieve reading success.

Speech-reading convergence in the blind

Katarzyna Jednoróg[1]; [1]Nencki Institute of Experimental Biology

All writing systems represent units of spoken language, and reading relies on access to speech processing brain areas. Speech-reading convergence onto a common perisylvian network is a hallmark of acquiring literacy and is considered universal among different writing systems. Using fMRI, we tested whether this holds true also for tactile Braille reading in the blind. Even though both blind and sighted participants showed similar perisylvian specialization for speech, in contrast to the sighted, blind subjects did not engage these areas for reading. Speech-reading convergence in the blind was instead present in the left ventral occipitotemporal (vOT). The involvement of the vOT in speech processing and its engagement in reading in the blind suggests that vOT is included in a modality-independent language network in the blind, also evidenced by functional connectivity results. We find that in the blind, language responses in the vOT increase both with age and Braille reading skill.

Distinctive neural basis of reading by touch in congenitally blind proficient Braille readers: a parieto-occipital gradient

Marina Bedny[1], Mengyu Tian[1]; [1]Johns Hopkins University

The neural basis of reading is highly consistent across visual scripts. Reading recruits a left-lateralized, ventral-occipito-temporal (vOTC) posterior-to-anterior gradient, with more posterior responses to letter shapes and more anterior responses to words. How does reading modality and sensory experience shape language networks? We compared the neural basis of written and spoken word comprehension across sighted and congenitally blind readers using fMRI. Blind and sighted participants read analogous stimuli varying in linguistic complexity: words, consonant strings, and shapes and heard spoken words and noise. Unlike the vOTC of sighted readers, vOTC of congenitally blind readers did not show a gradient, instead uniformly preferring written and spoken words across its anterior/posterior extent. Congenitally blind Braille readers recruit a distinctive parieto-occipital anterior to posterior reading gradient. Blind readers also showed a distinctive pattern of lateralization consistent with a parieto-occipital hierarchy of Braille processing. Experience modifies the neural basis of spoken and written language.

No Talk 6

Imaging the functional reorganization of the language network in recovery from aphasia

Friday, October 7, 8:00 - 10:00 am EDT, Regency Ballroom

Organizer: Stephen Wilson[1]; [1]Vanderbilt University Medical Center

Chair: Stephen M. Wilson, Vanderbilt University

Presenters: Stephen Wilson, Anika Stockert, Fatemeh Geranmayeh, Leonardo Bonilha, Cathy Price, Matt Lambon Ralph

Most individuals with aphasia after a stroke experience some degree of recovery of language function over time. Recovery from aphasia is thought to depend on neural plasticity, that is, functional reorganization of surviving brain regions such that they take on new or expanded roles in language processing. Using functional neuroimaging, we are beginning to make progress on understanding the mechanisms that underlie this process of functional reorganization. This symposium focuses on novel and innovative approaches to functional imaging of neuroplasticity in aphasia, highlighting important emerging themes including the dependence of reorganization patterns on lesion location, the importance of task design and patient performance considerations, consistency and variability of functional maps, the role of domain general networks in recovery, and the necessity of integrating behavioral and imaging findings in a theoretically grounded neurocomputational account.

Presentations

Imaging the language network in aphasia

Stephen Wilson[1]; [1]Vanderbilt University Medical Center

As an introduction to the symposium, I will describe some of the challenges we need to overcome to make progress in characterizing the nature of neuroplasticity in recovery from post-stroke aphasia. First, we need valid, reliable, and practical methods for identifying and characterizing language regions of the brain in individuals with aphasia. Second, we need to control or account for performance differences between individuals, groups, and time points over the course of recovery, because task performance has a dramatic effect on brain activation patterns. Third, we need to work together to recruit large samples of individuals with aphasia so that we can perform statistically rigorous analyses and unravel the complex set of relationships between structural damage to different brain areas, functional changes in language regions and other regions, and behavioral outcomes. The remaining talks in this symposium describe five research programs that address these challenges in diverse and innovative ways.

Dynamics of language reorganization after temporo-parietal and frontal stroke

Anika Stockert[1]; [1]University of Leipzig Medical Center

In my talk, I will present longitudinal fMRI data of patients with circumscribed lesions of either left temporo-parietal or frontal cortex. Lesion-dependent network reorganisation includes the following mechanisms: First, global network disturbance in the acute phase is characterised by reduced language activation including areas distant to the lesion (i.e., diaschisis) and subsequent subacute network reactivation (i.e., resolution of diaschisis). These phenomena are driven by temporo-parietal lesions. Second, a lesion-independent sequential activation pattern involves increased activity of perilesional cortex and bilateral domain-general networks in the subacute phase, followed by reorganisation of left temporal language areas in the chronic phase. Third, involvement of homotopic brain areas is observed only in patients with frontal lesions. Finally, irrespective of lesion location, language reorganisation predominantly occurs in pre-existing networks. These findings highlight that the dynamics of language reorganisation clearly depend on lesion location, creating new opportunities for neurobiologically motivated strategies for language rehabilitation.

Domain-general brain regions and language recovery after stroke

Fatemeh Geranmayeh[1]; [1]Imperial College London

Post-stroke aphasia recovery does not occur in a vacuum. Rather recovery is likely to include a complex interaction between residual brain systems underpinning language function, brain systems involved in learning, and brain regions able to flexibly adapt to increasing task demand in the face of the newly imposed cognitive challenge. I will present evidence from fMRI studies that show that the activity of domain-general brain regions outside the classical language network, is related to better language outcomes after stroke. I will discuss the implications of these findings for future studies of aphasic recovery.

Brain systems that support treated recovery from aphasia

Leonardo Bonilha[1], Julius Fridriksson[2]; [1]Emory University, [2]University of South Carolina

Although it is now generally accepted that behavioral therapy can improve language processing in aphasia, the location of brain areas that support this recovery remains elusive. In a relatively large study (N=126) that included six weeks of aphasia therapy, we tested whether brain activation at baseline and changes in activation before and after therapy are associated with outcome. Brain activation was measured using fMRI and cortical regions of interest (ROIs) were grouped based on their location: left hemisphere, right hemisphere, domain-general regions, and peri-lesional regions. An initial prediction model that included biographical factors (aphasia severity, age, and diabetes) explained approximately 30% of the variance in therapy outcome. Adding fMRI data to the model accounted for as much as 50% of the total variance. Specific comparisons across the different groups of ROIs revealed insights into where brain changes occur that support the greatest improvements in language processing in aphasia.

Lesion site-dependence of functional reorganisation of speech production after stroke

Cathy Price[1]; [1]University College London

We are using fMRI to investigate how functional reorganisation after stroke depends on lesion site. We have found that recovery of speech production increases activation in: (1) the right superior cerebellum in patients with focal left inferior frontal lobe damage compared to neurologically intact controls or patients with other left hemisphere damage; (2) the supplementary motor area in patients with focal right cerebellum damage compared to controls or patients with other focal cerebellar damage; and (3) the left posterior superior temporal cortex in patients with right hemisphere damage to motor regions (premotor and insula cortex) compared to controls or patients with other right hemisphere lesions. These results highlight the importance of considering lesion site in fMRI studies of post-stroke recovery and generate hypotheses for testing whether neural plasticity supporting recovery depends on the underlying anatomical/functional connectivity between different brain regions, and/or changes in cognitive strategies/demands.

Towards a neurocomputational account of partial recovery in post-stroke aphasia

Matt Lambon Ralph[1]; [1]University of Cambridge

We developed a neurocomputational, bilateral pathway model of spoken language production, designed to provide a unified framework to assimilate data from neurologically intact individuals and individuals with aphasia. The model encapsulates various key computational principles including differential computational resources, emergent division of labour across pathways, and experience-dependent plasticity-related recovery. The model provides an explanation for the typical bilateral yet asymmetric lateralisation of language, chronic aphasia after left rather than right hemisphere lesions, and the basis of partial recovery of function in patients, which reflects a combination of retuning within the damage pathway and a changed division of labour across pathways. The model provides a formal basis for understanding the relationship between behavioural performance and brain activation. Overall, the unified model is consistent with the degeneracy and variable displacement theories of language recovery, and adds potential computational insights about the neural machinery underlying language processing and plasticity-related recovery following damage.

How does the neural mechanism of language processing develop in children?

Saturday, October 8, 8:00 - 10:00 am EDT, Regency Ballroom

Organizer: Jin Wang[1,2]; [1]Vanderbilt University, [2]Harvard University

Chair: Matt Davis, MRC Cognition and Brain Sciences Unit, Cambridge

Presenters: Dawoon Choi, Alexis Bosseler, Alexander Enge, Jin Wang, Julie Schneider, Saloni Krishnan

Language is a complex cognitive function. Brain development supporting this higher cognitive function is prolonged, continuing over the first two decades of postnatal life. Although the neurobiology of language processing in adults has been extensively studied, how it emerges and evolves in developing children is unclear. Three general frameworks, such as maturation, skill learning, and interactive specialization account, have been hypothesized to account for human functional brain changes (Johnson, 2011). However, how these theories are supported in the domain of language processing remains to be investigated. In this symposium, our speakers will introduce their recent studies on the neural basis of language processing in both typically developing children and children with developmental language disorders. Discussions will be carried out on how studies in this field can inform the understanding of human functional brain development and suggest future educational and clinical strategies.

Presentations

Sensorimotor influences on auditory speech perception in pre-babbling infants

Dawoon Choi[1], Janet Werker[2]; [1]Yale University, [2]The University of British Columbia

Natural speech that infants perceive and learn from is highly multisensory. In a series of experiments, we explored whether infants' speech perception is influenced by articulatory-auditory relations. We found behavioral (eye-tracking) and neural (EEG) evidence that preverbal infants' auditory speech perception is influenced by articulatorily-specific sensorimotor input induced by experimentally restricting the movement of infants' articulators. We tested perception of both native and non-native phonetic contrasts to control for the possibility of learning. To explore whether the auditory-sensorimotor relation is in place even before feedback from self-produced speech vocalizations, we tested consonant discrimination in pre-babbling infants as young as 3-month of age who are unable to produce consonant sounds. Our results show that the sensorimotor-auditory link is in place prior to specific experience watching, hearing, or producing the relevant sounds. We discuss the putative role of spontaneous and activity-dependent processes underlying this surprisingly early emerging sensitivity to articulatory-auditory relations.

Right hemisphere brain responses to familiar words at 14 months predicts infants' future language skills

Alexis Bosseler[1]; [1]University of Washington

Word learning is an important milestone in language acquisition and the time between 13 and 20 months of age marks a period of dramatic advances in infants' expressive and receptive word-processing abilities. Electrophysiological event-related potentials studies indicate that during the early stages of word learning, brain activation to words bilateral, and an initial strong contribution of the right frontal brain region that attenuates as a function of age and language proficiency. We used magnetoencephalography (MEG) to explore the neural processes involved in word learning using a familiar-unfamiliar word paradigm in 14-month-olds. MEG source modeling revealed a broadly distributed network in frontal, temporal and parietal cortex that distinguished word classes between 150–900 ms after word onset. Importantly, brain activity in the right frontal cortex in response to familiar words at 14 months predicted the rate at which infants acquired new words at 18, 21, 24, and 27 months.

Meta-analyzing the cortical networks for language and semantics in children

Alexander Enge[1,2], Angela Friederici[3], Rasha Abdel Rahman[2], Micheal Skeide[1]; [1]Research Group Learning in Early Childhood, Max Planck Institute for Human Cognitive and Brain Sciences, [2]Humboldt-Universität zu Berlin, [3]Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences

Obtaining large samples remains challenging for developmental neuroimaging studies of language. This induces both false positive and false negative findings. We used coordinate based meta-analysis to identify regions that are reliably activated across fMRI studies of children's auditory language comprehension (27 experiments, 625 children, mean age = 8.9 years, range 3–15) and semantic processing (50 experiments, 1,018 children, mean age = 10.1 years, range 4–15). The results overlapped substantially with canonical left-lateralized networks known from meta-analyses in adults. However, for language comprehension, children showed stronger effects in the right hemisphere and in the pars triangularis of the left IFG, whereas adults showed stronger effects in the pars opercularis. For semantic processing, children showed weaker effects in the left ATL. Leave-one-out and fail-safe N procedures testified robustness against publication bias. These findings provide a comprehensive picture of our current knowledge on the cortical topography of language processing during childhood.

Language specialization in typically developing children ages 5, 7, and 9 years old.

Jin Wang[1,2], James Booth[1]; [1]Vanderbilt University, [2]Harvard University

One of the core features of brain maturation is functional specialization, during which some cortical regions become functionally tuned to preferred stimuli and less responsive to non-preferred ones. Successful language processing involves the coordination between phonological, semantic, and syntactic systems. Although decades of adult studies have shown specialized brain networks supporting each component during language comprehension, how children develop such specialized networks remains unclear. To address this gap, we examined phonological, semantic, and syntactic specialization at both the word and the sentence level in three groups of children ages 5, 7, and 9 years old, using functional magnetic resonance imaging (fMRI) and direct task comparisons. Our findings from multiple studies suggest that language specialization progresses from the temporal lobe to the frontal lobe as children grow older. In addition, phonological and semantic specialization appears at an earlier age than syntactic specialization.

What neural oscillations reveal about sentence processing throughout childhood?

Julie Schneider[1]; [1]Louisiana State University

Although young children process sentences quickly and effortlessly, research indicates that the development of adult-like sentence processing abilities, and the neural structures underlying those abilities, is prolonged, continuing into adolescence (Friederici, 2005; Wang et al., 2021). This ongoing development suggests children may engage somewhat different skills than adults during sentence comprehension (Holland et al., 2007). In this presentation, I will highlight a series of empirical research studies that identify differences in the skills children engage when processing sentences using time-frequency analysis of the EEG. Across six sentence processing studies in both the auditory and written modalities, I will provide evidence that a) children in late childhood/early adolescence rely more heavily on semantics for sentence comprehension than adults, and that b) topographical and temporal changes in theta are sensitive to age differences, while changes in beta are associated with language abilities.

Examining the structure and function of frontostriatal regions in DLD

Saloni Krishnan[1]; [1]Royal Holloway, University of London

Children with DLD struggle to learn their native language for no obvious reason. We hypothesise their language learning difficulties may be underpinned by frontostriatal abnormalities. We test this hypothesis using data from two scans from the Oxford BOLD study - the largest study examining language variation in childhood. We observed no evidence of group differences in frontostriatal regions while children performed a simple language task, verb generation (Krishnan et al., 2021, NeuroImage). Changes in this network were observed when we focused on the poorest performers, suggesting differences are attributable to task performance. We also used a novel quantitative imaging protocol that is sensitive to myelin (Krishnan et al., 2021, Biorxiv). We found that children with DLD had reduced myelin in the caudate nucleus bilaterally and across many regions in the language network. We discuss how to bring together these findings and future directions for this work.

Slide Session A: Language Production

Thursday, October 6, 1:30 - 3:00 pm EDT, Regency Ballroom

Chair: Sharon Thompson-Schill, University of Pennsylvania

Diverging neural dynamics of syntactic structure building in naturalistic speaking and listening

Laura Giglio[1,2], Peter Hagoort[1,2], Daniel Sharoh[1,2], Markus Ostarek[1,3]; [1]Max Planck Institute for Psycholinguistics, [2]Donders Institute for Brain, Cognition and Behaviour, [3]University of Glasgow

In the last decade there has been an increase in studies of naturalistic language comprehension (Brennan, 2016), with the benefit of increased ecological validity and reduced confounds due to the absence of context typical of controlled stimulus sets. Studying naturalistic production may be even more critical, since most production studies use highly artificial tasks to ensure the production of varied speech output. These tasks give speakers virtually no control over what is to be said, although deciding what to say and how is a critical characteristic of production. As a consequence, the current understanding of the neural infrastructure for sentence production is confounded by task requirements. In this study, we aimed to gain a better understanding of syntactic processing in naturalistic production and how it differs from naturalistic comprehension. We analysed an existing fMRI dataset where a group of participants (n=16) freely spoke for several minutes recalling an episode of a TV series (Chen et al., 2017). Another group of participants (n=36) listened to the spoken recall of one production participant (Zadbood et al., 2017). Each text was parsed with a probabilistic context-free phrase-structure grammar (Stanford parser, Klein and Manning, 2003). We then quantified word-by-word syntactic processing as the number of syntactic nodes that are built with each word. Nodes were counted with two parsing strategies that make different predictions about the timing of phrase-structure building operations: either highly anticipatory, predicting increased activity when phrases are opened (top-down), or integratory, predicting increased activity when they are closed (bottom-up). We expected these parsing strategies to successfully predict activity differently in each modality, due to processing differences between production and comprehension. We entered these word-by-word syntactic predictors into a linear mixed-effects model of brain activity in three regions of interest (pars opercularis and pars triangularis of left inferior frontal gyrus (LIFGoper and LIFGtri) and left posterior middle temporal gyrus (LpMTG)). Both parsers added unique contributions to a baseline model including word rate, word frequency and word surprisal extracted with GPT-2. Anticipatory node counts led to a decrease in BOLD activity in comprehension but an increase in in production, showing that syntactic processing happens in early stages in production. Additional parsing strategies were explored that make different predictions about the incrementality of sentence production, showing that phrase-structure building operations are highly incremental and happen before word onset. This was also confirmed by longer speech pauses before words associated with more top-down operations. Integratory node counts instead positively predicted BOLD activity in comprehension and negatively in production, confirming that phrase-structure building has a higher load in later stages of the sentence in comprehension, when all words can be unambiguously merged into the syntactic structure. Both LpMTG and LIFGtri responded to syntactic processing in comprehension, but only the LIFGtri was responsive in production, confirming LIFGtri as a critical hub for syntactic processing across modalities also in task-free designs. Overall, the results show that the unfolding of syntactic processing diverges between speaking and listening and highlight the insights that can be gained by studying naturalistic production.

Beyond Broca: Neural Architecture and Evolution of a Dual Motor Speech Coordination System

Gregory Hickok[1], Jonathan Venezia, Alex Teghipco; [1]University of California, Irvine, [2]VA Loma Linda Health Care System and Loma Linda University School of Medicine, [3]University of South Carolina

Classical neural architecture models of speech production propose a single system centered on Broca's area coordinating all the vocal articulators from lips to larynx. Modern evidence has challenged both the idea that Broca's area is involved in motor speech coordination and that there is only one coordination network. Drawing on a wide range of evidence, here we propose a dual speech coordination model in which laryngeal control of pitch-related aspects of prosody and song are coordinated by a hierarchically organized dorsolateral system while supralaryngeal articulation at the phonetic/syllabic level is coordinated by the classic ventrolateral speech/language system. We argue further that these two speech production subsystems have distinguishable evolutionary histories and discuss the implications for models of language evolution.

Cerebellar contributions to speech fluency in neurotypical adults

Sivan Jossinger[1], Maya Yablonski[1], Ofer Amir[2], Michal Ben-Shachar[1]; [1]Bar-Ilan University, [2]Tel-Aviv University

Producing fast and fluent speech is an astounding human ability which requires the precise integration between several processes, including conceptual framing, lexical access, phonological encoding, and articulatory control. Despite this complexity, studies investigating the neural substrates of speech fluency generally focus on either lexical access or articulatory control, but rarely contrast between the two. Neuroimaging data point to significant cerebellar involvement during verbal fluency tasks (Schlösser et al., 1998) as well as in tasks that require speech rate modulation (Riecker et al., 2005, 2006). Similarly, patients with cerebellar lesions exhibit impaired verbal fluency abilities and significantly slower speech rate compared to controls (Ackermann et al., 1992; Peterburs et al., 2010). Here, we evaluated the contribution of the cerebellar peduncles (CPs) to the lexical and articulatory components of speech fluency. Diffusion imaging data and speech fluency measures were evaluated in 45 neurotypical adults. Unstructured interviews were used to assess natural speaking rate and articulation rate, and timed verbal fluency tasks were used to assess semantic and phonemic fluency. Imaging data were acquired on a 3T Siemens Magnetom Prisma scanner using diffusion weighted single-shot EPI sequence (b=1000 s/mm2; 64 diffusion directions; ~1.7×1.7×1.7mm3 resolution). Probabilistic tractography and constrained spherical deconvolution (CSD) modeling were used to generate individual tractograms. Segmented tracts included the bilateral superior, middle and inferior CPs (SCP, MCP and ICP, respectively). To this end, we developed a new protocol within the automatic fiber segmentation and quantification (AFQ) package to adequately follow the trajectory of the SCP and MCP as they decussate. Spearman's correlations were calculated between speech fluency measures and diffusion measures along the tracts. The results demonstrate a dissociation in the functional contributions of the CPs in speech production. Specifically, fractional anisotropy (FA) within the right SCP was associated with phonemic fluency (r=.431), while mean diffusivity (MD) within the right MCP was associated with speaking rate (r=-.447) (p<.05, family-wise error corrected). Importantly, partial correlation analyses indicated that the correlation within the right SCP was not driven by speaking rate, and the correlation within the right MCP was not driven by phonemic fluency (partial correlation in right SCP: r=.438, p=.003; and in right MCP: r=-.451, p=.002). Moreover, these effects do not reflect articulatory control, as controlling for the contribution of articulation rate did not change the results (partial correlation in right MCP: r = -0.477, p = 0.001; and in right SCP: r = 0.442, p = 0.003). Finally, no significant associations were found between the CPs and articulation rate, in contrast to previous findings in adults who stutter. Our findings support the involvement of the cerebellum in aspects of speech production that go beyond articulatory control, in neurotypical speakers. Using CSD modeling and probabilistic tracking enabled us to follow the trajectory of the SCP and MCP as they decussate, and to detect novel associations with speech fluency in these pathways. By evaluating multiple measures of speech fluency, our study makes an important contribution to the understanding of the neural basis of speech production in neurotypical adults.

Timing and location of speech errors induced by direct cortical stimulation

Heather Kabakoff[1], Leyao Yu[2], Daniel Friedman[1], Patricia Dugan[1], Werner Doyle[1], Orrin Devinsky[1], Adeen Flinker[1,2]; [1]New York University School of Medicine, [2]New York University School of Engineering

Direct current stimulation (DCS) is routinely performed pre-operatively in order to identify eloquent cortical regions to preserve in neurosurgical patients. While various types of interruption to continued speech can indicate language localization, the most dramatic interruption is speech arrest, where the patient is unable to continue speaking. A majority of reports have identified motor cortex and inferior frontal gyrus (IFG) as most likely to elicit speech arrest, though superior temporal gyrus (STG) also induces speech arrest with high variability (e.g., Chang et al., 2017). While many studies have reported behavioral deficits following stimulation, none have investigated the temporal lag from stimulation of a region to actual speech arrest. The present study is the first to provide a map of the temporal dynamics of speech arrest across cortical regions that are critical to speech and language. We hypothesized that the time it takes from stimulation to speech interruption should vary across cortex. Based on report of activity in IFG preceding activity in motor cortex by approximately 250 milliseconds (Flinker et al., 2015), we predicted that stimulation of IFG would take longer than motor cortex to induce speech arrest because the active motor plans would need to be updated. Furthermore, recent evidence has indicated that stimulation of planum temporale leads to speech arrest, indicating that superior temporal activity could also be necessary for speech production (Forseth et al., 2020). Using continuous extra-operative intracranial EEG monitoring with high spatial and temporal resolution, we employed data collected during clinical direct electrocortical stimulation mapping in 20 patients with refractory epilepsy reciting automatic speech (e.g., numbers, days of week, months of year). From 359 measured speech interruptions that were labeled as speech arrest or as a motor-based interruption by the attending epileptologist, 255 followed stimulation in three broad regions of interest (motor cortex, IFG, STG). Among 78 motor hits, 65 (83%) were in motor cortex while only 7 (9%) were in IFG. The 177 speech arrest hits were more balanced across cortex, with 86 (49%) in STG, 60 (34%) in IFG, and 31 (18%) in motor cortex. We observed robust speech arrest in STG with short latencies, followed by frontal cortex, including IFG and motor cortex (in seconds, STG: mean=0.76, SEM=0.067; IFG: mean=1.17, SEM=0.12; motor cortex: mean=1.11, SEM=0.16). Nonparametric testing for the speech arrest hits revealed that region was a significant predictor of latency ($\chi 2=8.97, df=2, p=0.011$); a post-hoc pairwise test revealed that latencies in STG were significantly shorter than in motor cortex ($p=0.025$). In order to control for epileptiform activity we excluded 63 events with afterdischarges and found that region was still a significant predictor of latency ($\chi 2=8.16, df=2, p=0.017$). Pairwise tests revealed that latencies in motor cortex ($p=0.039$) and in IFG ($p=0.044$) were significantly longer than in STG. These rapid speech arrest events in STG likely indicate that retrieval has been interrupted at the lexical or sublexical level. Alternatively, the inability to continue speaking may also be a result of sudden cessation of auditory feedback, thus interrupting online integration of that feedback into outgoing motor plans.

Slide Session B: Perception

Friday, October 7, 1:30 - 3:00 pm EDT, Regency Ballroom

Chair: Suhail Matar, New York University

When abstract becomes concrete: the neurobiology of naturalistic conceptual processing

Viktor Kewenig[1], Gabriella Vigliocco[1], Jeremy Skipper[1]; [1]University College London

Most of what we know about the neurobiology of conceptual processing comes from experiments presenting individuals with isolated words and asking them to carry out artificial tasks to activate associated concepts. These studies have identified fixed sets of regions for concepts that do not have a physical referent (abstract) and those that do (concrete). Yet, in natural environments we are exposed to a range of dynamic, multimodal contextual information other than speech, like faces, bodies, objects, etc. Behavioral data suggests that conceptual processing is modulated by such context. However, no study has assessed to what extent this is the case for the underlying neurobiological organization. We investigate processing of a large set of words in naturalistic settings with rich context (watching a movie). Brain activity was estimated using a deconvolution, deriving the brain response function rather than assuming its shape. We predicted the following: (1) neural encodings of concepts are based on meaning-related experiential information processed in a set of corresponding brain regions. To address this, we used an automated web-based meta-analysis as well as a reverse correlation ("Peaks and Valleys Analysis"). (2) There are no fixed sets of regions for abstract and concrete concepts. Instead, activation dynamically changes depending on visual context. Specifically, if abstract concepts are highly embedded (e.g. "science" in the setting of a chemistry experiment), they activate concrete-like structures and vice versa. To test this, we added a "contextual embeddedness" regressor to our model, based on semantic similarity (measured with GloVe) between labels of visual objects present (obtained through automated feature extraction) and verbally produced concepts. Group analysis using linear mixed effect models revealed activation for abstract words in anterior cingulate cortex, thalamus, insula, bilateral medial prefrontal areas and anterior temporal lobe (ATL). Results from the meta-analysis and the reverse correlation showed that these regions were correlated with processing valence, interoception and social based information. Concrete words activated motor and premotor areas, right hemisphere prefrontal areas, visual cortex, precuneus, right inferior frontal gyrus and the bilateral superior temporal lobe (STL). These regions were correlated with processing information about body parts and motion. Overlap was found in STL, ATL and visual cortex. Activation in these regions was related to language in general. Results from the second model revealed that contextual embeddedness modulated activity in regions corresponding to the default mode network (DMN). A comparison between abstract and concrete concepts in high vs low context and the brain maps obtained from (1) showed that in low context conditions, the neurobiological organization of concrete concepts resembled more that of abstract concepts and vice versa. Our results indicate that during real-world conceptual processing, habitual experiences are encoded in a set of related brain regions. However, this underlying neurobiological organization is not fixed. Instead, activation depends on the dynamics of situational context. This conclusion emphasizes the need for incorporating experiential information into models of word meaning. It also suggests a new challenge for reaching more human-like representations in computational language processing: understanding and modeling the dynamic influences of multimodal contextual information.

Single neuron encoding of speech across cortical layers of the human superior temporal gyrus

Matthew Leonard[1], Laura Gwilliams[1], Kristin Sellers[1], Jason Chung[1], Barundeb Datta[2], Edward Chang[1]; [1]University of California, San Francisco, [2]imec

Decades of lesion and brain imaging studies have identified the superior temporal gyrus (STG) as a core area for speech perception in the human brain. However, little is known about how single neurons in human STG encode the properties of speech sounds. Here, we used high-density Neuropixels arrays to record neuronal spiking activity from all cortical layers simultaneously. We recorded from a total of 281 single neurons in mid-posterior STG in three participants while they listened to natural spoken sentences. Neurons exhibited multi-peaked spectro-temporal receptive fields, which correspond to acoustic-phonetic and prosodic speech features. Within single recording sites, tuning was heterogeneous and organized by depth, revealing a previously unknown third dimension of speech feature encoding in STG. We compared single neuron speech-evoked responses across cortical layers with electrocorticography (ECoG) recordings from the cortical surface. High-gamma ECoG activity correlated with neuronal firing along the entire depth, reflecting the diversity of tuning profiles across all cortical layers contributing to the surface ECoG potential. Together, these results demonstrate an important axis of encoding in STG, namely heterogeneous tuning of single neurons to speech features across the cortical laminae. *ML & LG contributed equally

Dorsal striatal contributions to speech sound categorization

Kevin Sitek[1], Bharath Chandrasekaran[1]; [1]University of Pittsburgh

Auditory decision making critically depends upon structural connections between superior temporal cortex and dorsal striatum. Auditory corticostriatal connections have been mapped in animal models including non-human primates, where primary auditory cortex preferentially connects to putamen while caudate head receives most of its inputs from anterior superior temporal cortex. However, it is unclear whether human auditory corticostriatal connectivity follows similar organizational principles due to challenges in non-invasively imaging small, deep brain structures. Using a publicly available high-quality, high-resolution diffusion-weighted MRI tractography, we identified structural connectivity streamlines between auditory cortical regions and dorsal striatal regions in a sub-millimeter resolution single-subject in vivo dataset and replicated our findings in a near-millimeter resolution public MRI dataset (n=13 participants). Across the auditory cortical hierarchy, putamen connections were more frequent than caudate connections; only anterior-most superior temporal cortex had meaningful connectivity with caudate, particularly the head of the caudate, and yielded a distinct rightward asymmetry. Finally, we examine the functional relevance of the auditory-putamen connectivity leveraging a well-studied speech categorization task that has yielded robust striatal activation in prior studies conducted at lower resolution (3T). Using ultra-high field 7T MRI, we acquired 1.5 mm isotropic resolution BOLD functional MRI from participants who categorized stimuli on the basis of dynamically varying pitch patterns. 16 stimulus tokens (the monosyllable “di” produced with each of the 4 lexical tones and spoken by 2 male and 2 female talkers) were pseudo randomly presented to participants. After each trial, participants were given minimal feedback (“correct” or “wrong”) based on their previous response. In each participant, we observed robust feedback-based (correct>incorrect) fMRI responses bilaterally in auditory cortex and in dorsal striatum, with the largest striatal clusters in putamen. These putamen clusters are well-aligned with regions that yield robust auditory-corticostriatal structural connectivity, with a rightward asymmetry. Overall, our work demonstrates prioritized connectivity between superior temporal cortex and putamen and is highly suggestive of distinct functional roles for striatal subdivisions in auditory speech categorization.

Decoding semantic relatedness and prediction from EEG: A classification model comparison

Timothy Trammel[1], Natalia Khodayari[2], Steven J. Luck[1], Matthew J. Traxler[1], Tamara Y. Swaab[1]; [1]University of

California, Davis, [2]Johns Hopkins University

While conventional univariate analyses of electroencephalogram (EEG) and event-related potentials (ERP) data continue to provide valuable insights into the neural computations underlying visual word recognition, recent work has shown that multivariate pattern analysis methods using machine-learning classification provide powerful tools to investigate the content of neural computations. Much less is known about the reliability and usefulness of EEG decoding methods to study language processing. EEG decoding studies commonly use classifiers such as support vector machines (SVM), discriminant function analysis (DFA), or random forests (RF), without justification for the classification method chosen. The present study formally compared these models' performance while classifying EEG data from two word-priming studies (visual prediction accuracy priming paradigm and semantic relatedness priming paradigm) to address the following questions: 1) Can SVMs, DFAs, and RFs each classify EEG data according to successful prediction or semantic relatedness? 2) Are there any significant differences between the models when classifying the EEG data? 3) If there are differences, how do the models differ in classification performance? 4) Can classifier performance be replicated across priming paradigms with different tasks? The first study used a predictive priming paradigm (Brothers et al., 2016). Participants (n=45) were presented with a prime word and instructed to actively predict the upcoming target word. The word pairs in each trial were either related (circus – CLOWN) or unrelated (trim – CLOWN). Participants self-reported prediction accuracy. Trials were labeled according to relatedness and prediction accuracy for classification leading to three binary decoding conditions: predicted related vs. unpredicted related, unpredicted related vs. unpredicted unrelated, and predicted related vs. unpredicted unrelated. The second study (n=40) used a relatedness decision task (Kappenman et al., 2021). This paradigm resulted in a single decoding condition: related vs. unrelated word pairs. Decoding analyses were adapted from an SVM-based classification analysis method (Bae & Luck 2018). Decoding was performed over 128 iterations using 10-fold cross-validation to avoid over-fitting and ensure robust decoding performance. The models were compared against chance-level accuracy (50%) and against each other using a cluster-based permutation testing method. Each model was tested using averaged EEG data and using single-trial EEG. For the prediction task, both the prime-locked and target-locked EEG signals were decoded. For the relatedness task, the target-locked EEG signals were decoded. The permutation-based cluster analyses of the models over the time course of the data showed that the SVM significantly outperformed the other classification methods tested: it showed the best EEG classification accuracy in both priming studies and was reliable across the prediction and relatedness tasks: peak decoding accuracy above 90% for the averaged data and above 75% for the single trial data. In future studies, we will use SVM to examine the content of the representations that are pre-activated during language processing.

Slide Session C: Disorders

Saturday, October 8, 10:30 am - 12:00 pm EDT, Regency Ballroom

Chair: William Matchin, University of South Carolina

Effects of transcranial alternating current stimulation on language fluency in post-stroke aphasia: A proof-of-concept study

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Introduction Speech entrainment (SE) facilitates fluent speech production for speakers with nonfluent aphasia1,2. It is hypothesized that nonfluent speech results from a functional disconnection of anterior and posterior cortical regions and that SE may improve coherence between these regions for successful entrainment.3 Transcranial alternating current stimulation (tACS) delivers low, periodically-alternating currents to improve functional connectivity between targeted regions through the amplification and entrainment of endogenous oscillations.4 Previous work suggests that in-phase tACS (alternating current with 0° relative phase difference) improves behavioral performance while anti-phase stimulation (180°) results in impaired behavioral performance due to impeded network synchronization. The purpose of the current study is to determine if tACS improves speech output in an SE task in patients with nonfluent aphasia. Methods 18 patients with chronic, nonfluent poststroke aphasia (mean age = 66 years; months post onset = 89) were enrolled in a double-blind, pseudorandomized study. 1mA of HD-tACS was delivered at 7Hz to residual anterior (IFGpo) and posterior (pMTG) regions of interest in the left hemisphere for 25 minutes across three different stimulation conditions: 1) in-phase; 2) anti-phase; and 3) sham while patients participated in SE. Individualized montages were created for each participant to estimate current flow and account for brain damage secondary to stroke (Soterix Medical, Inc.). Patients' productions were recorded for transcription.5 Results We identified a significant main effect of condition for a secondary outcome measure, the number of different words produced: $\chi2(2) = 5.94$, $p = 0.05$ where patients produced more words in the 'in-phase' condition as compared to 'anti-phase' and 'sham' conditions. Although not statistically significant, the primary behavioral outcome measure (proportion of correct words as compared to the script) and secondary measures such as the number of words per minute demonstrated a higher median for the 'in-phase' condition while number of errors reveals a higher median for the 'anti-phase' condition. Spectral-temporal analysis used mel-frequency cepstral coefficients in a dynamic time warping algorithm to examine the distance between the AV model and patient productions during the task. Results suggest that patients' speech was better aligned (as evidenced by a smaller distance between the model and pt) during the stimulation conditions as compared to sham. Retrospective neurophysiological data suggest that patients who demonstrated better behavioral performance during the 'in-phase' stimulation, had greater preservation of the inferior temporal gyrus ($z = 4.26$) and poorer coherence as measured by rsfMRI and DTI between anterior and posterior regions (e.g. DTI: L insula to middle temporal gyrus; $z = -4.24$ and rsfMRI: inferior frontal gyrus to middle temporal gyrus). Conclusion/Summary Preliminary data suggest that tACS may not only improve speech output in speakers with nonfluent aphasia during a speech entrainment task, but also improve fluency, as evidenced by linguistic data (number of words per minute) and temporal data (mel-frequency cepstral coefficients). Outcomes from this proof-of-concept study encourage future investigations of tACS as an adjuvant for aphasia rehabilitation.

Global Motor Inhibition Precedes the Initiation of Stuttered Speech

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Stuttering is a neurodevelopmental communication disorder that manifests itself, most saliently, as intermittent interruptions in speech. Despite progress towards discovering structural and functional abnormalities in the brains of stutterers compared to fluent speakers (i.e., trait differences), little is known about the neural bases of stuttered speech (i.e., state differences). This is because neuroimaging studies have focused on neural activity associated with fluent speech in stutterers, primarily due to the difficulty of reliably eliciting stuttered speech during laboratory testing. In this study, we simulated a real-life speaking situation in which the speaker knows the word they are about to say (e.g., their own name) and is then given a cue signaling the impending requirement to speak the word. To elicit a balanced number of stuttered and fluent speech, we leveraged a recently introduced clinical interview procedure in which participants identify anticipated words (words perceived as likely to be stuttered). In the motor literature, global motor inhibition is understood as an adaptive response to prevent the execution of motor actions. Global motor inhibition is typically observed as enhanced beta power in response to No-Go signals in regions of the action-stopping network, such as the right pre-supplementary motor area (R-preSMA) and the basal ganglia. It has also been proposed that global motor inhibition impedes the initiation and sequencing of speech motor commands in stuttering. Using magnetoencephalography (MEG), we tested the hypothesis that stuttered speech results from a global motor inhibition response. Twenty-nine adult stutterers participated. There were two experimental sessions: (1) Stuttering assessment and clinical interview following Jackson et al. (2021) to obtain participant-specific anticipated words likely to elicit stuttered speech. (2) MEG procedure during which participants produced 300 words (6 x 50 words, pseudorandomized) from the list constructed during the clinical interview. Words were visually presented, followed by a pre-cue and then a cue to speak. To determine differences in beta power between stuttered and fluent trials, we conducted a time-frequency decomposition separately for each type-trial (stuttered and fluent, equalized in counts). The decomposition was performed for frequencies in the beta band (12-30 Hz), and for times between the pre-cue and the cue to speak. To determine cortical origin, we conducted a power spectral density analysis in source space. Both fluent and stuttered trials showed the expected beta suppression pattern after the presentation of the pre-cue (i.e., when the participant becomes aware of the need to produce the anticipated word). However, stuttered trials were characterized by greater beta power (reduced beta suppression) compared to fluent trials. This power differential in the beta band originated in a single cluster corresponding to the R-preSMA. Results provide evidence that stuttered vs. fluent speech is associated with greater beta power in the R-preSMA, a node of the action-stopping network. This finding is in line with proposals that stuttered speech results from global motor inhibition, which could be the primary cause of stutterers' inability to initiate motor programs hypothesized in models of speech production.

Left posterior temporal cortex is the most critical brain region for recovery from aphasia

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In this cross-sectional study, we investigated neuroplasticity in post-stroke aphasia, making a concerted effort to ameliorate previously identified methodological concerns [1], and using multivariable models to disentangle the effects of structural damage and functional activation on behavior. Participants included 67 individuals with chronic or late sub-acute post-stroke aphasia and 46 neurotypical controls. Language function was measured with the Quick Aphasia Battery [QAB; 2] and varied across individuals with aphasia (QAB overall mean 7.5 ± 2.5 out of 10; range 0.7–9.9). Language regions were mapped using an adaptive semantic matching paradigm [3] that can reliably identify left-hemisphere language regions and minimizes effort confounds; both groups were able to perform the scanner task above chance. Whole brain analyses were corrected for multiple comparisons using permutation testing (voxelwise $p < 0.005$, corrected $p < 0.05$). Region of interest analyses used individually defined ROIs [4] to allow for the precise locations of language regions to differ across individuals. We found that language remained largely lateralized to the left hemisphere in aphasia. A direct comparison between groups revealed reduced activation in people with aphasia in several left-hemisphere language regions and the contralateral cerebellum. In the aphasia group, functional activation was positively correlated with language outcome (QAB overall score) in similar left-hemisphere language regions. Critically, at the whole-brain level, there was no evidence for differential recruitment of the right hemisphere, or correlations between right hemisphere activation and language outcome. We next defined four regions of interest (ROIs) in the bilateral inferior frontal gyrus (IFG) and bilateral posterior superior temporal sulcus (pSTS), and investigated relationships between structural damage, functional activation, and behavior. The greater sensitivity of this approach did reveal a modest association between right pSTS activity and language outcome in a simple correlational analysis ($p = .033$); stronger associations were observed in the left hemisphere regions that emerged from the whole brain analysis. We then used multivariate lesion-symptom mapping to derive a structural predictor of language outcome [5], and asked whether functional activity was associated with language outcome above and beyond expectations based on damage. We found that only in the left pSTS did functional activity remain a significant predictor of language outcome ($p = .006$). The right pSTS and the left IFG were no longer predictive of behavior. In sum, our data suggest that people with aphasia continue to process language in spared left-hemisphere language regions. Our whole-brain findings—that between-group differences are observed in left-hemisphere language regions, and that activation in left-hemisphere language regions is correlated with overall language function—directly mirror the two most compelling findings from our previous meta-analysis [1]. We found no compelling support for differential recruitment of right-hemisphere homotopic regions. Instead, our data provide strong evidence that left posterior temporal cortex remains the most critical neural substrate for recovery of language processing in post-stroke aphasia. References: [1] Wilson & Schneck, Neurobiol Lang 2021;2:22-82. [2] Wilson et al., PLoS One 2018;13(2):e0192773. [3] Wilson et al., Hum Brain Mapp 2018;39:3285-307. [4] Fedorenko et al., J Neurophysiol 2010;104:1177-1194. [5] Levy, Dissertation; 2021.

Premature brain aging is associated with aphasia severity mediated by compromised neural network controllability in the posterior superior temporal gyrus

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Introduction: Aphasia recovery in the chronic stroke stages primarily depends on residual brain regions outside of the lesion. The integrity of the residual brain tissue can be directly measured by the tissue’s brain age, which is a significant predictor of aphasia severity independent of the characteristics of the lesion. We sought to investigate the underlying pathophysiology relating premature brain age (older biological brain age than chronological age) to aphasia severity in a cross-sectional study of 93 individuals with chronic aphasia. We hypothesized that the structural, dynamic embedding of language-specific regions within the remaining network, termed controllability (Gu et al., 2015; Wilmskoetter et al., 2021), mediates the relationship between premature brain age and aphasia severity. Additionally, we sought to validate the relationship between brain age and neural network controllability in an independent cohort of 54 age-matched individuals without a stroke. Methods: For each participant, brain-predicted age was estimated from the structural T1-weighted images using the freely available brainageR (v2.1) pipeline (Cole et al., 2017). We also calculated the brain age gap as the absolute difference between chronological and brain age. Higher (lower) values of the brain age gap reflect older (younger) brain age than chronological age. Further, we calculated modal controllability for a pre-selected set of core brain regions in the left hemisphere that are involved in language processing (Fedorenko et al., 2010). This set of regions spanned from the left frontal to the temporal and parietal areas. For the stroke group, we determined aphasia severity using the Aphasia Quotient of the Western Aphasia Battery (Revised; WAB-AQ) (Kertesz, 2007). Results: Brain age gap predicted WAB-AQ (β=-0.70, p=0.015) independent of chronological age and total lesion volume. Further, we observed a significant direct effect of brain age gap on WAB-AQ (effect=-0.74, standard error (SE)=0.29, 95% confidence interval (CI)=-1.32 to -0.16, p=0.013), as well as a significant indirect effect of brain age gap on WAB-AQ mediated by the modal controllability of the posterior STG (effect=0.13, bootstrapping SE=2.64, 95% CI=-1.19 to -0.04). Specifically, a higher brain age gap was associated with higher modal controllability of the posterior STG, and in turn, higher modal controllability of the posterior STG was associated with lower (worse) WAB-AQ scores. With a multivariable linear regression, we corroborated the significant relationship between the modal controllability of the posterior STG and the brain age gap in the non-stroke group after controlling for chronological age (β=-0.280, 2-tailed p=0.033). Conclusions: The effects of premature brain age on aphasia severity are significantly mediated by the modal controllability of the posterior superior temporal gyrus. Premature brain aging compromises widespread dynamic network mechanisms measured as modal controllability of language regions, in individuals with and without stroke, and predicts aphasia severity in individuals with chronic stroke.

Poster Slam A

Thursday, October 6, 10:00 - 10:15 am EDT, Regency Ballroom

Chair: Michele T. Diaz, The Pennsylvania State University

Poster	Title	First Author	Topic Area
A13	Reduced functional connectivity may drive task-fMRI underactivation within spared language-tissue in chronic post-stroke aphasia	DeMarco, Andrew	Disorders: Acquired
A19	Left superior temporal sulcus lesions reduce semantic access during oral reading	Dyslin, Sara M.	Reading
A21	Merging Research and Education Through an Undergraduate Laboratory Course Involving Aphasia Assessment and Student Projects Using the Lesion Method	Fiez, Julie	Methods
A27	The neurobiology of language mediates alterations in conscious experience induced by psychedelic drugs	Harle, Regan	Multisensory or Sensorimotor Integration
A38	Neuroanatomical and Developmental Contributions to an Understanding of Mind	Koch, Saskia B.J.	Development
A40	Resection of putative “Wernicke’s area” is neither necessary nor sufficient to cause “Wernicke’s aphasia” in a neurosurgical population	Levy, Deborah F.	Disorders: Acquired
A42	Language system contributes to ‘gist’ extraction during code comprehension	Liu, Yun-Fei	Meaning: Combinatorial Semantics
A63	A Coordinated Temporal Interplay within the Language Network: Evidence from TMS-EEG during Sentence Processing	Schroën, Joëlle	Speech Perception
A67	Semantic decoding of continuous language from non-invasive brain recordings	Tang, Jerry	Computational Approaches
A72	Neural correlates of natural speech errors during continuous picture naming	Volfart, Angelique	Language Production

Poster Slam B

Thursday, October 6, 6:15 - 6:30 pm EDT, Regency Ballroom

Chair: Suhail Matar, New York University

Poster	Title	First Author	Topic Area
B19	Interpretability tools reveal what components of NLP models drive similarity to human brain activations in language processing	de Heer Kloots, Marianne	Computational Approaches

B22	Left prefrontal regions mediate the influence of executive functioning on sentence processing in primary progressive aphasia	Gajardo-Vidal, Andrea	Disorders: Acquired
B29	Disentangling semantic and domain-general control networks: the role of stimuli versus task process	Hodgson, Victoria	Control, Selection, and Executive Processes
B31	Changes in Effective Connectivity in the Language and Multiple-Demand Network after Left Temporo-Parietal and Frontal Stroke	Jiang, Zhizhao	Disorders: Acquired
B41	Using fMRI to study language regions in a conversational context	Olson, Halie	Meaning: Discourse and Pragmatics
B54	Concurrent Transcranial Direct Current Stimulation and task-fMRI to Discern Auditory Lexical Decision Processing in Chronic Aphasics	Song, Serena E.	Methods
B55	From Sounds to Words: Evidence for Lexical Representations Distinct from Nonwords	Sorensen, David O	Speech Perception
B57	Assessing Parallel Word Processing in Deaf Readers with an ERP Flanker Paradigm	Terhune-Cotter, Brennan	Signed Language and Gesture
B72	Distinct prefrontal networks for semantic integration and articulatory planning	Yu, Leyao	Language Production

Poster Slam C

Friday, October 7, 10:00 - 10:15 am EDT, Regency Ballroom

Chair: Stephen M. Wilson, Vanderbilt University

Poster	Title	First Author	Topic Area
C13	Familiarity and iconicity impact lexical access in LSE (Spanish Sign Language)	Costello, Brendan	Signed Language and Gesture
C14	Graded Functional Organization in the Left Inferior Frontal Gyrus: Evidence From Task-Free Functional Connectivity And Task-Based Coactivation	Diveica, Veronica	Control, Selection, and Executive Processes
C23	Disentangling the effects of a bilingual fetal acoustic environment on neonatal neural sound encoding	Gorina-Careta, Natàlia	Development
C29	Investigation of the Gradual Increase of Lesion Size in the Chronic Stage of Stroke	Johnson, Lisa	Disorders: Acquired
C31	Moving away from lexicalism in psycho- and neuro-linguistics: A non-lexicalist model of language production	Krauska, Alexandra	Language Production
C34	Prosodic Entrainment Influences Subsequent Sentence Comprehension	Lamekina, Yulia	Speech Perception
C38	Development of Cerebellar Lobule VI, and Its Association With Stuttering Severity in Children Who Stutter	Liu, Yanni	Speech Motor Control

C40	Bilateral temporal involvement in predictive morphological segmentation and processing during spoken word comprehension: MEG evidence from Arabic	Matar, Suhail	Morphology
C47	Tracking lexical access during sentence production	Morgan, Adam	Language Production

Poster Slam D

Friday, October 7, 5:15 - 5:30 pm EDT, Regency Ballroom

Chair: Liina Pylkkänen, New York University

Poster	Title	First Author	Topic Area
D28	EEG-based neural tracking of linguistic speech representations in people with post-stroke aphasia	Kries, Jill	Disorders: Acquired
D33	Real-time feedforward and feedback lateralization in speech motor control	Mantegna, Francesco	Speech Motor Control
D39	A novel and effective language-specific training: The BCI-supported aphasia training	Musso, Mariacristina	Language Therapy
D42	Cognitive control in thematic role assignment: Evidence from neural oscillations	Ness, Tal	Control, Selection, and Executive Processes
D45	Probing the categorical structure of fifty abstract words	Persichetti, Andrew	Meaning: Lexical Semantics
D47	Structural differences in the cortex and subcortex between healthy aging bilinguals and monolinguals from the Human Connectome Project	Polczynska, Monika M.	Multilingualism
D52	Neural representation of prosody	Regev, Tamar I	Prosody
D56	White matter associations with performance on a difficult English spelling task	Sagi, Romi	Writing and Spelling
D57	Prediction of Language and Social Communication Deficits from fMRI Functional Connectivity in a Cross-Diagnostic Developmental Sample	Sanchez-Alonso, Sara	Disorders: Developmental

Poster Slam E

Saturday, October 8, 3:00 - 3:15 pm EDT, Regency Ballroom

Chair: Michele T. Diaz, The Pennsylvania State University

Poster	Title	First Author	Topic Area
E5	Anomalous morphology of the inferior frontal cortex in children with developmental language disorder	Bahar, Nilgoun	Disorders: Developmental

E18	The cortical representation of lexical semantics is shared across English and Chinese	Chen, Catherine	Meaning: Lexical Semantics
E34	Auditory cortex morphology is related to overlaps between phonological inventories of multilinguals' languages	Kepinska, Olga	Multilingualism
E35	Brain Directed Connectivity Analysis Shows Evidence of Auditory Corollary Discharge	Khalilian-Gourtani, Amirhossein	Speech Motor Control
E36	Brain Age Predicts Long-Term Recovery in Post-Stroke Aphasia	Kristinsson, Sigfus	Disorders: Acquired
E45	Intracranial neural dynamics of cognitive control in rapid word recognition.	McCarty, Meredith	Reading
E47	Development of the language network in the brain	Ozernov-Palchik, Ola	Development
E50	Hemispheric asymmetries in the cortical myeloarchitecture parallel the functional lateralization of language	Perrachione, Tyler	History of the Neurobiology of Language

Poster Sessions

Poster Session A	*Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
Poster Session B and Reception	*Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*
Poster Session C	*Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
Poster Session D with Social Hour	*Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*
Poster Session E	*Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Poster A1 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Effects of lexical valence and (in)congruency with affective state in naturalistic reading aloud

Jessica M. Alexander[1], Ana Lopez-Nuñez[1], Brittney M. Rodriguez[1], Anfernee N. Duncombe[1], Sarah B. Malykke[1], George A. Buzzell[1]; [1]Florida International University

Valence describes the positive-negative spectrum of affective mood states as well as the intrinsic appetitiveness (“kitten”) or aversiveness (“puke”) of a stimulus, such as a written word. Both affective and lexical valence have been shown to influence cognitive behavior and neural activity; synergy or conflict between them can impact performance on activities involving natural language, such as reading an emotionally-charged text. Long-standing research into the impact of lexical valence on performance in word recognition tasks has uncovered a distinct processing advantage for positively valenced words over their negative counterparts. This has been understood as evidence for a nuanced model of automatic vigilance whereby the immediate identification of stimuli that threaten or promote survival interacts with a cross-language bias for positive words. Positive words are more frequent in human languages and tend to have greater semantic richness, both of which facilitate lexico-semantic activation, amplify priming effects, and reduce eye fixation times during reading. Electrophysiological data have further corroborated this processing advantage: positive words are associated with neural responses that suggest facilitated semantic integration, enhanced attention, and deeper encoding. Investigations into the inter-relation between an individual's internal affective state with externally-presented lexical valence have found evidence for mood-congruent facilitation effects, which are particularly pronounced in positive mood states. Positive mood has been found to subserve assimilative processes that broaden access to stored semantic structures. Likewise, it has been argued that positive mood states relax inhibitory control and thereby broaden the scope of attentional filters, which facilitates the processing of unexpected or mood-incongruent stimuli. The generalizability of these patterns relating word recognition, lexical valence, and mood state has, however, been hampered by the low ecological validity of existing laboratory tasks. The current study investigated performance on a “real-world” task in which participants read aloud 20 passages, each 140-223 words in length and presented as a unified whole, and responded to simple, multiple-choice comprehension questions. The first half of each passage was designed to be strongly valenced to one extreme (e.g., very positive) with lexical valence making a dramatic switch at the midway point to the opposite extreme (e.g., very negative). Participant mood was assessed by self-report. For a subset of participants, simultaneous EEG is collected during performance of the reading task, and the audio waveform is synchronized with the recorded EEG to allow for event-related neural analyses at the individual word level. Data collection and analyses are currently underway. With a focus on speed, pitch, frequency of errors (such as mispronunciations), and post-error reading behavior, planned analyses will investigate the impact of individual differences in the (in)congruency between mood and lexical valence. Within the subset of participants with simultaneous EEG recording, we will further investigate the impact of the mid-passage switch in the valence of the lexical stimuli. Findings have the potential to shed light on the degree to which (in)congruency of lexical stimuli and mood state impact reading behavior and associated neural responses within a naturalistic setting.

Topic Area: Reading

Poster A2 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Are inter-hemispheric shape asymmetries of white matter tracts related to language lateralization?

Ieva Andrulyte[1], Christophe de Bezenac[1], Simon S. Keller[1]; [1]University of Liverpool

Introduction: Interhemispheric anatomical asymmetries are thought to be related to language lateralization. White matter (WM) tracts provide the basis for neural communication between cortical regions important for language. There have been some studies that have examined whether interhemispheric asymmetries of fundamental diffusion scalar metrics of WM tracts known to be important for language are consistent with the side of language lateralization in healthy and brain damaged populations, with inconsistent results. In the present study, we examined whether asymmetric morphometric features of WM tracts are related to the side of language lateralization in a large cohort of healthy individuals. Methods: We studied 1040 healthy young (22-35 years) adult subjects from the Human Connectome Project (HCP), an open-access data initiative, which offers high quality anatomical and functional neuroimaging in the healthy human brain using magnetic resonance imaging (MRI), behavioural, and demographic data. Participants underwent both functional and diffusion magnetic resonance imaging. The language comprehension task used in Human Connectome Project was designed by Binder and colleagues (2011), which consists of two runs each consisting of four blocks of a story task alternating with four blocks of a math task, with a matched length and difficulty. A laterality index (LI) was calculated to determine hemispheric language lateralization for each subject's fMRI. The language tracts, such as a superior longitudinal fasciculus and corpus callosum were reconstructed in MNI space using q-space diffeomorphic reconstruction to obtain the spin distribution function (Yeh et al, 2010). Then, shape measures of bundles (length, span, curl, elongation, diameter, volume, and surface area) were extracted. The motivation for doing tract geometry analyses came from the recent study (Yeh, 2020) that showed geometrical laterality differences in the arcuate fasciculus. An asymmetry index (AI) for all shape descriptors was calculated to determine structural asymmetries of all WM tracts. A linear regression analysis was performed to assess the relationship between functional LI and structural AIs. Results: Based on the laterality index of the fMRI language task, 978 participants were classed as left-hemisphere dominant (93%), 60 as bilateral (6%), and the remaining 11 as right-hemisphere dominant (1%). fMRI analysis revealed asymmetric activation in core language areas, including the inferior frontal gyrus, superior temporal gyrus, angular gyrus, posterior cingulate cortex, and lateral prefrontal cortex. No evidence was found for associations between LI and the AI of each shape metric for all white matter tracts analysed. Discussion: Our results indicate that interhemispheric shape asymmetries of white matter fibre tracts are not related to the lateralization of language comprehension functions. On the one hand, this is consistent with other studies that indicate no relationship between language lateralization and interhemispheric asymmetries of white matter (Ocklenburg et al, 2016) and grey matter (Keller et al, 2010) structure, suggesting that the lateralization of language functions may not have a gross morphological basis.

Topic Area: Language Production

Poster A3 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Why is speech rate slow in nonfluent/agrammatic primary progressive aphasia?

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BACKGROUND: The diagnostic criteria for nonfluent/agrammatic primary progressive aphasia (naPPA) include "effortful, halting speech..." but the features that constitute such speech are not specified. It is well known that individuals with naPPA pause more while speaking than healthy individuals do, but other durational characteristics of naPPA speech are less well characterized. In this study, we examined durational features of individual words as well as pauses in connected speech to contribute to the understanding of slowed speech rate in naPPA. METHODS: We analyzed spontaneous, connected speech elicited by descriptions of the Cookie Theft scene in individuals with naPPA (N=30), behavioral variant frontotemporal degeneration (bvFTD) (N=22) as a brain-damaged control group, and healthy controls (HC) (n=16), matched for age, education, and sex. The two patient groups were also matched for disease duration. We automatically measured the durations of all words and pauses between words. We compared the durations of identical words spoken by the participants and the frequency and durations of pauses ≥ 150 msec occurring between words within independent clauses and their associated dependent clauses. Words were sorted by part of speech to investigate the possible effect of grammatical category on variation in word duration. RESULTS: The mean (±SD) speech rates in words per minute of individuals with naPPA, bvFTD, and HC were 61±27, 94±40, and 143±33, respectively. naPPA patients were significantly slower than both bvFTD and HC (p<.01), and bvFTD patients were slower than HC (p<.01). The durations of identical words in naPPA compared to both bvFTD and HC were significantly greater for all nouns (N=29, e.g., cookie), verbs (N=32, e.g., see), pronouns (N=15, e.g., she), determiners (N=9, e.g., the), and prepositions (N=17, e.g., of) (p<.01 for all comparisons). For adverbs (N=10, e.g., very), the duration for naPPA vs. bvFTD and HC was also significantly greater (p<.05). For the few identical adjectives (N=2, e.g., open) and conjunctions (N=4, e.g., and) that could be compared among the 3 participant groups, naPPA showed the longest durations but the differences between naPPA and the other groups were not significant. There were no significant differences in word duration between bvFTD and HC for any of the words that could be compared among groups. The mean duration of pauses between words was greatest for bvFTD (1307±1469 msec) but was not significantly different from the mean duration of pauses in naPPA (894±402 msec) or HC (697±266 msec). The mean frequency of pauses between words in naPPA was 36.3±17.8 per 100 words, compared to 12.6±6.3 per 100 words in bvFTD and 9.3±4.1 in HC. This frequency of pauses between words in naPPA was significantly greater than that in both bvFTD and HC (p<.01). CONCLUSIONS: Speech rate in naPPA is slowed by overall lengthening of the duration of words, which occurs regardless of grammatical category. The lengthening of word duration is unique to naPPA, in contrast to bvFTD and HC. In addition, naPPA speech is slowed by a higher frequency of pauses between words compared to other groups, but not by a greater duration of pauses.

Topic Area: Language Production

Poster A4 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Crime Scene Investigation in the MRI scanner: Putting language and autism in context

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Everyday communication seems easy and effortless, but in fact requires inferences operating over multiple timescales and modalities. For instance, to interpret an utterance we often need to consider what has been said a second ago or on yesterday's news, as well as check the presence of any co-occurring gestures or facial expressions. These context-dependent inferences might hold the key to understanding the difficulties individuals with Autism Spectrum Conditions (ASC) encounter in everyday social interactions (Wadge et al., 2019). However, research has largely focused on how people process carefully dissected experimental stimuli instead. Here we used combined fMRI/pupillometry to examine how people disambiguate utterances embedded within an unfolding communicative context, and whether and how such contextual inferences are altered in autistic individuals. Our approach is inspired by Crime Scene Investigation (CSI) and involves the dynamic analysis of unfolding chats between two potential criminals. Fifty adults with ASC and forty-two controls participated in this study, and read a total of 60 chat dialogs. In each dialog, their task was to judge whether the chat was sufficiently suspicious to be reported to the FBI or not. Importantly, half of the dialogs used ambiguous slang, such as "candy" for "drugs". Understanding the context-specific use of these expressions necessitated inferences based on other information conveyed in the chat, such as information inconsistent with the literal reading of the slang word (mentioning "police" in a dialog about sweets). To isolate contextual inferences and control for linguistic properties of the items in each dialog, the implied meaning of the slang expressions was revealed beforehand in the other half of the dialogs. Presentation of these 'Unknown' and 'Known' dialogs was counterbalanced across participants. We focused analysis on sentences where information inconsistent with the unfolding communicative context was first mentioned and needed to be resolved. Pupil dynamics revealed an increase in pupil size time-locked to these critical sentences in Unknown relative to Known dialogs in both groups, a physiological validation of task efficacy. Preliminary fMRI findings revealed an interaction between dialog type (Known, Unknown) and group (ASC, controls): Activity in the left and right inferior frontal gyrus/frontal operculum, left fusiform, and inferior temporal gyrus showed similar responses across Known and Unknown dialogs in controls, and a weaker response in ASC participants when processing Known dialogs. These findings suggest that neurotypicals integrate semantic/pragmatic cues in the unfolding communicative context differently than participants with ASC. While both groups show physiological and fMRI markers of contextual integration when unexpected semantic/pragmatic cues are encountered during a dialog, participants with ASC do not routinely implement that contextual integration when a cue's given meaning suffices. More generally, this study illustrates a novel naturalistic yet quantitative approach to capture and identify (altered) mechanisms of contextual integration evoked by utterances embedded within an unfolding communicative context.

Topic Area: Meaning: Discourse and Pragmatics

Poster A5 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Is the rTPJ necessary for processing indirectness and/or change of communicative function? A TMS study

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In communication, information can be conveyed indirectly. For instance, when asked by A "Are you bringing your cat to the vet?" a person B could reply "It got hurt jumping down the table". The reply would then implicate that, the cat is being brought to the vet (indirect speech acts, ISAs). In order to understand implicated messages, the listener needs to infer mental states or beliefs of the speaker, as well as assumptions shared between A and B (Common Ground or Theory of Mind, ToM). In particular, when B replies "It got hurt jumping down the table", both A and B would typically assume that getting hurt jumping down a table can motivate a vet visit, and they would even assume that the respective other makes this assumption too. Several neuroimaging studies indicate that those cortical areas active during non-language ToM processing – most notably the right temporo-parietal junction, rTPJ (Schurz et al., 2022) – also become active when indirect speech acts are being understood (Basnakova et al., 2014; 2015; Feng et al., 2017; 2021), which is open to the interpretation that high ToM processing load is a critical feature of indirectness. However, previous studies compared conditions in which indirectness was not the only feature distinguishing between the critical indirect speech act condition and the direct control. Instead, indirectness was accompanied by a change in speech act function. Therefore, it is not clear whether the rTPJ is relevant for indirectness processing per se or rather for the processing of changes in communicative function, or possibly both. In the present study, we disrupt activity in the rTPJ during ISAs understanding and asses the effects on the comprehension of ISAs with and without co-occurring communicative function change. We either altered activation in the ToM-relevant rTPJ by applying repetitive transcranial magnetic stimulation (TMS condition) or applied sham (placebo) stimulation. We find that, in absence of TMS stimulation, both types of indirect replies are understood more slowly compared to matched controls. Crucially, TMS to the rTPJ differently affected the two types of ISAs. Under the effect of TMS, RTs delays between ISAs and their matched direct controls remained unaltered when both speech acts conveyed the communicative function (assertion). However, the response time difference between direct and indirect speech acts was reduced by TMS when these speech acts also differed in their communicative function (assertion vs acceptance/refusal of an offer). As no TMS effect was found in the speech-act matched condition, our results are inconsistent with a causal role of rTPJ in

the processing of indirectness per se. However, they support the role of this region in processing the communicative function change that co-occured with indirectness in most previous experimental studies. The rTPJ might possibly be necessary for assessing common ground or for processing the speakers' mental states to determine the correct or re-process the communicative function of an the utterance. Our findings suggest that TMS to rTPJ affected processing communicative function and related common ground, rather than indirectness.

Topic Area: Meaning: Discourse and Pragmatics

Poster A6 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Segretation vs. Integration of language and inhibition in the inferior frontal cortex

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INTRODUCTION: One of the oldest findings in human neuroscience is that the brain control of some cognitive functions is lateralized, that is, they are mainly processed in one of the two cerebral hemispheres. Atypical functional lateralization has been considered a risk factor toward some neurodevelopmental disorders such as schizophrenia or dyslexia, and recent studies have hinted at lower cognitive capacities in some atypical individuals. However, the specific mechanisms behind these relationships are still unclear. Here, we will test the hypothesis that a weak hemispheric distribution of functions is the relevant factor to understand this cognitive dampening, via increasing the interhemispheric transfer. We will focus on the hemispheric specialization present in the inferior frontal cortex (IFC), defined by language production in the left hemisphere and inhibitory control in the right hemisphere. METHOD: We preselected 86 left-handed individuals following an fMRI assessment of their language production (verb generation task) and inhibitory control (stop-signal task). Participants were divided into functionally segregated (n=38) and functionally integrated (n=48). Segregation was defined as having both language and inhibition clearly separated in different hemispheres, whether typically (left language and right inhibition) or atypically (left inhibition and right language). The integrated group comprised individuals that did not show strong hemispheric specialization in at least one of the two functions (Laterality Index ranging from +40 to –40). We compared these two groups in their cognitive performance during response inhibition (reaction time, RT; and stop-signal reaction time, SSRT) and word/pseudoword reading (speed and accuracy), as well as in their preclinical schizotypal traits via the Schizotypal Personality Questionnaire (SPQ). Additionally, we tested if differences existed in their interhemispheric connectivity between both frontal lobes, functionally (resting-state fMRI) and structurally (voxel-based morphometry). RESULTS: The integrated individuals presented a higher SSRT (t83=1.73; one-tailed P=0.04) during the stop-signal task, indicating an inhibition processing 20 msec slower. No differences were found in the RT. When testing their reading skills, although no differences were found in speed, the segregated group presented a higher accuracy (F=9.69; P=0.003) when reading long unfamiliar words. The integrated group scored higher in the SPQ scale (t81=2.03; one-tailed P=0.02). We confirmed that the integrated group presented a higher interhemispheric functional coupling in the pars triangularis of the IFC (t76=2.02; one-tailed P=0.02), and a larger genu volume (t82=1.71; one-tailed P=0.04) than the segregated group. CONCLUSION: We have presented evidence that left-handers lacking hemispheric specialization in either function of the IFC (i.e. integrated distribution) are: (1) less cognitively efficient, (2) more predisposed to certain neurodevelopmental disorders, and (3) more connected interhemispherically. In basis of these results, we propose that hemispheric specialization enables parallel processing of separate cognitive functions and decreases the time delay associated to interhemispheric traffic, acting as a mechanism behind the differences in cognitive performance. Crucially, these connectivity differences would also fit our current knowledge about the typical ontogenesis of the language network, defined by a shift from inter- to intrahemispheric connectivity. In conclusion, our data supports the notion that hemispheric specialization may be phylogenetically and ontogenetically facilitated for a higher cognitive efficiency.

Topic Area: Control, Selection, and Executive Processes

Poster A7 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Retrieval precedes evaluation: An MEG study on implausible gaps in English

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[INTRODUCTION] Language comprehension is predictive. Brain recordings differentiate predicted words vs. unpredicted words resulting in semantic anomalies <400ms, e.g., I like my coffee with sugar and *socks*. However, results are mixed when the semantic anomaly arises from an implausible thematic relation, e.g., 'meal' as agent of 'devoured' in 'the hearty meal *devoured*…', suggesting this information is not integrated into verb predictions. Some results suggest detection of thematic relation anomalies are delayed (>600ms), but others show early responses in sentences with filler-gap dependencies (e.g., 'city/book' in 'which city/book did you *write*'). We conducted a magnetoencephalography (MEG) experiment to compare neural responses to thematic relation anomalies in sentences with filler-gap dependencies and sentences without. We found that left anterior temporal lobe (LATL) activity responds to implausible thematic relations ~700ms post verb-onset for sentences without filler-gap dependencies, and ~1000ms for sentences with. Left inferior frontal gyrus (LIFG) activity showed sensitivity to filler-gap dependencies ~700ms post verb-onset. This pattern fits the hypothesis that detecting implausible filler-gap dependencies is delayed because the filler must be retrieved from short-term memory before its meaning can be evaluated. [METHODS] MEG activity from 30 English-speaking adults was recorded in a 2×3 within-subjects design of Question Type (Wh-Subject, Wh-Object, Yes/No) and Plausibility (Plausible, Implausible). In Wh-Object and Wh-Subject sentences, there was a filler-gap dependency. In Plausible sentences, the verb's thematic roles assigned to the filler or subject were plausible, and implausible for Implausible sentences. Sentences (49 sets) were displayed in randomized order, word-by-word, with each word displayed 300ms on/300ms off. After each sentence, participants registered one of two responses or "N/A" for uninterpretable stimuli. Wh-Object, {Plausible/Implausible} Which {sandwiches/forks} do hungry kids *eat voraciously*? Wh-Subject, {Plausible/Implausible} Which {kids/forks} in the kitchen *eat voraciously*? Yes/No, {Plausible/Implausible} Do you think that {kid/forks} *eat voraciously*? [RESULTS] We conducted a two-stage regression analysis, regressing on experimental factors and nuisance variables, then conducting cluster-based permutation tests on the coefficients. Analyses were conducted in 4 time windows (300-500ms, 600-800ms, 800-1000ms, and 1000-1200ms post verb-onset, 'eat') in LIFG and bilateral frontotemporal regions. [QUESTION TYPE] There was a cluster showing an effect of Question Type in LIFG ~700ms, in which Wh-Object and Wh-Subject diverged from Yes/No ($p = 0.047$). We propose this LIFG activity reflects retrieval of the filler phrase from short-term memory. [PLAUSIBILITY] There was a cluster showing an effect of Plausibility in LATL ~700ms ($p < 0.01$), although pairwise comparisons show that this effect is driven by greater activation in Yes/No, Implausible sentences compared to Yes/No, Plausible sentences ($p < 0.0001$). A later cluster showed an interaction of Question Type x Plausibility in LATL ~1000ms ($p < 0.01$). This cluster shows a trend of greater activation for Implausible sentences over Plausible, with a polarity reversal for Wh-Subject conditions (all ps < 0.1). [CONCLUSION] Language processing is predictive, but thematic role information may not be integrated into verb predictions. We show that detecting thematic role anomalies is delayed generally (>600ms), but specifically for filler-gap dependencies (>1000ms), likely due to the need to retrieve the filler from short-term memory.

Topic Area: Syntax

Poster A8 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Semantic processing requires communication between semantic and domain general systems

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How do brain networks coordinate to process meaning? Neuroimaging studies have provided evidence for a distributed contribution of semantic areas, but the interaction of specialized areas for semantic processing with the rest of the brain is less clear. Some research has begun to illuminate these interactions1, but limitations in scope have caused evidence to be accumulated for interactions of only a few semantic regions. Other studies suggest that domain general networks such as the multiple demand network (MDN) are recruited even for basic semantic processing2, but it remains unclear which networks are important and under which conditions they are recruited. The current study explored how semantic networks interact with domain general networks during semantic processing. Interactions between semantic and domain general networks were investigated with correlational psychophysiological interaction analyses (cPPI). Forty-one participants performed two semantic tasks and a baseline task during fMRI. In the semantic tasks, participants decided whether two simultaneously presented pictures were related to each other; in the baseline task, participants performed visual judgments on scrambled images. Ttask-related data were submitted to an independent components analysis (ICA). Non-noise components were compared with network templates for the semantic system,2 MDN,3 and the 17-network map of Yeo et al.4 using the Jaccard similarity index. Eight components with highest similarity to semantic and domain-general networks were submitted to a cPPI, which derived a partial correlation between components for each pair of regions and each task condition. We then used linear mixed models to determine which components showed different functional coupling during semantic tasks compared to the baseline task, using Bonferroni correction to assess significance across the 28 comparisons. Results showed that our primary semantic component increased functional coupling with MDN and dorsal attention components during semantic processing compared to baseline. Furthermore, MDN and dorsal attention components increased functional coupling with components overlapping the default mode network (DMN). Interestingly, semantic-DMN component pairs and DMN-DMN component pairs showed stronger functional coupling during baseline than semantic tasks. Our results provide evidence that communication between semantic and domain general networks is necessary for semantic processing. Such coupling may be necessary for retrieval and comparison of semantic representations. Domain-general networks showed similar patterns of coupling with semantic and DMN components, consistent with theories suggesting that the DMN has an explicit role in declarative —perhaps specifically semantic—memory.5-6 The observed stronger coupling between semantic and DMN components during non-semantic processing is surprising. This result may suggest that the particular networks have partially distinct functions—and thus less functional coupling—during controlled semantic processing, whereas during non-semantic processing, the regions have more similar functions and are thus more strongly functionally coupled.
References: 1 Palacio N. & Cardenas F. (2019). Rev Neurosci 30(8): 889-902. 2 Jackson R.L. (2021). NeuroImage 224: 117444. 3 Fedorenko E. et al. (2013). Proc Natl Acad Sci USA 110(41): 16616-21. 4 Yeo B.T. et al. (2011). J Neurophysiol 106: 1125-1165. 5 Stark C.E. & Squire L.R. (2001). Proc Natl Acad Sci USA 98(22): 12760-6. 6 Spreng R.N. et al. (2009). J Cogn Neurosci 21(3): 489-510.

Topic Area: Meaning: Lexical Semantics

Poster A9 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Phasic norepinephrine release during sentence comprehension? Influence of transcutaneous auricular vagus nerve stimulation on the P600

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The P600 event-related component is elicited by a wide range of anomalies in the linguistic input, such as structural violations, ambiguities, and semantically deviant words. The component is traditionally interpreted as a signal of specific linguistic combinatorial operations and continues to inform neurocognitive models of language comprehension (e.g., Kuperberg, 2021, Top. Cogn. Sci.). However, the P600 – just like the earlier domain-general P3 – has alternatively been proposed to signal phasic norepinephrine (NE) release from the locus coeruleus (LC) to salient and relevant stimuli more generally (e.g., Bornkessel-Schlesewsky & Schlesewsky, 2019, Front. Psychol.). Indeed, the

P600 mirrors the LC/NE phasic response in that its latency is response-aligned (Sassenhagen & Bornkessel-Schlesewsky, 2015, Cortex) and its amplitude covaries with pupil size (Contier et al., in prep). To complement this correlational evidence, we plan to further test the link between the P600 and NE release by applying non-invasive auricular transcutaneous vagus nerve stimulation (taVNS; Farmer et al., 2021, Front. Hum. Neurosci.), which likely affects activation of the LC/NE system. 40 Participants will come to the lab for two experimental sessions, one for each stimulation condition (order counterbalanced). In both sessions, participants will perform a sentence processing task, in which they read sentences word by word with either morphosyntactic violations, semantic violations, or correct control sentences. During the entire task, they will receive either continuous stimulation at the cymba conchae (an area exclusively innervated by the auricular branch of the vagus nerve, experimental condition) or the ear lobe (sham condition). If the P600 is linked to NE release from the LC, its amplitude should be larger under vagus than sham stimulation. Additionally, we will administer a non-linguistic oddball task in both sessions with the same stimulation manipulation in order to replicate the effect of taVNS on the P3 (Ventura-Bort et al., 2018, Front. Hum. Neurosci.). Finally, to test the specificity of the effects, we will test whether the stimulation also has an effect on the N400 in the semantically violated sentences. As a manipulation check, we will additionally assess two putative biomarkers of NE: salivary alpha-amylase levels and baseline pupil size. The study has been preregistered on OSF, data collection is ready to start, and we expect to present preliminary results at the 2022 SNL meeting. The results of this study will contribute to our understanding of the neurobiological basis of the P600 ERP component. An effect of taVNS on the P600 and P3 amplitude would further support the idea that both ERP components might rely on a shared neural generator and, more specifically, that they may both be linked to phasic NE release.

Topic Area: Control, Selection, and Executive Processes

Poster A10 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

How Aging Shapes Semantic Memory: Exploring the Relationships between Language Abilities, Network Construction, and Word Characteristics on Semantic Network Structure in Younger and Older Adults

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Healthy aging is associated with declines across a variety of cognitive domains, including memory, processing speed, executive functioning, and language production ability (Burke & Shafto, 2004, 2008; Salthouse, 2010). Life experiences and conceptual knowledge, however, tend to increase with age (Park et al., 2002). While some researchers claim that age-enriched semantic information leads to greater interference, other research shows that vocabulary measures are positively associated with increased naming and verbal fluency production, suggesting that vocabulary knowledge supports production (Kavé _& Halamish, 2015; Shafto et al., 2017). Regardless of the effect that this extra information has on aging, individuals continuously acquire and retain new words, concepts, and ideas that need representation in the semantic system. Computationally modeled networks allow us to analyze the interactions between a large sample of semantic information (Siew et al., 2019). These semantic networks have been utilized across various research areas – creativity, language acquisition, aphasia patients, and healthy aging. Previous work focused on semantic networks and aging have found that with increased age, semantic memory becomes less efficient, less organized, and sparsely connected (Cosgrove et al., 2021; Dubossarsky et al., 2017; Wulff et al., 2018, 2019). While these early studies contributed seminal knowledge about the effect of age on semantic network structure, they focused on group-level differences and only considered a limited sample of words. It still remains unclear if language production abilities are influenced by differences in individual network properties, local structural characteristics, or linguistic features of the word (i.e., concreteness). These questions remain especially pertinent for aging populations where differences in environment, life experiences, and cognitive abilities are more variable across the cohort (Wulff et al., 2019). This proposed project will provide evidence regarding the extent to which the organization of an individual's ample semantic system influences their language communication abilities. In addition, no studies have yet compared the structural property differences between abstract and concrete concepts in semantic memory and how this relates to the efficient processing of information through the network (Kenett et al., 2021). However, both abstract and concrete concepts make up one's mental lexicon and therefore contribute to the semantic network. Moreover, studying differences between abstract and concrete words remain critical to examine the effects of context on network organization (Crutch et al., 2009). For example, abstract words generally require more effortful retrieval from semantic memory, yet older adults have been shown to have a heavier reliance on semantic knowledge and context when completing semantic selection tasks (Hoffman, 2018). Therefore, we might expect that abstract words are not as well connected in semantic memory, making them less resistant to age-related decline. Finding evidence of this relationship between abstract and concrete words in semantic memory could shed new light on the successful processing and retrieval for a broader set of words in the aging lexicon.

Topic Area: Meaning: Combinatorial Semantics

Poster A11 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Conceptual Combination in Non-Local Dependencies

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Language enables us to compose meaning from words regardless of whether the words are directly adjacent. In both the phrase 'blue hat' and 'the blue color of that hat', the words 'blue' and 'hat' compose to form a complex conceptual representation. We know that the left anterior temporal lobe (LATL) is sensitive to conceptual combination. But we do not know whether this sensitivity extends to long-distance instances of conceptual combination, that is, cases in which the two composing elements are not adjacent. Here, we addressed this by varying the locality of conceptual combination during an MEG measurement. Parrish & Pylkkänen (2022) showed that LATL composition does not require an accompanying syntactic merge, as long as the elements conceptually combine. But in that study, the combining elements were still adjacent. Here, we break that adjacency to further examine the independence of the LATL from syntax. Further, we use a decoding approach to measure the activation of lexical representations during composition, in particular, the activation of the first element (e.g., blue) during the presentation of the second element (e.g., hat) in both long-distance and local contexts. Our aim is to understand the format of lexical representations that serves as input to composition. [METHODS] So far, data from 12 participants have been collected. They read English sentences via RSVP in a picture-verification task during a magnetoencephalography recording. This study uses a 2x2x2 design of locality (local, non-local) by conceptual combination (combinatory, non-combinatory) by word order (noun-adjective, adjective-noun). The combinatory comparison varies whether the target word conceptually composes with an earlier adjective/noun: COMBINATORY: 'the hat is a really pretty *blue* color' / 'the blue color of this *hat* is pretty'; NON-COMBINATORY: 'the hat is near a pretty *blue* lamp' / 'the blue lamp near this *hat* is pretty'. [RESULTS] ~ROI analyses~ Using a cluster permutation test within pre-determined ROIs, we observe a marginally significant increase in activation for combinatory stimuli relative to non-combinatory stimuli in the adjective-noun order condition (but not noun-adjective order) in the LATL, measured on the target noun. This effect was present in both the long-distance stimuli and local controls, with no interaction of these factors, consistent with an account of a conceptual combination mechanism that is sensitive to conceptual compatibility but not to linear adjacency. ~Decoding analyses~ Our decoding analysis reveals greater decoding accuracy of the preceding adjective on the noun that it composes with in local combinatory contexts compared to non-combinatory contexts. However, we observe no difference between conditions in non-local contexts or noun-adjective word order. [CONCLUSION] By separating two conceptually composing words with intervening material, we show that the mechanism behind LATL conceptual combination tracks conceptual compatibility without regard to linear adjacency. Via our decoding analysis, we are also able to show activation of the context word while it combines with the currently presented word, but this

was only observed for local composition, suggesting a different format of lexical representations for local and non-local conceptual combination.

Topic Area: Meaning: Combinatorial Semantics

Poster A12 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Assessing the effect of bilingualism on the left frontal cortex connectivity in the CIMAQ cohort.

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Over the years, studies have shown that bilingualism provides an advantage in cognitive performance, more so in aging individuals. By frequently practicing the language control mechanism, bilinguals tend to be faster and more accurate in tasks of attention, working memory, and cognitive control. The bilingual advantage is also evident in the structural and functional differences in the regions related to bilingual language control. The aim of the current study is to examine the effect of multilingualism on the resting-state functional connectivity (rsFC) for the left frontal cortex (LFC) as a region of interest. Thus, explore the role of bilingualism in building cognitive reserve through the higher LFC connectivity. These bilingualism-related connectivity differences may help build a cognitive reserve that eventually renders the bilingual brain more resistant to age-related cognitive decline. We computed rsFC for the LFC seed and performed seed-based connectivity and graph analysis while comparing group differences for the monolingual and multilingual participants with age, diagnosis, and gender as covariables. Seed-based connectivity results show higher strength of functional connectivity between LFC, and right planum temporale and central opercular cortex for the multilingual group compared to the monolingual group. These regions are part of the primary auditory cortex and are also related to stimulus-driven auditory attention and phonological processing. For the graph analysis, the multilingual group showed greater local efficiency than the monolingual group at the cost of 0.45. Contrary to our expectations, we did not find global connectivity differences between the groups. The present results suggest that lifelong juggling with two or more languages may impact the brain at a network level, in this case, LFC connectivity. In the future, however, decomposing cognition and measures of bilingualism into its elementary constituents may allow an in-depth understanding of the mechanisms by which bilingualism may contribute to cognitive and neural advantages.

Topic Area: Multilingualism

Poster A13 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Reduced functional connectivity may drive task-fMRI underactivation within spared language-tissue in chronic post-stroke aphasia

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A consistent finding in post-stroke aphasia is that spared language regions exhibit underactivation during language processing. When measured reliably, degree of underactivation contributes to the severity of behavioral aphasic impairment, even independent of lesion size. Moreover, resolution of task-related underactivation contributes to early post-stroke aphasia recovery. Therefore, a mechanistic understanding of processes driving underactivating language nodes (ULNs) could enrich our understanding of network dynamics in post-stroke aphasia and help explain

aphasic deficits beyond lesion characteristics. Measures of connectivity index the relationship between brain regions, making it a natural candidate for understanding how brain regions might manifest functional changes even when spared by a lesion. Thus, the aim of this project was to identify how reduced connectivity or disconnection might drive underactivation in spared tissue. We tested two main hypotheses, namely that reduced activation in ULNs would correlate: 1) with reduced connectivity within those same ULNs, and 2) with reduced connectivity between ULNs and normally-activating language nodes. A neurotypical cohort (N=66) and a cohort of people with aphasia (PWA) and chronic stroke (N=51) underwent a structural scan, an adaptive semantic decision fMRI task and a movie-viewing resting scan. Lesioned tissue was manually traced and excluded from analyses. We first constructed a language-network parcellation by intersecting a mask of regions activated by the neurotypical group with an anatomical atlas to break up large clusters. We then determined whether each resulting node classifies as a ULN, based on a 2-sample t-test comparing PWAs to neurotypical activation for that node. We then computed functional connectivity between all nodes. Finally, to assay how connectivity might drive underactivation, in the patient cohort, we correlated average activation in ULNs with average functional connectivity both 1) between ULNs, and 2) between ULNs and the rest of the network. The language-network parcellation consisted of 35 nodes, encompassing left temporal and frontal lobes, less-extensive right-hemisphere homotopes, and right cerebellum. Patients exhibited underactivation in 10 nodes ($P < .01$, unc.), including left mid- and anterior temporal lobe, angular gyrus, retrosplenial cortex, medial prefrontal and bilateral medial temporal lobes, and right cerebellum. Average activation in the ULNs correlated significantly with aphasia quotient, even controlling for lesion volume ($r=.42$, $P=.002$). Average activation in ULNs was significantly correlated with average functional connectivity ($r=.38$, $P=.007$) between the 10 ULNs, and this relationship remained after controlling for lesion volume ($r=.37$, $P=.009$). Similarly, average activation in ULNs was significantly correlated with average functional connectivity ($r=.45$, $P=.001$) between the ULNs and the spared language network, and the relationship remained after controlling for lesion volume ($r=.46$, $P<.001$). We found evidence that reduced functional connectivity within the language network may play a role in underactivation within spared tissue, which is associated with worse aphasic symptoms. These results suggest that underactivation may relate to network effects caused by the lesion. Next steps include considering how structural disconnection may influence underactivation, fractionating the underactivating nodes into subnetworks, and understanding how these connectivity changes may involve canonical brain networks.

Topic Area: Disorders: Acquired

Poster A14 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Lesion site predictors of syntactic deficits in aphasia

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Introduction: Syntactic problems in aphasia are multidimensional, yet syntactic abilities do not dissociate well along the major aphasia types (Den Ouden et al., 2019). In the present study, we leveraged the largest sample of stroke survivors with aphasia reported to date who were tested with the Northwestern Assessment of Verbs and Sentences (NAVS; Cho-Reyes & Thompson, 2012). In addition, participants' spontaneous speech samples were rated on a scale for presence and severity of morphosyntactic and phrase-structure production deficits. We then investigated lesion predictors of relative impairments in these subcomponents: syntactic comprehension, complex-sentence production, verb-argument-structure production, phrase-structure production, and morphosyntactic production. Methods: 112 Left-hemisphere stroke survivors with aphasia in the chronic stage (>6 months post stroke) participated in several studies from which these data were leveraged (39.3% female; Mean age 60.4, sd 10.7; Mean WAB-R AQ 64.0, sd 22.3). All participants were tested with the following NAVS subtests: the Argument Structure Production Test "A" score (ASPT-A), the Sentence Production Priming Test (SPPT), and the Sentence Comprehension Test (SCT). For a subset of participants (30%), investigators blindly rated discourse production for the presence and severity of morphosyntactic simplifications (deletion of inflections and function words) and the presence and severity of sentence simplifications (short sentences, absence of embeddings and noncanonical structures), each on a scale from 0-10 (see Matchin et al., 2020). All underwent neuroimaging (Siemens 3T MRI), collecting T1-Weighted images. Lesions were manually drawn based on visual examination of structural images. Voxel-based univariate lesion-symptom mapping was then performed using linear regression analysis with permutation thresholding (3000 permutations) and a one-tailed alpha level of .05. Results: Syntactic comprehension (SCT) was affected by lesions in mid to posterior middle and superior temporal regions, argument structure production (ASPT-A) was dependent on integrity of posterior temporal to inferior parietal regions, complex-sentence production (SPPT) was dependent on integrity of superior temporal and supramarginal regions, morphosyntactic deficits were predicted by lesions in inferior to middle frontal and prefrontal regions, and phrase-structure production problems were predicted by lesions covering the inferior frontal operculum. Conclusions: Results show a syntactic continuum along left-hemisphere perisylvian cortex, in line with the model for the cortical organization of syntax proposed by Matchin and Hickok (2020). This model places the greatest load for hierarchical syntactic computations on (middle) posterior temporal cortex in both comprehension and production, for argument-structure computations on the superior posterior temporal and angular gyrus, with a role for inferior frontal cortex in morphosyntactic computations and linearization of sentence elements in production. One notable exception is that reduced morphosyntactic production as well as simplified sentence productions were predicted by lesions to the inferior-frontal pars opercularis, rather than the pars triangularis. This latter result is somewhat more in line with the neurolinguistic model of Friederici (2012), who particularly emphasizes the role of pars opercularis (BA44) in 'syntactic processing'. Overall, these findings confirm that different lesions will affect different functional abilities that are part of the syntactic domain. The neural basis for these behavioral dissociations may inform the differential treatment of specific syntactic impairments.

Topic Area: Syntax

Poster A15 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Effects of early language exposure on speech category learning and speaker identification

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International adoptees (IA) often experience early but discontinued exposure to their original birth language during the first few years of life, prior to being adopted and acquiring the language of their new adopted family. Previous research with IA from China has shown that early but discontinued exposure to their birth language Chinese can result in maintained neural traces of Chinese phonology despite having no functional knowledge of the language at time of testing (Pierce et al., 2014). Here, we build on this work by examining in what way IA can leverage their early language representations established during infancy to exhibit a re-learning advantage for the perception of their original birth language in adulthood. We recruited 2 groups of adult participants: 1) IA from China, who were exposed to Chinese lexical tones during infancy before being adopted into French-speaking families (subsequently discontinuing their birth language for French), and 2) French monolinguals (FM) without prior exposure to Chinese tones. The first research question addressed whether the maintained neural traces of IA's original birth language provide them with an advantage in the learning of Chinese phonology, compared to the group of FMs with no exposure to Chinese. Furthermore, since evidence is emerging that listeners more accurately identify voices when they can understand the language being spoken and this advantage is believed to depend on listeners' knowledge of the phonology of the language (Perrachione & Wong, 2007), a second question was whether IA's early experience with Chinese provides them with an advantage in the identification of different speakers of their birth language, as compared to individuals without prior exposure to Chinese. To address question 1, both groups of participants performed a Chinese lexical tone categorization task while in an MRI scanner. During this task, participants were presented with monosyllables produced using the 4 different lexical tones spoken by 4 talkers (2 male, 2 female) and were asked to categorize the stimuli, with lexical tone being the category of interest. Participants received minimal visual feedback (“Correct” or “Wrong”) after each trial. To address question 2, participants were asked to identify 4 male speakers of Chinese producing full sentences (10 sentences each, shared across talkers), rather than tones in isolation. The IA performed significantly better than the FM group throughout the tone-categorization task ($p < 0.001$), as well as on the speaker-identification task ($p = 0.02$), although more pronouncedly during initial stages of speaker-identification learning. This suggests that early exposure to a language may provide a re-learning advantage for the perception of speech categories (at the phonological level), and that this advantage may generalize to higher-level sentence and speaker identity perception. Preliminary examination of brain activation patterns during the tone-categorization task revealed that the IA group had greater activation in the left primary auditory cortex and right putamen compared to the FM group at the end of learning. The behavioural and neural activation results are discussed in the context of theories of language development, the sensitive period hypothesis, and neuroplasticity.

Topic Area: Multilingualism

Poster A16 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Test-retest reliability of TRF-derived measures of cortical tracking of speech

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Introduction: Cortical tracking of speech refers to the alignment of neural oscillations to quasi-rhythmic fluctuations in speech. Temporal response function (TRF) modeling has emerged as an ecologically-valid tool for estimating cortical tracking of speech and may prove useful in clinical populations (Gnanateja et al., 2022). For example, aberrant cortical tracking of the speech envelope has been observed in individuals with hearing loss (Fuglsang et al., 2020) and logopenic variant primary progressive aphasia (Dial et al., 2021). However, the clinical utility of this approach is dependent upon its test-retest reliability. Recent work confirmed the reliability of tracking amplitude modulated noise (Cabral-Calderin & Henry, 2022), but researchers have yet to report on the reliability of TRF-derived measures of cortical tracking of the speech envelope. The current study sought to fill this gap. Methods: Nine neurotypical adults (mean age = 26.92 years, SD = 10.68) listened to 30 one-minute segments of an audiobook (Who Was Albert Einstein?) at two timepoints separated by at least one week (mean = 27.78 days, SD = 10.81). Cortical tracking of the multi-band speech envelope was estimated for neural oscillations in delta (1-4 Hz), theta (4-8 Hz), and delta-theta (1-8) bands using the mTRF toolbox (Crosse et al., 2016, time lags = -100 to 1000 ms). Cortical tracking was operationally defined as prediction accuracy of the TRF model, quantified as Pearson’s correlation between the observed and TRF-predicted EEG. Test-retest reliability for prediction accuracy was assessed using Pearson’s correlation (with 95% confidence intervals derived via bootstrapping) and Wilcoxon signed-rank tests across the two sessions. Results: Prediction accuracy (r) for the multi-band envelope was significantly above chance in delta (mean $r = 0.08$, SD = 0.03), theta (mean $r = 0.06$, SD = 0.02), and delta-theta (mean $r = 0.06$, SD = 0.02) bands. A strong correlation was observed across sessions in the theta band ($r = 0.88$, 95% CI [0.59, 0.97], $p < 0.001$), with weaker correlations observed in the delta ($r = 0.42$, 95% CI [-0.39 – 0.87], $p = 0.23$) and delta-theta ($r = 0.55$, 95% CI [-0.04, 0.93], $p = 0.10$) bands. Wilcoxon signed-rank tests identified no significant differences across sessions for any of the three frequency bands (p’s > 0.20). Discussion: The findings of this study indicate that theta-band tracking of the multi-band speech envelope has high test-retest reliability in neurotypical adults. Weaker evidence was provided for the reliability of delta and delta-theta band tracking of the multi-band speech envelope. This is a promising finding regarding the clinical utility of this method. That said, for populations with language disorders, this method will likely be of most value when estimating cortical tracking of linguistic features of speech. Thus, our next step is to examine the reliability of cortical tracking of linguistic features of speech, such as reported in Gillis et al. (2021). In ongoing work, we are collecting data from adults across the lifespan and individuals with stroke-induced aphasia to determine whether test-retest reliability of TRF-derived measures differs as a function of age and/or neurological disorder.

Topic Area: Perception: Auditory

Poster A17 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Modality Independent Representations of Conceptual Categories in Picture Naming and Word Reading

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In speech production, meanings are transformed into sounds. For example, when naming a picture of a dog or reading the word "dog" out loud, a speaker typically activates a conceptual representation about dogs. While a picture of a dog illustrates a specific exemplar, the word "dog" refers to the class of dogs. It remains an open question whether shared representations are activated prior to speech independently of the input modality or whether those representations are modality specific. In fact, while some theories hold that concepts are exclusively encoded via the perceptual system (Barsalou, 1999), others suggest the existence of amodal representations (Mahon & Caramazza, 2008; Ralph, Jefferies, Patterson, & Rogers, 2017). Here we addressed this question by asking 24 participants to name pictures and read words aloud during an MEG measurement and by decoding for a tool vs. animal distinction in the MEG data with generalization both across time and stimulus modality (King & Dehaene, 2014). Crucially, the visual forms of the words did not contain information about their category-membership and the language production task did not explicitly require a categorization judgment. This allowed us to investigate whether and when modality-independent conceptual representations spontaneously come online in each of the two language production tasks. We found that while evidence of modality-specific category representations emerges at 75ms post-stimulus onset for picture naming and at 95ms for word reading, modality independent representations are active slightly later at 125ms for pictures and at around 150ms for words. Further, modality-specific representations evolved as a feedforward process for both modalities, while modality independent representations were active simultaneously early in the timecourse, while later, they were delayed in picture naming compared to word reading. A follow up analysis indicated that our decoding of semantic categories is very unlikely to be confounded with information related to the word forms. Finally, we explored the spatial and temporal evolution of category information in the MEG sensors for each of the overt reading and picture naming tasks. All together, these findings provide evidence for the spontaneous activation of modality-independent representations of categories in picture naming and word reading, thus supporting theories of concepts in which modality independent representations exist (Mahon & Caramazza, 2008; Ralph, Jefferies, Patterson, & Rogers, 2017).

Topic Area: Meaning: Lexical Semantics

Poster A18 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Long-distance dependencies in Chinese, English, and French brains

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In natural language, words can occur arbitrarily far away from the position in the sentence where they (intuitively) make their meaning contribution. While these long-distance dependencies have been extensively studied, this study investigates the brain bases of two specific types, WH-questions and object-extracted relative clauses, using as stimuli translation-equivalent naturalistic texts in Chinese, English, and French. DATA: The fMRI data analyzed are the The Little Prince Datasets [1], a dataset in which Chinese, English, and French participants are scanned while they engage in the naturalistic process of listening to an audiobook of a children's story in their native language. METHODS: The

BOLD time series are extracted for twenty-four left hemisphere language network ROIs from the Human Connectome Project Multi-Modal Parcellation 1 [2]. The selected ROIs make up the inferior frontal gyrus, lateral temporal lobe, and temporoparietal cortex. A number of word-by-word metrics are defined in order to capture different aspects of language comprehension. The storybook texts are parsed with near state of the art parsers for their respective languages, with the parse trees being used to identify and then label WH-question and object-relative constructions such that, beginning at the filler and ending at the gap site, each word in the long-distance dependency is annotated with a 1, while all other words are assigned a value of 0. The parse trees are also used to calculate a bottom-up processing metric corresponding to the number of reduce operations in a shift-reduce parser. Additionally, large, autoregressive transformer language models on the scale of GPT2 [3] trained on 14, 40, and 60 GB of data for Chinese, English, and French, respectively, are used to calculate word-by-word surpsisal. Following other neurocomputational models [see e.g., 4], a Bayesian linear regression is fit for each ROI in each language. Regressors of non-interest include spoken word-rate, log lexical frequency, speaker pitch, and root mean squared amplitude of the speaker narration. Word-by-word regressors of non-interest include the bottom-up processing metric and large language model surprisal. The regressors of interest are the word-by-word object-relative and WH-question metrics. The model results are aggregated across the three languages in order to see the cross-linguistic similarities and differences in the neural correlates of long-distance dependency processing. RESULTS: Even after including coregressors in the neurocomputational model which account for lower-level linguistic processing, bottom-up syntactic construction, and word-by-word surprisal, quite a large portion of the left-lateralized language network is implicated in the processing of long-distance dependencies. This reaffirms the cognitive demand that these construction types impose upon the brain's language network. In all three languages, object-relative processing is associated with an increase in activity in the left middle and posterior temporal lobe as well as left temporoparietal cortex. For WH-question processing, all three languages show an increase in activation in the left inferior frontal gyrus and the left posterior superior temporal sulcus. These results are interpreted with respect to syntactic processing in the middle and posterior temporal lobe [5], argument storage in temporoparietal cortex [6], and argument (re)analysis in the inferior frontal gyrus [7].

Topic Area: Computational Approaches

Poster A19 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Left superior temporal sulcus lesions reduce semantic access during oral reading

Sara M. Dyslin[1], J. Vivian Dickens[1], Candace M. van der Stelt[1], Alycia B. Laks[1], Sarah F. Snider[1], Andrew T. DeMarco[1], Peter E. Turkeltaub[1,2]; [1]Center for Brain Plasticity and Recovery, Georgetown University, [2]MedStar National Rehabilitation Hospital

Accurate oral reading relies on the interaction between orthographic, phonological, and semantic knowledge. The reading network in the brain is generally divided into the sublexical, dorsal route and lexical, ventral route. The degree to which semantic knowledge contributes to the lexical route is debated. The importance of semantics in reading is evidenced by the imageability effect, in which better reading performance is observed for words with high imageability (e.g., “horse”) compared to words with low imageability (e.g., “trust”). Most prior research on the role of semantics in reading has focused on individuals with semantic dementia. However, lesion studies of individuals with post-stroke alexia provide a model for isolating regions of the brain that are critical for different aspects of reading. We hypothesized that semantic contributions to reading rely on temporal lobe regions of the ventral stream; thus, lesions to these regions would reduce the imageability effect, particularly for words that are the least supported by lexical knowledge, i.e., low frequency, regular words. Participants included 53 adults with history of a left-hemisphere stroke at least six months prior to testing (Age = 62.1 (14.4); Gender = 22F, 31M; Months since stroke = 48.8(56.5). All participants completed an MRI scan and an oral word reading task with 200 words crossed on frequency, regularity, and imageability, resulting in 8 categories of words with 25 items each. Lesions were manually traced from FLAIR and T1-weighted scans and warped to MNI space. Support Vector Regression Lesion-Symptom Mapping (SVR-LSM) was applied. Analyses tested for lesions that reduced accuracy on high imageability words while controlling for the effect on low imageability words. Four analyses examined this effect for words within each combination of frequency and regularity. Age, education level, and lesion volume were regressed out of behavioral and lesion data, and 10,000 permutations were used to control the cluster-level family-wise error rate. Significant clusters were identified for the analyses of low frequency irregular words and low frequency regular words. Both clusters were localized in the temporal lobe, overlapping in the superior temporal sulcus and posterior middle temporal gyrus. There were no significant lesion locations identified for a reduced imageability effect in high frequency irregular or high frequency regular words. This study clearly demonstrates that loss of semantic support for reading does occur in stroke participants with lesions to the reading network. The findings indicate that the superior temporal sulcus and middle temporal gyrus are critical for the use of semantic knowledge in reading, and that semantic support is most evident in low frequency words. The different location of the lesions in this study relative to the primary area of atrophy in semantic dementia suggests that a different mechanism of action is disrupting semantic contributions to reading in these populations. Further research is needed to determine whether this difference is due to disconnections between semantics and orthography rather than degradation of semantic representations themselves as in semantic dementia.

Topic Area: Reading

Poster A21 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Merging Research and Education Through an Undergraduate Laboratory Course Involving Aphasia Assessment and Student Projects Using the Lesion Method

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As part of a National Science Foundation grant, we have designed and implemented an undergraduate laboratory course on the neuropsychology of brain injury. This course serves as the primary source of data collection for a project using the lesion method to study the neural basis of numeracy and its connection to the language network. In the interest of making the course materials and resources freely available to others, we describe its basic structure and provide evidence of its effectiveness. Overall, the course has a flipped structure, with reading and video tutorials providing the information necessary to complete homework assignments that prepare students to apply their knowledge “hands-on” during class time. In the first part of the course, students work in pairs to learn how to administer and score a 3-hour battery that involves a variety of speech, language, and numeracy assessments with high fidelity. Following training, each student pair completes and scores a proctored assessment session with a research participant who has a focal lesion due to stroke, with participants drawn from a research registry of over 3,000 stroke survivors (the Western Pennsylvania Patient Registry). In the second part of the course, students learn how to develop and test a hypothesis involving the lesion method, using a course database with results from 48 prior participants. To learn the component skills, students work individually during class to operationalize and test a prototype hypothesis focused on the importance of Broca’s area for speech production. Interestingly, students obtain different statistical results due to differences in how they operationalize the hypothesis about Broca’s area (e.g., how they define Broca’s area, which measure of speech production they choose from the prior testing, and if they include a covariate such as lesion volume, participate age, or years of education in their analysis). This creates a rich opportunity to discuss issues related to interpreting statistical results with respect to the hypothesis being tested and the current literature. In parallel, students work in teams to develop and test a hypothesis of their choice based on the previously collected data (48 participants). In the last part of the course, the students’ effort culminates in a poster that is presented to the class. The course has been successfully offered for five terms with a variety of instructional

formats (in-person, hybrid, completely online) and a typical enrollment of 24 students. After the first term, the neuropsychological assessment battery was successfully migrated to an exclusively online administration format, which creates considerable geographic flexibility. In terms of research effectiveness, to date all but one of 54 student pairs successfully completed the testing battery, including cases in which the research participant had significant impairments due to the stroke. In terms of instructional effectiveness, across terms students have given the course excellent ratings, with frequent open-ended comments that note the uniqueness of the course and its importance to their career goals. We conclude that this course can serve as a platform for authentic data collection while also providing an exciting and unusual educational opportunity.

Topic Area: Methods

Poster A22 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Electrophysiological correlates of short-term word learning and consolidation

Julie Franco[1], Marina Laganaro[1]; [1]University of Geneva

Word learning is a skill that is used daily even in adults (Hartshorne & Germine, 2015) for new words in the mother tongue, in a second language or when recovering from anomia following brain damage. Integrating a new word into the mental lexicon is a complex process that involves several steps from short-term recall to full consolidation (Van der Ven et al., 2015). In adulthood, the human brain is capable of acquiring and memorizing new words rapidly via hippocampal systems first and then through neocortical brain networks as a result of consolidation (Davis & Gaskell, 2009). Word learning processes have been studied mainly with word recognition approaches (Kapnoula et al., 2015; Takashima et al., 2017), and to a lesser extent in word production (Cornelissen et al., 2004; Grönholm et al., 2005; Fargier & Laganaro, 2020). However, most studies focused on short term learning while the brain regions while processes leading to consolidation and lexical integration are still poorly explored. In word recognition, recent research tends to show the involvement of different processes during the different learning phases (Bakker et al., 2015; in eye tracking: Weighall et al., 2017), but studies on the production of newly leaned/consolidated words are missing. The aim of the present study is to investigate electrophysiological correlates of word learning at short-term and consolidation (lexical-semantic integration) with word production (rather than recognition) paradigms. 26 participants learned two matched lists of 40 infrequent words in two x 2-days learning periods, with active digital methods. Test sessions were carried out on word production (picture naming) task with EEG recording before and after each learning period, the last test being 72 hours after 1st learning period, allowing to test consolidation for the first list. Here we report analyses on the list of 40 words learned during the first learning period were at short-term learning assessment (day 3, 1-day after learning) and consolidation (day 5, 3-days after learning), where lexical-semantic integration was also assessed with a picture-word interference task. Results showed higher accuracy at day 3 than at day 1 ($z = 7168$, $p < .001$, $\beta = 7.38$, $SE = 0.001$), with no further difference at day 5 ($z<1$). Reaction times were faster at day 3 relative to day 1 ($t(941) = -2.41$, $p < .05$) and further decreased at day 5 ($t(1829) = -15.11$, $p < .001$). ERP analyses revealed significant differences between day 1 and day 3 on amplitudes and microstates. In particular, different global electrophysiological patterns, indicating different brain processes, appeared on the P2 component (at ~250 ms after picture onset), which has been previously associated with lexical selection. In the comparison between short term (day 3) and consolidation (day 5) further ERP differences appeared only on microstates, with qualitative differences between 250 and 400 ms after picture onset. The results of the present study show that consolidation 72 hours without additional exposure to the newly learnt words involves further electrophysiological changes during word production in the the time period associated to lexical encoding processes.

Topic Area: Language Production

Poster A23 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Speech planning in classic picture naming vs. “dialogue” in children and adults

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[INTRODUCTION] The picture naming task is common both as a clinical task and as a method to study the neural bases of speech production in the healthy brain. However, this task is not reflective of most naturally occurring productions, which tend to happen within a context, typically in dialogue as a response to someone else’s production. How the brain basis of confrontation picture naming compares to the planning of utterances in dialogue is not known. Here we used magnetoencephalography (MEG) to investigate neural activity associated with language production using the classic picture naming task as well as a minimal variant of the task, which made it more “dialogue” like. We assessed how neural activity is affected by the interactive context in children and adults. [METHODS] 50 adults and children participated in several language tasks within a larger experimental protocol designed to measure neural correlates associated with language comprehension and production at the lexical and phrasal levels in adults and children. The picture naming task elicited descriptions of colored objects either as nouns (cup) or as phrases (blue cup). The “dialogue” task involved responding to a computer-generated utterance. Specifically, an image of two objects was presented and the computer named one of them. The subject’s task was to name the other object. Again, the utterances were either single nouns or phrases, depending on the block and task instruction. Participants were grouped by age into three groups: children (7-12, n=18), teens (13-19, n=15), and adults (20+, n=17). We epoched data backwards from speech onset and conducted non-parametric cluster-based permutation tests in temporal and ventromedial prefrontal cortices, implicated in prior MEG studies of naming, as well as in Broca’s area, given its classic role in the neurobiology of language. [RESULTS] We observed a pattern of significant interactions of age by task. In adults, there was a robust sustained increase of activity for the dialogue task, while this increase was less pronounced in teenagers and absent in children, as detailed below. VMPFC: Robust, sustained increase for dialogue in adults, somewhat less sustained in teens, absent in children. Instead, simple picture naming elicited higher vmPFC activation in children. MTG: Robust, sustained increase for dialogue in adults. Subtle trend in teens in the same direction. Reverse pattern in children (late increase for simple picture naming), as in vmPFC. BROCA’S AREA: Increase for dialogue in adults. Brief effects in the opposite direction in teens and children. LATERALITY: These patterns were by and large bilateral. [CONCLUSION] The design of the dialogue task targeted neural correlates of speech planning in a more dialogue-like context than the simple picture naming task. We sought to characterize how the relevant neural activity changes across development. Our results reveal a sustained effect of task in the adult population and a pattern of maturation in which the vmPFC becomes adult-like the earliest, followed by middle temporal cortex, and with Broca’s area patterning last.

Topic Area: Language Production

Poster A24 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Time-course of processing for syntactic properties in spoken word recognition

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A fundamental issue in spoken language comprehension involves understanding the interaction of linguistic representations across different levels of organization (e.g., phonological, lexical, syntactic, and semantic). In particular, there is debate about when different levels are accessed during spoken word recognition. Under serial processing models, comprehension is sequential (e.g., phonological processing precedes lexical access, which precedes access to higher-level syntactic and semantic representations). In contrast, under parallel processing models, simultaneous activation of representations occurs at multiple levels. The current study investigates this issue by isolating neural responses to one type of higher-order information—syntactic class of a word—from low-level acoustic and phonological responses. This allows us to identify the earliest time during which listeners distinguish

syntactic class information in speech. Using a component-independent event-related potential (ERP) design, we collected EEG responses to spoken words varying in syntactic class. Stimuli consisted of synthesized disyllabic nouns and adjectives. The adjective and noun lists were matched for word frequency, phonological neighborhood density, and biphone probability. A cross-splicing procedure was used to cancel out low-level acoustic differences, such that the same set of initial and final syllables occurred in both lists. The point of disambiguation (POD; i.e., the earliest point at which the incoming acoustic information would indicate whether the word is a noun or adjective) occurred at the syllable boundary. EEG data were recorded from 32 electrodes placed at International 10-20 System sites. Electrode impedances were less than 10 kΩ, EEG data were recorded at a sampling rate of 500 Hz, and data were referenced online to the left mastoid and re-referenced offline to the average of the two mastoids. On each trial, participants heard a spoken word and then saw a visually presented word 500±150 ms later. Participants performed a two-alternative forced choice task, where they determined whether the auditory and visual words shared the same syntactic class (match vs. mismatch). There were 20 total items (10 nouns, 10 adjectives), and auditory words were repeated 19 times (once with each other word from the set of items as the visual comparison) for a total of 380 experimental trials. We predicted that overlap in the time-course of processing among different levels of linguistic organization would produce effects of syntactic class on ERP responses within 200 ms after the POD, during which listeners are still processing acoustic properties of the words. To evaluate this, we used an analysis approach to decode syntactic class. This analysis showed that syntactic class is decodable at approximately 200 ms post-POD, supporting the prediction that different levels of representation would have overlapping time-courses. Overall, these results support a parallel, interactive processing model of spoken word recognition, in which higher-level information—such as syntactic class—is accessed while acoustic analysis is still occurring.

Topic Area: Speech Perception

Poster A25 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Correspondence between cognitive and neural representations for phonology, orthography, and semantics in supramarginal compared to angular gyrus

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The angular and supramarginal gyri (AG and SMG) roughly correspond to Brodmann areas 40 and 39, and von Economo areas PF and PG. Together they constitute the inferior parietal lobule (IPL) and have been associated with cognitive functions that support reading. How those functions are distributed across the AG and SMG is a matter of debate, the resolution of which is hampered by inconsistencies across stereotactic atlases provided by the major brain image analysis software packages. Schematic results from tools that automate meta-analyses suggest primarily semantic (word meaning) processing in the left AG, with more spatial overlap among phonological (auditory word form), orthographic (visual word form), and semantic processing in the left SMG. To systematically test for correspondence among patterns of neural activation and phonological, orthographic, and semantic representations, we re-analyzed a functional magnetic resonance imaging dataset of participants reading aloud 465 words. Using representational similarity analysis, we tested the hypothesis that within cytoarchitecture-defined subregions of the IPL, phonological representations are primarily associated with the SMG, while semantic representations are primarily associated with the AG. To the extent that orthographic representations can be de-correlated from phonological representations, we hypothesized that they would be associated with cortex peripheral to the IPL, such as the intraparietal sulcus. Semantic representations were quantified using the Global Vectors for Word Representation model, which learns co-occurrence based embeddings from a large corpus of text. While the relationship between semantic and orthographic or phonological representations is nearly arbitrary and therefore uncorrelated, investigating orthographic and phonological representations is more challenging. To that end, we defined orthographic and phonological dissimilarity in terms of string edit distance, but for phonology we included phonetic features corresponding to place and manner of articulation. Results largely confirmed our hypotheses, with both ROI and searchlight analyses showing neural correspondence with semantic representations primarily in left AG, phonology in left SMG, and orthography outside but adjacent to the IPL in the intraparietal sulcus and nearby superior parietal lobule. Comparing these results to computational models of reading that also specify the relevant representations, we note that, contrary to models that do not implement semantic representations, the results are more consistent with neurally inspired computational cognitive models of reading that learn mappings among distributed representations for orthography, phonology, and semantics. Overall, our results lend new clarity to the spatial organization of reading-related cognitive representations within the left IPL. This additional precision was achieved through careful selection of word stimuli and representational formats to aid in using partial correlation RSA for localizing orthographic, phonological, and semantic representations. On the neural side, cytoarchitecture-based segmentations were used to distinguish PF/SMG from PG/AG in a way that largely agreed with landmark-based atlases. We propose this approach as a roadmap for achieving additional cognitive and neural precision in future cognitive neuroscience investigations.

Topic Area: Reading

Poster A26 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

What does varying the standards in an MMN paradigm really do?

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The varying-standards paradigm (Phillips et al., 2000) varies standards within a phoneme category and is believed to enforce a phoneme representation as a memory trace for deviance detection. Studies adopting the paradigm have assumed that varying the standards precludes a phonetic MMN (Eulitz & Lahiri, 2004; Hestvik & Durvasula, 2016). Specifically, if the phoneme-based memory trace is purely abstract, there should be no within-category MMN. However, if the memory trace encodes phonetic information, a within-category MMN is expected. In two previous experiments (Han et al, submitted), we did observe an MMN to a within-category contrast, suggesting that the memory trace activated by the varying standards must encode phonetic information. This does not necessarily invalidate Phillips et al, as they could be right that varying the standards recruits a phoneme, but that representation may contain fine-grained acoustic information. However, an alternative interpretation is that varying the standards does not recruit a phoneme at all, but rather results in a memory trace that is a statistical summary of the presented stimuli, as demonstrated by Garrido et al (2013, 2016) with pure tones. To distinguish between the two interpretations, we replicate Garrido's with VOT-varying speech sounds. Participants will hear 840 standard [tæ]s of VOT drawn from a normal distribution with a mean of 128ms and a standard deviation of 10ms. The deviants are 105 tokens of [tæ] with 64ms VOT and were compared to 105 tokens of [tæ]s with 128ms VOT. The deviant VOT is an outlier to the stimuli presented in the experiment but is approximately equivalent to the mean VOT of /t/ (~60ms, estimated by the empirical VOT in Chodroff & Wilson, 2018) which could be stored with the phoneme. If this deviant VOT results in an outlier MMN effect when compared to standards with a mean of 128ms, then it can only be a result of the memory trace being a statistical summary of the standards. On the other hand, if the standards invoke a latent phoneme with a mean VOT of ~60ms, then the deviant would be identical to the memory trace and no MMN is expected. Combined with our previous experiments, this would provide decisive evidence that varying standards evoke a memory trace containing prototypical phonetic information. To interpret the possible absence of MMN, we are adding a non-speech control condition, where participants will hear a spectral-rotated version of the same stimuli as presented in the speech condition. The spectral-rotated stimuli preserve the acoustic difference between the standards and deviants as the standard-deviant VOT difference in the speech condition but remove the linguistic information. The presence of MMN in the control condition can thus inform us that the possible absence of MMN in the speech condition is not due to the lack of VOT difference between standards and deviants. Assuming the same effect size (d = -0.83) as one of our previous experiments, a power analysis suggests 21 subjects to get 90% power for

a standard-deviant a standard-deviant comparison in a two-tailed t-test (\alpha = .05)

Topic Area: Speech Perception

Poster A27 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam A session.

The neurobiology of language mediates alterations in conscious experience induced by psychedelic drugs

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Psychedelic drugs profoundly affect conscious experience. This often involves ‘ego-dissolution’ or the loss of self and a sense of ‘oneness with the universe’, purportedly correlated with changes in the ‘default mode network’ (DMN). However, the ‘self’ is largely a narrative construct mediated by language. Language is also a general tool for categorizing the world, e.g., organizing visual spectral information into color labels. Anecdotally, some patients who recover from aphasia describe their aphasic state as having lacked a self and the world as being more interconnected or one, descriptions that grossly resemble psychedelic phenomenology. For these reasons, we hypothesized that a more parsimonious explanation of the psychological effects of psychedelics has to do with their relative impact on the neurobiology of language. We tested this hypothesis using neuroimaging meta-analysis. Specifically, we conducted a search for neuroimaging studies of psychedelic drugs using PRISMA standards (assessed May, 2022). This resulted in 3212 articles of which 94 met inclusion criteria of having neuroimaging Talairach or MNI stereotaxic coordinate tables, including seven ayahuasca, one DMT, 64 ketamine, 10 LSD, and 12 psilocybin studies. Seed-based d Mapping (v6.22) was used to model drug vs placebo. We limited this analysis to studies collected from ‘classic’ psychedelics (i.e., excluding ketamine), during the resting (as opposed to active) state, and in healthy volunteers (N=432), using dose (low, medium, or high) as a covariate. We queried the neurosynth.org database to determine which of more than a thousand terms were most associated with resulting clusters ($p < .05$ corrected) and which whole-brain meta-analyses most resembled the unthresholded drug vs placebo map ($r > 0.1$). Classic psychedelic drugs significantly increased activity in a large distributed set of brain regions with the largest cluster peaking in the dorsal medial prefrontal cortex (not typically associated with the DMN). Other peaks included the left posterior inferior frontal gyrus and superior temporal regions associated with language related meta-analytic terms. Significant negative interactions included ‘lower-level’ superior temporal regions and associated terms (e.g., ‘speech’). Unthresholded whole-brain maps were most positively correlated with the ‘task’ meta-analysis (followed by ‘working memory’, ‘load’, ‘demands’, and ‘memory’, among others). Negative whole-brain correlations were with the terms ‘auditory’, ‘listening’, and ‘sounds’ (among others). Contrary to existing suggestions in the neuroimaging literature, our results show that the primary effects of classic psychedelic drugs are not related to the DMN. Rather, these drugs drive increases in activation in memory and language systems, and decrease activity in regions most central to sound and low-level speech perception. Thus, loss of ‘self’ and feelings of ‘oneness’ are parsimoniously explained by changes to the neurobiology of language during psychedelic use. Psychedelic induced neuroplasticity in these networks, in concert with changes in self narrative centered around alterations in conscious experience, likely underlie the positive changes in mental health and wellbeing associated with psychedelic drugs.

Topic Area: Multisensory or Sensorimotor Integration

Poster A28 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Examining the Cognitive Neural Basis of Insight Problem Solving with Chinese Character Decomposition Task

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Insight, “a sudden change in the concept or other form of knowledge representation which often leads to the solution of the problem” (p.73, Beeman & Kounios, 2014), is usually linked to the performance of creative thinking. For decades, researchers tried to establish its psychological nature and neural basis. Two paradigms, the remote associates test (RAT) and the chunk decomposition task (CDT), have been proposed to examine insight processing and incongruent results were found. One of the main issues of these tasks was the difficulty in separating analytic and insightful processes in participants’ responses. The present study extended from previous tasks and proposed a new Chinese character decomposition task to examine the cognitive neural mechanism of insight problem solving. Taking the advantage that most Chinese characters can be decomposed by different strategies of stroke patterns, it is possible to differentiate analytic and insightful solutions. In the Chinese character decomposition task, participants were asked to find a hidden Chinese character of a specific category (e.g., animals) within a more complex Chinese character. Whereas a solution of the independent radical (e.g., find “犬”, a dog, in “哭”, means cry) suggested the analytic solution, that of the embedded hidden character indicated the insightful solution (e.g., find “虫”, a bug, in “寓”, means apartment). Fifty-nine native Chinese readers were recruited and were asked to find a hidden character in the to-be decomposed character in the Chinese character decomposition task, with their blood flow changes in ROIs, including middle frontal gyrus, inferior frontal gyrus, inferior parietal lobules, superior parietal lobules, and temporal lobes in both hemispheres, monitored with functional near infra-red spectroscopy (fNIRS). Three experimental conditions, i.e., analytic, insightful, and control conditions, were manipulated. The fNIRS data were preprocessed and analyzed with GLM applying nirsLAB software (NIRx Inc.). The results found stronger blood flow changes in the right supramarginal gyrus/inferior parietal lobule in the insightful condition. These brain areas has frequently been associated with creative thinking in previous studies, suggesting that insight problem solving may share similar mechanisms of other higher-order cognitive abilities as proposed by previous studies applying RAT (e.g, Beeman et al., 2004), rather than semantic or visual-spatial processes suggested in previous studies applying CDT (e.g., Huang et al., 2015; Lin et al., 2018). In conclusion, the present study provided a new and promising strategy to further explore the underlying cognitive processing and neural correlates of insight problem solving.

Topic Area: Methods

Poster A29 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Brain total creatine differs between Primary Progressive Aphasia (PPA) subtypes and correlates with disease severity

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Primary progressive aphasia (PPA) is a debilitating neurodegenerative disease that primarily impairs language function. It is comprised of three subtypes with varied clinical presentation and cortical atrophy patterns: logopenic variant (lvPPA), non-fluent variant (nfvPPA), and semantic variant (svPPA). No prior work has examined differences in brain chemistry between the PPA subtypes, or associations of brain chemistry with symptom severity. In the present work, we collected magnetic resonance spectroscopy (MRS) data in a main language production region, the left inferior frontal gyrus (IFG), and a control region, the right sensorimotor cortex (SMC) from 61 patients with PPA (ClinicalTrials.gov identifiers: NCT02606422, NCT03887481, and NCT04122001). Brain metabolite levels of total N-acetylaspartate (tNAA), total choline (tCho), total creatine (tCr), and glutamate+glutamine (Glx) were measured with conventional MRS, and gamma-aminobutyric acid (GABA) was measured using MEGA-PRESS. All data were processed using a state-of-the-art MRS analysis pipeline (Osprey), which generated tissue- and relaxation-corrected metabolite levels to account for the effects of cortical atrophy and other tissue-specific properties. We aimed to: 1) characterize differences between PPA subtypes for the 5 brain metabolites: tNAA, tCho, tCr, Glx, and GABA; and 2) test for associations between these neurometabolites and PPA symptom severity. We found that tCr levels differed by PPA subtype across both the left IFG and right SMC. In both regions, tCr levels were lowest among lvPPA patients and highest among svPPA patients. Moreover, across the whole cohort, higher tCr and lower Glx levels in the left IFG correlated with greater disease severity. Global atrophy (i.e., total intracerebral volume divided by total intracranial volume) did not differ by PPA subtype or correlate with tCr or Glx concentrations, suggesting that these effects were not dependent upon overall cortical atrophy. Given that tCr is involved in brain energy metabolism and homeostasis, our results indicate that svPPA pathology might involve perturbations to specific cellular energy processes. Our finding that higher tCr was associated with worse PPA symptom severity suggests that perturbations to cellular energy homeostasis in cortical language areas may contribute to PPA symptoms. In addition, reduced cortical excitatory capacity (i.e., lower Glx) in brain areas related to language processing may also contribute to PPA symptoms. Together, these findings suggest that tCr could serve as a biomarker to differentiate between PPA subtypes, and that both tCr and Glx might have utility for better understanding PPA disease mechanisms and tracking disease progression. Our forthcoming work will expand upon these findings, investigating whether and how these neurometabolites change in response to neuromodulation (transcranial direct current stimulation, tDCS) combined with language therapy in a double-blind randomized controlled trial.

Topic Area: Disorders: Acquired

Poster A30 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Clustering and Switching on Verbal Fluency in the Logopenic Variant of Primary Progressive Aphasia

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Introduction: A defining feature of the logopenic variant of primary progressive aphasia (lvPPA) is significant lexical retrieval difficulties, which are often characterized using confrontation naming tasks. Other lexical retrieval measures that have been less studied are verbal fluency (VF) tasks, which examine the ability to produce as many unique words as possible that begin with a specific letter (letter fluency) or that belong to a specific category (semantic fluency) in 60 seconds. Importantly, performance on VF tasks offer a unique opportunity to investigate the nature of lexical retrieval difficulties. Optimal VF performance depends on generating words within a subcategory (clustering) and, when a subcategory is exhausted, shifting to a new subcategory (switching). Only a few studies have investigated the qualitative (clustering and switching) aspect of this task in lvPPA. Indeed, a reduction in the number of words generated on VF tasks has been well documented, but limited research has examined the qualitative aspect of their performance. This examination can offer important insights into the organization of the lexical-semantic system in lvPPA. The purpose of this study was to examine clustering and switching on a semantic VF task (animal fluency) in patients with lvPPA and examine their relationship to gray matter atrophy. Methods: Participants with lvPPA ($n = 13$; mean age=68.69±5.27 years; mean education=17.31±4.48 years) and 21 age- ($t(32)=.049$, $p=.481$) and education- ($t(32)=-.660$, $p = .257$) matched controls were recruited from the University of Arizona. All participants underwent neuropsychological and language testing and a magnetic resonance imaging (MRI) scan. On animal fluency, participants named as many animals as possible in 60 seconds. We calculated the number of correct words, number of clusters, mean cluster size, and number of switches based on established guidelines. Differences between the lvPPA and controls were assessed using independent sample t-tests. Additionally, voxel-based morphometry (VBM) will be implemented to identify areas of gray matter atrophy in lvPPA. These VBM maps will be entered into multiple regression to investigate the relationship between gray matter volumes and clustering and switching measures. Results: Our results indicate that number of words ($t(32)=-9.37$, $p<0.001$), number of clusters ($t(32)=-6.74$, $p<0.001$), average cluster size ($t(32)=-4.13$, $p<0.001$), and number of category switches ($t(32)=-8.08$, $p<0.001$) were significantly reduced in participants with lvPPA. VBM will be computed to identify patterns of gray matter atrophy and to investigate the relationship between regional gray matter volume and fluency measures. Conclusion: The present study examined differences in quantitative and qualitative features of VF in patients with lvPPA and neurotypical controls. Patients with lvPPA generated fewer words than their respective controls and demonstrated significant impairment on clustering and switching measures. This is consistent with involvement of frontal lobe functions during switching and temporal regions for clustering. Our findings are consistent with the literature on lvPPA and align with the patterns observed in Alzheimer's Disease (AD). Interestingly, lvPPA is often associated with underlying AD pathology and show similar behavioral patterns to those observed in AD. Our results offer clinically and empirically important insights regarding the organization of the lexical-semantic system in lvPPA.

Topic Area: Disorders: Acquired

Poster A31 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Speech production facilitates audiovisual word matching

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Earlier behavioral and neuroimaging studies showed that listening to speech (even when it is auditory-only) activates our own motor representations for speech. We examined whether such engagement of motor representations may, in turn, facilitate audiovisual processing of observed speech. Participants first saw a picture of an everyday object and heard it named (e.g., see toys, hear "toys"). The picture disappeared for 2 seconds, and when it appeared again, participants had to either press a response key as soon as possible (PRESS condition) or say the word that they just heard (SPEAK) condition. They then saw a silent video of a woman producing either the same word (e.g., "toys") or a word that was visually different – e.g., "bus." Participants pressed one key if they thought the video matched the previously heard word and another button if they thought it did not. Each participant completed both conditions on two different days. We recorded event-related brain potentials (ERPs) to silent videos when they were perceived as either congruent or incongruent with preceding auditory words. In both conditions, incongruent videos elicited a larger phonological N400 compared to congruent videos. Importantly, when participants themselves articulated a word prior to observing a silent video, the N400 occurred significantly earlier. The results suggest that activated motor representations for speech facilitate the perception of visually observed speech of others. The findings may serve as a benchmark for understanding the connection between motor and visual representations of speech in disorders with impaired audiovisual processing, such as autism, dyslexia, and developmental language disorder.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster A32 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Brain lesions associated with communication-related quality of life following surgical removal of primary left-hemisphere tumours

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Introduction. Long-term quality of life (QOL) is an important consideration in the planning of treatment for individuals undergoing brain tumour surgery, especially given that this population are at increased risk of aphasia. The current study examined relationships between QOL and anatomical characteristics of the lesion in patients 6-24 months post-surgery. Methods. Thirty-seven individuals (17 female; mean age: 47.24) underwent behavioural testing and MRI following left-hemisphere resective surgery. The majority of participants met the criteria for aphasia on at least one subtest of the Comprehensive Aphasia Test (CAT). QOL was assessed using the CAT Disability Questionnaire, the Depression, Anxiety, and Stress Scale (DASS), and the Functional Assessment of Cancer Therapy-Brain (FACT-Br), resulting in 10 QOL measures. A principal component analysis of these measures identified two components explaining ~62% of the variance: a communication-related component and a mood-related component. Three lesion maps were generated per participant capturing (1) the primary resection, (2) the resection plus residual tumour/oedema (resection+), and (3) the residual tumour/oedema alone. The relationship between QOL components and lesion location were examined using voxel-wise lesion symptom-mapping (VLSM) as well as general linear models predicting severity of tract- and voxel-wise disconnection. The tract-wise analysis focused on the five major dorsal and ventral language tracts from the Human Connectome Project (HCP-842), while the voxel-wise analysis covered the whole brain. Results. On average, QOL scores were within normal limits for all measures except for anxiety, which was rated as mild. A wide range of QOL scores was, however, observed. Maximum overlap of the primary resection lesions occurred in the left superior medial frontal region, while maximum overlap of both the resection+ and residual lesions occurred in the left posterior temporoparietal region. The VLSM analyses showed that communication-related QOL, but not mood-related QOL, was significantly associated with lesions comprising both the resection+ and residual tumour in the left medial inferior parietal lobe. The tract-wise analyses of white matter disconnection severities failed to reach statistical significance. The voxel-wise analyses of white matter disconnection severities revealed significant associations between communication-related QOL and thalamostriatal fibres for the residual tumour lesions. Paradoxically, higher communication-related QOL was related to more severe disconnection. None of the analyses involving mood-related QOL or the primary resection lesion maps were significant. Summary. Despite evidence of chronic language impairment for the majority of participants, self-rated QOL was largely within normal limits. This may suggest either minimal impact of language impairment on QOL (e.g., due to more subtle deficits) or limited patient insight into their communicative ability due to parietal lobe damage. Communication-related QOL was associated with the resection+ and residual tumour lesion maps, highlighting the importance of progressive tumour infiltration in this population. Finally, higher communication-related QOL was associated with more severe thalamostriatal disconnection, which may also implicate a mechanism for lack of awareness of deficits. Future studies may benefit from obtaining measures of awareness of impairment and corroborating evidence of QOL from family members.

Topic Area: Disorders: Acquired

Poster A33 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Accounting for interindividual variability in normative language network organization to explain post-stroke aphasia deficits

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Introduction: Language function relies on a network of connected brain regions, and there is a high degree of interindividual variability in language network organization in the typical population. Given this variability, the same lesion might cause different outcomes depending on idiosyncrasies of the brain in which it occurs. Yet, the potential impact of this natural variability has not been considered in prior studies of post-stroke aphasia. To account for this variability, we employ a cohort of typically-aging adults to derive a set of normative language networks (NLNs), which catalog the combinations of nodes that activate during a language task in each typically-aging participant. We then quantify lesion-induced disruption by calculating graph theory measures of each NLN in lesioned brains, using connectivity data from a cohort of chronic left-hemisphere stroke survivors. Finally, to investigate if NLN disruption underpins aphasia deficits, we correlate graph theory measures to language scores. Methods: NLNs were derived from 51 typically-aging adults (27 female, mean age 60.0 ± 11.8 years). Mean activation on a semantic decision fMRI task was calculated in all 234 nodes from the Lausanne 2007 parcellation. Each control participant's NLN was defined as the top 10% highest activating nodes. To investigate lesion-induced disruption, functional connectivity (FC) data was collected from 52 chronic left-hemisphere stroke survivors (20 female, mean age 60.7 ± 11.8 years). We performed a graph theory analysis on each NLN's combination of nodes, calculating clustering, global efficiency, and modular FC to quantify segregation and integration in each stroke survivor and the control participant from whom the NLN was derived. This procedure was repeated for all NLNs, such that all control-stroke survivor pairs were examined. Disruption of the language network, factoring in normative variability, was then calculated as the mean difference in graph measures between each stroke survivor and all controls. We then performed a principal component analysis (PCA) on 16 tests of language function in the stroke survivors. Finally, we correlated (Spearman's rho) each principal component score with measures of network disruption in stroke survivors. Results: Our PCA revealed three principal components explaining 83% of the variance in language test performance. These components are summarized as Naming/Word-finding (NWF); Repetition (REP); and Comprehension (COMP). Correlations showed significant relationships (all $P < .005$, uncorrected) between NWF and clustering ($\rho = .401$); COMP and FC within left temporoparietal cortex [LTPC] ($\rho = .454$); and COMP and FC between default mode network and LTPC ($\rho = .404$). FC within LTPC also trended towards a significant relationship with REP ($\rho = .358$, $P = .009$). After controlling for lesion size, the relationships with COMP survive but relationships with NWF and REP do not. Conclusions: The effect of a stroke on brain connectivity depends on properties of both the lesion and premorbid network organization. Accounting for variability in the latter may be critical for understanding observed deficits. Deficits may arise from effects on the language network as a whole, as we observed with naming and fluency, or from disruption of specific subnetworks, as we observed with comprehension and repetition.

Topic Area: Disorders: Acquired

Poster A34 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

On the sensitivity of bilinguals to German and Russian acoustic cues for stop consonants

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Bilingual listeners are able to handle different sets of relevant acoustic–phonetic cues from both languages. With respect to voicing contrasts in stop consonants, Russian and German are based on different laryngeal features. In Russian it is based on voice onset time (VOT, negative vs. positive), whereas in German it depends on aspiration. We predicted that the bilingual speakers would show sensitivity to both Russian and German acoustic cues. Moreover, the language dominance might result in pre-attentive preference of the native cue of the dominant language. We measured the mismatch negativity (MMN) using the roving standard design on three types of contrasts in CV-syllables in a bilingual group and, for comparison, in a German monolingual group. The bilingual group included participants born in Germany to Russian-speaking parents or brought here at an early age. Russian and German native stop contrasts as well as a contrast where both standards and deviants exhibited Russian or German acoustic cues were presented. They were spoken by four female bilingual speakers, balanced for Russian and German as a dominant language. The two groups showed different response patterns. We found an early positivity in the latency range of 200 – 250 ms which could be interpreted as an involuntary attention shift in the roving standard set-up and (late) MMN responses in the latency range from 350-400 ms. An involuntary attentional shift was invoked by the German native contrast with aspirated deviants or Russian deviants with negative VOT after German aspirated stops, i.e. it was set off by the emergence of a cue in the native German contrast or by a cue signaling a switch to the non-dominant language. Late MMN responses were observed to deviants with negative VOT irrespective of the context (preceding standards) in which it occurred as well as to an aspirated deviant in a German native contrast. The monolingual group displayed a different pattern, with an early positivity elicited by the emergence of acoustic cues in native and non-

native contrasts and an MMN response to an aspirated deviant in the non-native context. In sum, bilingual participants responded to both Russian and German acoustic cues without an overt preference of their dominant language. They were also sensitive to the acoustically cued switches towards the non-dominant language.

Topic Area: Multilingualism

Poster A35 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Resting-state functional connectivity of the ventral precentral gyrus

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Past research suggests that functional brain networks underlying speech can be bilateral at rest and left-lateralized during speech production[1]. This seeming contradiction may reflect differences between the dorsal and ventral streams for speech, which are putatively left-lateralized or bilaterally distributed, respectively[2]. In this Sandbox series abstract, we explore the lateralization of dorsal speech production functional networks at rest in healthy older adults. For this purpose, we selected an area in ventral precentral gyrus associated with tongue and larynx in the left hemisphere and its homolog in the right hemisphere. We chose this region because of its unambiguous involvement in speech production, and defined the region based on the Brainnetome Atlas that specifies a tongue-larynx (T-L) region in the ventral precentral gyrus based upon functional and structural connectivity data[3]. Resting-state functional magnetic resonance imaging (rs-fMRI) data of healthy older adults ($n = 46$, $M = 58.89 \pm 8.29$ y) from the publicly available OASIS-3 database were used to analyze the connectivity in the T-L regions[4]. After motion correction, anatomical images were aligned with rs-fMRI data to facilitate spatial normalization, followed by spatial smoothing, regression of nuisance variables, and bandpass filtering. Participants with a minimum of 9 minutes of usable data were retained[5, 6]. We conducted whole brain correlation analyses using the first eigenvariate time series of three seed regions: left T-L region, right T-L region, and a region defined as the bilateral combination of those two. We computed the eigenvariate to find the central tendency in activity of each seed region and extracted this time series for each seed for each subject. Linear correlation coefficients were then computed for the extracted time series for each seed with the time series from every other voxel in the brain. Voxel-wise correlation coefficients were converted into Fisher's z-scores to permit comparison across participants. We first compared the correlations of the eigenvariate from left T-L with right T-L using a paired t-test with AFNI's 3dClustSim to control for false positives (corrected $p < 0.01$). We primarily observed differences in the areas adjacent to left T-L and right T-L, in which each region was more strongly connected to the ipsilateral adjacent voxels. In addition, we observed a stronger correlation between right T-L and the rostroventral area of the right inferior parietal lobule (near the temporal-parietal junction) with no analogous finding on the left. A second analysis compared the functional connections of the bilaterally defined region (left + right T-L) with the whole brain. We observed that this bilaterally defined region was correlated to perisylvian regions in each hemisphere. Additionally, we compared the eigenvariate of the bilaterally defined region with each of the unilateral regions; there were no areas associated with the dual route speech and language processing system that were more associated with the lateralized regions than the bilateral regions. This suggests that even at the level of ventral precentral gyrus associated with the tongue-larynx, the functional connectivity at rest between this area and the rest of the language system is best defined bilaterally.

Topic Area: Speech Motor Control

Poster A36 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

The influence of dopamine genotypes on the relationship between rhythm and syntax processing

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Introduction: Previous research has shown that the ability to discriminate musical rhythms predicts grammar proficiency in children (Gordon et al., 2015; Lee et al., 2020). Here, we investigated genetic factors mediating the relationship between multiple rhythm and grammar skills in adults. Methods: A total of 132 participants aged 18-37 years (mean: 20.2 years; 70 females) underwent an array of behavioral tasks measuring rhythm, grammar, and working memory skills. In the rhythm tasks, participants listened to a pair of rhythm sequences and decided if they were the same or different (rhythm discrimination), tapped their index finger consistently at their most natural and comfortable tempo (spontaneous tapping), and tapped along metronome beats at 36, 53, 80, and 120 beats-per-minutes (auditory beat tapping). In the grammar tasks, participants decided if each spoken sentence was grammatically correct (grammaticality judgment), and identified the gender of the agent in spoken sentences varying in syntactic complexity (i.e., subject- vs. object-relative) (sentence comprehension). In the working memory task, participants heard a sequence of alternating numbers and letters and subsequently repeated them back in numerical and alphabetical orders. After the behavioral tasks, participants were genotyped for the DRD1, DRD2, and COMT polymorphisms. Results: Partial correlation analysis revealed that higher spontaneous and auditory beat tapping consistency predicted higher sentence comprehension and grammaticality judgment accuracy even after working memory being controlled. The results indicated a double dissociation between rhythm and grammar skills. That is, when further controlled for each other, spontaneous tapping correlated only with grammaticality judgment whereas auditory beat tapping correlated only with sentence comprehension. We also found that higher rhythm discrimination accuracy predicted better sentence comprehension and grammaticality judgment performance. Critically, the correlation between rhythm discrimination and grammar performance was more pronounced in DRD1 G/A alleles than DRD1 A/A or G/G. Conclusion: Together, our findings demonstrate (1) that internal (i.e., spontaneous tapping) and external (i.e., auditory beat tapping) rhythm abilities play distinct roles in predicting individual differences in grammar performance and (2) that the relationship between perceptual rhythm and syntax processing is dependent on genetic variations (i.e., DRD1) affecting the dopaminergic system in the basal ganglia.

Topic Area: Language Genetics

Poster A37 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Sleep components involved in the consolidation of new vocabulary and morphological regularities

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It was previously shown that sleep plays an active role in the consolidation of newly learned linguistic information. However, a more accurate mapping of consolidation for various learning types to specific underlying sleep properties, and its relation to the temporal dynamics of consolidation, is still under investigation. In the current study we are assessing the involvement of sleep in learning of novel vocabulary, and novel plural inflections based on implicit morpho-phonological regularities. We consider the temporal dynamics of these learning types and test their association with sleep spindles, which were shown to be connected to overnight consolidation. Participants were trained in the evening on the inflection of 36 novel words, in which morpho-phonological regularities were embedded, and were presented either frequently or infrequently during training. Training was followed by an immediate testing of acquisition and generalization, a night in a sleep lab with a polysomnography, a test in the morning, and additional testing of offline consolidation – 36 hours post-training and one-week post-training. Preliminary data analysis (N=29) indicated a high variability in performance change after sleep, allowing to test associations with sleep more effectively. Overall, memory for novel vocabulary improved over the first night after training, and declined to the initial post-training level throughout the following week. Consistent with previous studies, the dynamics was different for frequent and infrequent items. Both the improvement and the deterioration were significant for the infrequent items (immediate vs. morning: $t = 2.5$, $p = 0.017$; 36 hrs. post-training vs. week after: $t = 3.1$, $p = 0.004$) but not for the frequent items, the performance for which did not significantly change throughout the 4 tests. Both the absolute score in the morning and the overnight improvement for infrequent items were associated with sleep spindle density during slow-wave sleep (SWS; correlation with morning score: Spearman's rho 0.606, $p = 0.001$; correlation with overnight improvement: 0.602, $p = 0.001$). Interestingly, while performance one week post training was not correlated with sleep spindles during SWS it was strongly associated with sleep spindles during the N2 sleep stage (Spearman's rho: 0.583, $p = 0.001$), in agreement with previous suggestions on a different role of spindles during N2 sleep vs. spindles during SWS. We did not find a strong association of sleep spindles with generalization, which relies on regularity learning in this task. To conclude, our results show that distinct sleep components are associated with learning novel items and learning a regularity. Specifically, the temporal dynamics of learning vocabulary vs. learning morphological regularities seem to be different, and accordingly their dependence on sleep differs as well. Spindles occurring during SWS are associated with item learning (vocabulary) but not with regularity acquisition (morphological inflections), and are not associated with the efficacy of the learning process before sleep, but are strongly associated with the overnight change in performance. Spindles during N2 sleep might be associated with long-term retention of novel items.

Topic Area: Morphology

Poster A38 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Neuroanatomical and Developmental Contributions to an Understanding of Mind

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Given a diverse and ever-changing social world, how can we possibly expect to reliably understand those around us? Social psychologists tend to emphasize the importance of generalizable knowledge such as stereotypes for representing others (Allport, 1954). Other scholars have suggested that we construct an understanding of mind within social interaction, an interpersonal capacity that is thought to develop ontogenetically through experience with social interactions (Carpendale & Lewis, 2004). However, research on understanding other minds has largely probed stereotype beliefs outside social interaction, irrespective of interpersonal dynamics or prior social experience. In this longitudinal study, we aimed to disentangle the contribution of stereotype beliefs and interpersonal cues to understanding other minds in social interaction, taking into account neuroanatomical substrates and socio-developmental trajectories. We build on prior work showing that the degree of non-familial social interaction in the first years of life influences how children communicate at age 5, over and above effects of the familial social environment (Stolk ea., 2013). We recruited ninety-six participants from the Nijmegen Longitudinal Study, a community-based sample which has been followed since infancy, to play a live non-verbal communication game when they were 17 years old. Participants were told that they would be playing the game with two partners, sitting in other rooms, alternating between an adult and a 5-year-old child (8 blocks of 5 trials). In reality, a role-blind confederate experimenter performed both roles, such that the two partners differed only in terms of the participants' stereotype beliefs about their cognitive abilities. By precisely quantifying participants' behaviors, we could differentiate between communicative adjustments to stereotype beliefs and interpersonal cues, the latter being embedded in the confederate's behavior and reflecting the actual level of understanding of the two partners. As before, we quantified developmental exposure to two main sources of social interactions, namely familial (number of siblings, socio-economic status) and non-familial experiences (daycare at 15 and 28 months of age). Furthermore, we acquired T1-

weighted MRI scans (n = 71) to identify neuroanatomical variance associated with communicative adjustments to stereotype beliefs and interpersonal cues. Participants placed greater emphasis on communicatively relevant aspects of their behaviors when interacting with the presumed child addressee. These communicative adjustments to stereotype beliefs were prominent at the onset of the game, and correlated with gray matter volume in the right anterior cingulate gyrus (ACCg) as well as cortical thickness across the Theory of Mind (ToM) network, over and above variance associated with adjustments to interpersonal cues. Interpersonal adjustments to the actual communicative behavior of the partners developed through the game, and correlated with the magnitude of non-familial social experiences early in life, over and above variance indexed by neuroanatomical variation in the right ACCg. These findings unify competing accounts of social understanding, showing that stereotype beliefs and interpersonal cues constitute complementary sources of information in developing an understanding of mind in social interaction. Moreover, the findings qualify contributions from cortical regions of the ToM network to social interactions, showing that these regions leverage stereotype representations in tailoring communication to an individual partner.

Topic Area: Development

Poster A39 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Structural covariance network identifies FoxP2 gene allele-specific variations and its association to reading and language

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The Forkhead box protein P2 (FOXP2) gene was first linked to language impairment in the KE family. Since then, genetic associations with several aspects of challenged speech and language function and the alterations in neural structure and function have been revealed. A few studies on FOXP2 single nucleotide polymorphisms (SNPs) have also demonstrated associations between specific SNPs and brain function and structure in the general population. However, the impact of allele-specific variation on neural structure and behavior has not been well-established. In this study, we investigated the allele-specific alterations in three different SNPs of FOXP2 gene which were previously linked to speech and language related alterations in brain function and structure. Genetic, neuroimaging and behavioral data from a total of 45 participants (mean age: 9.70 ± 1.31 years, 17 females) were analyzed for the study. Three SNPs, rs4727799, rs6980093, and rs10249531 were considered and, for each SNP, we compared ancestral to derived genotypes. Cortical morphometries (thickness, volume) were obtained using FreeSurfer toolbox from all participants using the T1-weighted MPRAGE anatomical scans. The obtained cortical measures were then analyzed using a Graph theoretical framework to compute different network measures for each SNP. Finally, relations between morphometry for the significant network of regions for each SNP and behavior (measures of reading and language) was evaluated using support vector regression analysis. We observed that path length and related network measures (global efficiency and closeness centrality) were significantly different between the ancestral and derived genotypes for all three SNPs. For rs4727799 and rs6980093, the ancestral genotype group exhibited significantly ($p < 0.05$, FDR corrected) lower path length and higher global efficiency and closeness centrality in a network of brain regions when compared to the derived genotype group. The network included left (lateral orbital sulcus, anterior insular cortex, precentral gyrus, sylvian fissure) and right (frontomarginal gyrus, pericallosal sulcus and superior parietal gyrus) brain regions. However, for SNP rs10249531, the derived allele carriers showed lower path length and higher global efficiency and closeness centrality in a different network of brain regions. This network included left (inferior prefrontal sulcus, medial occipito-temporal and lingual sulcus) and right (orbital H-shaped sulcus, transverse, and superior temporal cortex) brain regions. Finally, using cortical thickness from these regions we registered an association between language- and reading-related measures (the Woodcock Johnson Word Attack, PPVT, and CTOPP indicators) and genotype. We demonstrate that a structural covariance network approach can reveal FOXP2 allele-

specific variations across a specific network of brain regions. Furthermore, the network of these regions was also predictive of reading and language scores. Importantly, the network of brain regions that differentiated ancestral and derived groups was different for the different SNPs indicating that variation across SNPs impacts different networks in the brain.

Topic Area: Language Genetics

Poster A40 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Resection of putative “Wernicke’s area” is neither necessary nor sufficient to cause “Wernicke’s aphasia” in a neurosurgical population

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“Wernicke’s aphasia” describes a clinical syndrome characterized predominantly by disproportionate impairment to comprehension, classically accompanied by fluent yet paraphasic speech. This syndrome is thought to be caused by damage to “Wernicke’s area”, a term most often used to refer to the posterior third of the superior temporal gyrus (pSTG) and, debatably, aspects of the supramarginal and/or angular gyri. However, the mapping between the two Wernicke-inspired terms is not one-to-one. Inspired by seminal papers by JP Mohr revealing important distinctions between Broca’s area and the region implicated in Broca’s aphasia, here we demonstrate a set of circumstances in which there is a clear lack of correspondence between “Wernicke’s aphasia” and putative “Wernicke’s area”. Drawing from a dataset of 259 individuals, we present 7 cases in which circumscribed resection of the pSTG was performed, along with 21 cases in which a transient Wernicke’s aphasia was induced per the standards of the Western Aphasia Battery (WAB). There was no overlap between these two groups; that is, circumscribed resections of the pSTG did not lead to diagnoses of Wernicke’s aphasia (associating instead with post-surgical deficits in repetition), and diagnoses of Wernicke’s aphasia did not follow from circumscribed resections of the pSTG (associating instead with larger and more anterior resections). Additionally, exact sign tests revealed strikingly preserved single word comprehension relative to sentence comprehension regardless of clinical or anatomical grouping (median advantage for single words: 7.65, $p<0.01$ in the clinically-defined group; median advantage for single words: 4.30, $p=0.02$ in the anatomically-defined group), demonstrating inherent multidimensionality within a composite comprehension measure often used in classifications of aphasia. These cases illustrate that the relationship between anatomically defined “Wernicke’s area” and clinically defined “Wernicke’s aphasia” is not strictly causal, and support prior work demonstrating marked variability within aphasia subtype classifications. Though a limitation is the potential for atypical language organization in this population, recent functional imaging work has suggested that reorganization in neurosurgical cohorts is minimal, particularly in cases with late disease onset, as in the majority of cases described here. These findings have implications for clinical practice in that they caution against over-reliance on preconceived notions of “forbidden zones'' and their functions when making surgical decisions. Furthermore, for the cognitive neuroscience of language, these results demonstrate the need for more precise descriptions of both anatomical regions of interest and clinical language profiles, and invite further investigation of the role of the far posterior STG in language.

Topic Area: Disorders: Acquired

Poster A41 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

The spectro-temporal information distinguishes between speech and music

Yike Li[1], Andrew Chang[1], David Poeppel[1]; [1]New York University

Speech and music are two forms of auditory signals that are related but also highly specialized. The similarities

between speech and music have been characterized across multiple levels, including sound elements, temporal organization, syntax, and even semantics (Patel, 2007), while the fundamental question of how speech and music are treated by the brain as two unique forms with distinct functions remains unclear. Given that previous neuroimaging and lesion studies showed that speech and music are processed differently in the auditory cortex (e.g. Norman-Haignere et al., 2015), we hypothesize that the brain makes the distinction based on the low- to mid-level acoustic properties. Consistent with our hypothesis, previous studies showed that the amplitude modulation rate may be a crucial acoustic feature to separate speech from music (Ding et al., 2017). However, it is not well understood to what extent spectral information is also a crucial acoustic distinction between speech and music, given its essential role in pitch in music and formants in speech. We apply signal processing techniques to speech and music recordings from standardized corpora to extract spectro-temporal modulations. Sound waveforms are transformed into a spectrogram using a filter-Hilbert method, and then decomposed to the modulation domain using a 2D FFT (Flinker et al., 2019). We found that speech and music have different modulation patterns. Speech has a higher temporal resolution and music has a higher frequency resolution. The distinct pattern in speech and music is consistent with past studies on the functional asymmetry of the auditory cortex. It has been shown that temporal modulations are dominantly processed by the left hemisphere and are crucial to speech intelligibility while frequency modulations are primarily processed by the right hemisphere and are critical for pitch-related tasks (Albouy et al., 2020; Flinker et al., 2019). A study on the primary and secondary auditory cortices indicates that the early auditory cortex is selectively tuned to the combination of spectro-temporal information (Schönwiesner & Zatorre, 2009), suggesting that this information may play an essential role in the perception and recognition of different sound categories. New types of behavioral and neuroimaging studies are needed to investigate whether the spectro-temporal modulation pattern is crucial for perceptually distinguishing between speech and music, and how the brain implements this computation. This study extends our understanding of fundamental cognitive and neural principles of human auditory processing and communication, and it potentially benefits individuals with auditory and speech-language disorders, such as persons with aphasia and cochlear implant users.

Topic Area: Perception: Auditory

Poster A42 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Language system contributes to ‘gist’ extraction during code comprehension

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Programming languages, such as Python and C++, are a recent cultural invention that “recycles” cortical systems that evolved for other purposes. Natural and computer languages share some features: They use common symbols (letters and words), both have hierarchical structure, and both are recursive (Fedorenko et al., 2019, TiCS). Does computer programming reuse cortical networks that evolved for language processing? Two recent studies, including one from our lab, suggest that programming does not recycle fronto-temporal language systems and instead makes use of fronto-parietal executive/logical reasoning systems (Liu et al., 2020, eLife; Ivanova et al., 2020, eLife). However, there is strong co-lateralization between the code and the language systems across individuals and some, albeit small, overlap between language- and code-comprehension (Liu et al., 2020, eLife). We conducted follow-up time-course and MVPA analyses to ask whether the language network is involved in the initial stages of extracting meaning from code, whereas the fronto-parietal logic network computes the algorithms. During an MRI scan, expert programmers (mean years of experience=5.7, n=15) read Python functions containing either FOR or an IF control structures, followed by an input, then an output. Participants judged whether the output was correct. Participants performed a memory control task with the same FOR or IF functions but with the words presented in scrambled order, rendering the function meaningless. The same participants also performed a separate language/logic localizer scan where they judged whether two sentences have the same meaning (language) or whether two logical statements are consistent (logic. e.g., if both X and Y then not Z, if Z then not either X or Y?) (Monti et al., 2009, PNAS). As previously reported, in univariate analysis, the code-responsive network identified by real > scrambled code overlapped more with logic than language. In a time-course analysis, the fronto-parietal logic network showed a robust peak of activation around 15 seconds after the onset of code stimuli, consistent with its involvement in the algorithmic processing of code. By contrast, lateral temporal language areas showed a small peak of activation earlier, 5 seconds after code function onset. Surprisingly, multivariate decoding of FOR vs. IF functions was just as robust in lateral temporal language areas (72.3%) as fronto-parietal logic areas (PFC 64.7%, IPS 67.4%). Decoding in language areas was evident in both ROI and whole-brain analyses, showing overlap between language localizer and FOR vs IF function decoding. Could language areas distinguish between FOR and IF functions based on the presence of different words (e.g., presence of the keywords “for” and “if”)? Contrary to this idea, we could not decode scrambled FOR from scrambled IF functions. This suggests that decoding in language areas is not driven by word-level differences. We hypothesize that the language system plays a role in the initial stage of code comprehension during which “gist” information is extracted but the algorithm underlying the code is not yet parsed. Later, the information extracted by the language system is transmitted to the logical reasoning system, where the algorithm is understood.

Topic Area: Meaning: Combinatorial Semantics

Poster A44 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Periodic Chunking of Language: Rhythmic Neuronal Processing Mirrored in Self-Paced Reading?

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INTRODUCTION: Humans segment verbal stimuli into multi-word chunks (Fodor and Bever 1965). Chunks are limited in duration due to cognitive limitations (e.g., memory constraints; Christiansen and Chater 2016). Recently, it has been suggested that the duration and pace of chunking might also be affected by the period of the underlying rhythmic neuronal processes (Meyer et al., 2020; Henke and Meyer, 2021). Periodic electrophysiological activity may relate to phrase-level language processing (Ding et al., 2016). In particular, neural oscillations in the delta band (< 4 Hz) have been found to synchronize with multi-word chunks (Meyer et al. 2017; Henke and Meyer 2021). It remains unclear whether this apparent role of rhythmic activity is behaviorally relevant for language comprehension. It is also unclear what type of cognitive units rhythmic activity may relate to (for discussion, see Kazanina and Tavano 2021). We test here whether behavioral responses during language comprehension show periodic patterns within the range of the delta band. We also assess whether this hypothetical behavioral periodicity links to chunks as formalized through natural language processing (NLP). METHODS: We analyzed self-paced reading data from 180 participants (Futrell et al., 2021). Participants read 10 stories from the National Stories Corpus word by word, advancing through button press. In the first step, we performed frequency analysis on word-by-word reading times (RT) to assess periodicity. RTs were converted into a time-series. To highlight chunking, we performed differencing of the time series, highlighting abrupt changes from slow to fast RTs. Such changes have been related to chunking previously (Tosatto et al., 2021). In the second step, we statistically predicted the slow–fast changes from a model that defines and outputs chunks as saturated local syntactic dependency graphs (Anderson et al., 2019). RESULTS: Frequency analysis showed periodicity of differenced RTs at a frequency of ~2 Hertz, suggesting that slowdown–speedup transitions occur periodically with a period of 0.5 seconds. Moreover, they cluster at sentence boundaries (Just and Carpenter, 1980; Rayner et al., 2000), but also at the boundaries of the cognitive units predicted by our NLP chunker. This was substantiated by regression of reading times on word positions within chunks, which show a continuous increase from chunk on– to offset. Our results provide the first evidence that endogenous electrophysiological rhythms in the delta band are behaviorally relevant for the segmentation of verbal stimuli into multi-word chunks. In other words: Chunking is a periodic behavior, possibly related to the periodicity of the underlying neuronal processes.

Topic Area: Syntax

Poster A45 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Speech connectedness discriminates Alzheimer's Disease from cognitively healthy older adults and is associated with poorer semantic memory

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Connected speech is commonly used over a lifespan in everyday conversation, representing an ecologically valid language production source. Narratives are a type of connected speech that require organizing a sequence of events in chronological order, with a well-established macro propositional organization, such as observing a plot with characters and a scenario. Difficulties with narrative production have been reported in clinical populations, including early-stage Alzheimer's disease (AD). In addition, although deficits in semantic, episodic, and working memory seem to relate to connected speech difficulties, the contribution of each type of memory to connected speech is still not clear for AD. Taking this background into consideration, the aims of the present study are two-fold. First, to verify whether connected speech can differentiate oral narrative production between adults with AD and cognitively healthy older adults (HOA). Second, to verify whether specific speech graph attributes are associated with episodic, working, and semantic memory. Twenty-four AD patients (age=72.75±8.13; education=4.25±3.30) and forty-eight HOA (age=69.85±7.06; education=5.08±3.10) produced oral narratives based on a sequence of pictures, and performed episodic, working, and semantic memory tasks. Narratives were transcribed and each word was represented as a node and the temporal sequence was represented as directed edges. Since AD participants produced narratives with significantly smaller word counts than HOA, the narratives were analyzed using a moving window of a fixed word length (30 words) with a step of one word. Three connectedness attributes were calculated: 1) the number of edges, defined as each temporal connection between consecutive words; 2) the number of nodes in the largest connected component (LCC), defined as the largest set of nodes directly or indirectly linked by some path; and 3) the number of nodes in the largest strongly connected component (LSC), defined as the largest set of nodes directly or indirectly linked by reciprocal paths so that all the nodes in the component are mutually reachable. AD participants produced less connected narratives than the HOA, with fewer edges (p=0.0035) and smaller LSC (p=0.0116). Semantic memory correlated with LCC (Rho=0.59, p=0.002) exclusively in AD. Episodic memory correlated with LSC exclusively in HOA (Rho=0.47, p=<0.001). The results indicate that semantic memory deficits might lead to lower connected speech in AD, suggesting that such a link might represent a marker of AD, as it occurs exclusively under pathological conditions. These results suggest that the macrolinguistic deficits of patients with AD are linked primarily to deficits in cognitive processes in semantic memory rather than in episodic or working memory. Furthermore, while, in typical aging, the more verbal information or details one can access while planning a narrative, the more connected the graph representing that narrative is; in AD, semantic memory seems to take precedence over episodic memory to produce well-connected narratives . Overall, the results demonstrate the relevance of speech connectedness to discriminating between AD participants and HOA, representing a practical tool to assess cognitive impairment in AD patients.

Topic Area: Language Production

Poster A46 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Morphosyntactic comprehension in primary progressive aphasia: evidence from Spanish

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The clinical diagnosis of primary progressive aphasia (PPA) relies on the identification of neurodegenerative impairment with predominant language features. Further classification into one of three variants -semantic (svPPA), logopenic (lvPPA) and nonfluent (nfvPPA) – is based on patterns of relative preservation and impairment in the language domain, as described in Gorno-Tempini et al. (2011). Agrammatism, a heterogeneous constellation of morphosyntactic deficits in production and comprehension, is typically associated with the nfvPPA. Yet, evidence has been accumulating concerning the presence of morphosyntactic impairment in fluent variants, i.e., svPPA and lvPPA (see Auclair-Ouellet et al. 2015 for a review). The goal of this study was to investigate whether and how impairment in the comprehension of morphosyntactic information extends to fluent variants, by capitalizing on the rich morphological system of Spanish. Twenty-eight native speakers of Spanish diagnosed with PPA [9 nfvPPA, 12 lvPPA and 5 svPPA], and 16 age- and sex-matched control participants participated in the study so far. Classification in one of the three variants followed guidelines in Gorno-Tempini et al. (2011) and was supported by neuroimaging and neuropsychological assessment. Participants were visually and aurally presented with 48 sentences (50% incorrect) on a computer and were instructed to evaluate the acceptability of each stimulus. Unacceptable sentences contained different types of morphosyntactic anomalies [e.g., agreement: *Las botellas(pl) está(sg) en la nevera/*The bottles is in the fridge; word order: *Tomamos un café la en terraza del bar/*We had coffee the in bar terrace; verb-argument structure anomalies: *Pinté al mueble nuevo/*I painted to the new piece of furniture]. Analysis of accuracy and response times showed that participants in the three PPA variants were less accurate and slower at evaluating the acceptability of sentences compared to the control group [ACCURACY (%): control – mean: 0.96 (standard error: 0.01); nfvPPA- mean 0.89 (se: 0.03); svPPA: 0.83 (se: 0.06); lvPPA: 0.86 (se: 0.04); RESPONSE TIMES (sec): control: 5.54 (se: 0.82); nfvPPA: 7.16 (se: 0.99); svPPA: 9.16 (se: 1.39); lvPPA: Mean 8.28 (se: 0.91)]. nfvPPA, svPPA and lvPPA groups performed similarly on this task. This set of data show that fluent, as well as non-fluent variants of PPA can show morphosyntactic impairment and suggest that this type of deficit may not be as strong a predictor of the non-fluent PPA variant as once thought. The analysis of a larger sample, together with the inclusion of additional comprehension (sentence-picture matching) and production tasks (sentence elicitation and connected speech) will further elucidate the degree of impairment in this linguistic domain across the three PPA variants. REFERENCES: Auclair-Ouellet, N. (2015). Inflectional morphology in primary progressive aphasia and Alzheimer's disease: a systematic review. Journal of Neurolinguistics. Gorno-Tempini et. Al. (2011). Classification of primary progressive aphasia and its variants. Neurology.

Topic Area: Disorders: Acquired

Poster A47 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Tracking language in naturalistic speech: an EEG investigation of the mechanisms underlying aphasic comprehension

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Tracking language in naturalistic speech: an EEG investigation of the mechanisms underlying aphasic comprehension Individuals with aphasia (IWA) often exhibit marked difficulties in sentence comprehension. Mechanistic accounts of aphasic comprehension have proposed a diverse array of possible causes, such as: 1. intermittent sentence parsing disruptions (Caplan, Michaud, and Huffman, 2015), 2. reduced processing speed (Burkhardt, Piñango, and Wong, 2003), 3. reduced memory resources (Dronkers, et al., 2000), and 4. increased susceptibility to interference/noise (Dickey, Choy, and Thompson, 2007; Gibson et al., 2013). The present study investigates these possible mechanisms by assessing differences in cortical responses for IWA and a group of healthy controls as they passively listen to a set of naturalistic sentences that vary in their length and complexity. We specifically intend to assess how each suggested mechanism may alter the cortical “tracking” of abstract linguistic units (e.g., words and syntactic phrases), which has been suggested as a possible mechanism for internally representing abstract linguistic information. Tracking will be quantified via Mutual Information (MI) between EEG responses and the acoustic envelope of the stimulus materials, filtered at the rate of occurrence for words and syntactic phrases. Critically, because MI is a single measure of statistical dependency between two continuous signals, it may be used as a valid measure of cortical response for relatively few experimental trials. This is specifically relevant to studies of IWA because it allows for a drastically reduced amount of time for recording, consequently reducing the overall task-demands and fatigue that IWA may experience during studies with many trials. To determine whether IWA exhibit altered cortical tracking, MI at word and phrase rates will be compared. Following this, possible mechanisms for aphasic comprehension will also be operationalized and compared between groups. Intermittent deficits in IWA (1) will be quantified as the overall variance in MI that each subject exhibits for items of interest—for example, to words at the word rate and to items that close syntactic phrases at the phrase rate. To assess reduced processing speed (2), we plan to quantify the temporal lags that contain the highest amount of MI at each item of interest (i.e., words/phrase closures) for each subject. To assess reduced memory resources (3), we plan to assess how MI relates to sentence length in each group, and to evaluate susceptibility to interference in IWA (4), we intend to assess how MI relates to syntactic/lexical ambiguity. Following between group comparisons, each factor will be entered into a regression analysis investigating the ways that each relates to severity and aphasia type. These results may provide novel insights into cortical function/disfunction in IWA during online comprehension and may serve as useful tools for evaluating the success of interventions.

Topic Area: Disorders: Acquired

Poster A48 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Theory of Mind in Autism Spectrum Conditions: a task-based neuroimaging approach

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One of the leading hypotheses about the communicative difficulties in autism attributes these difficulties to an impairment in theory of mind (ToM), the ability to understand emotions, beliefs and desires of others (Baron-Cohen et al., 1985). The hypothesis is that impaired ToM abilities might hinder pragmatic interpretation, which requires taking the intentions of a speaker into account (Sperber & Wilson, 2002). However, this assumption has been recently questioned, as autistic people have been shown to perform above chance on pragmatic tasks that theoretically require understanding other people’s mental states, such as irony comprehension (e.g. Chevalier et al., 2011). We test the possibility that autistic individuals process mental states differently than neurotypical individuals by measuring fMRI activity and pupil dilation evoked by an animated movie. This movie was designed to induce mental state inferences, and is known to engage the ToM network in neurotypical individuals (Jacoby et al., 2016; Schurz et al., 2014; Paunov et al., 2019). 41 neurotypical adults and 46 adults diagnosed with Autism Spectrum Disorder matched on verbal IQ watched the six-minute movie in the MRI-scanner. They received instructions to simply watch the movie without any additional objective. Afterwards, we administered a questionnaire assessing their understanding of the plot and key emotional and mental state events. The fMRI analysis contrasted movie sequences previously linked to mental state inferences, emotional processing, and physical events (Jacoby et al., 2016; Paunov et al., 2019). Correlation between time-courses of participants’ pupil diameter during the entire movie (Nastase et al., 2019) was used to identify epochs with between-group differences in similarity of pupil responses. We considered epochs with a duration of 1 second and shorter to represent discrete events, in which primarily single actions of characters take place, and epochs of 5 seconds or longer to represent higher-level events, in which scenes and narrative-building take place. Preliminary results show that movie sequences linked to mental state inferences, as compared to physical events, activate core ToM brain regions (bilateral precuneus, angular gyrus and dmPFC) across both groups to a similar extent. In addition, neurotypical and autistic participants show similar understanding in their verbal descriptions of the movie plot and key events. Moreover, exploratory analyses of pupil size show that movie epochs of the short timescale in which discrete events happen to the characters on screen evoked weaker inter-participant correlation in pupil diameter in the autistic than in the neurotypical group. No such between-group differences were found in epochs at the longer, higher-level time scale. Neurotypical and autistic participants do not show differences on average in ToM processing in a nonverbal movie localizer. This finding corresponds with a large-scale study using a comparable ToM task in the same populations (Moessnang et al., 2020). We plan to use Bayesian inference to affirm this lack of between-group difference in brain activation. Lastly, the difference in synchronicity of processing in pupil size between the two groups might be a sign that autistic people's processing of emotional expressions or physical actions could be distinctive in more subtle ways.

Topic Area: Meaning: Discourse and Pragmatics

Poster A49 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Word reading in autism shows enhanced activation of dorsal visual association cortex

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Previous studies have robustly shown that the neural correlates of word reading for the neurotypical (NT) population largely take place within a left-lateralized network of regions that include higher-order association cortices such as the visual word form area (VWFA), inferior frontal gyrus (IFG), supramarginal gyrus (SMG) as well as middle and superior temporal regions. For individuals with autism spectrum disorder (ASD), however, studies have observed an atypical involvement of sensory and sensory association cortices during word reading. One possibility is that such activation differences may relate to the developmental association of hyperlexia with autism. Hyperlexia is characterized by being able to read aloud beyond grade level, often without an equally advanced ability to comprehend what is being read. In this exploratory study, we examined neural responses to word reading among individuals on the autism spectrum with no obvious language delays and their neurotypical counterparts. If it is the case that reading in autism is associated with greater focus on word-form level processing compared to neurotypical readers, as would be predicted from a history of hyperlexic-style reading, then we predict greater levels of engagement in the visual or visual association regions in individuals with ASD as compared to neurotypicals. Participants were 35 English speaking neurotypical individuals ($n = 19$), and individuals with autism ($n = 15$) that were matched by age, IQ, and verbal IQ. The fMRI scanner task consisted of reading aloud 110 English words randomly intermixed with 110 pseudowords (pseudowords not analyzed here). There were no differences between groups their reading aloud pronunciation accuracy (ASD: $M = 0.97$, $SD = .02$; NT: $M = 0.96$, $SD = .03$, $p = .44$). Groups also did not significantly differ in their Wechsler Individual Achievement Test – Second Edition (WIAT-II) Word Reading subtest scores (ASD: $M = 108.2$, $SD = 4.7$; NT: $M = 110.1$, $SD = 8.3$, $p = .39$). Neural data were processed using AFNI software to contrast brain activations between groups in response to words. Results were thresholded at voxel-level $p <.005$, and cluster corrected to $p<0.05$. Individuals within both groups showed activation in response to words in standard reading-related areas described above (e.g., SMG and middle temporal cortex). When directly comparing ASD and NT groups, there was greater right-lateralized activation in response to words for individuals with autism as compared to neurotypicals with the activation peak occurring in the cuneus, a region of dorsal visual association cortex. Despite having no obvious language delays or differences in pronunciation accuracy and word reading ability, participants with autism exhibited greater activation in the right dorsal visual association cortex, specifically the cuneus, in response to words when compared to a neurotypical population. While this result is outside the canonical visual word form area, its occurrence in visual association cortex suggests a greater than typical association with visual form related-processing in the ASD group when reading. Whether this result indicates an adult vestige of hyperlexia will be the subject of future studies.

Topic Area: Reading

Poster A50 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Music to my ears (and fingers): Investigating causal effects of verbal vs. musical labels on tactile discrimination

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Can language affect the nature of our perception? How much of our perception is shaped by our own language? These questions were investigated using a controlled, within-subject experimental design, where participants associated fine-grained, difficult-to-distinguish tactile patterns on their fingertips with pseudowords and with tones, respectively. Their discrimination ability was tested both before and after the associative learning, to test if there was indeed a difference in their discrimination abilities. Associating a specific tactile pattern to a verbal label such as "fromp," while at the same time associating a similar tactile pattern to a different verbal label, such as "schpepf", may communicate to the learner that, though they share commonalities, these two tactile patterns are indeed distinct.Would, however, musical sequences of tones work as well as language-like stimuli? To address this question, we used tactile patterns, and paired them either with verbal, language-like labels or with matched musical sequences, testing participants' ability to discriminate the tactile patterns both before and after. Tactile patterns were divided into two equally matched sets, and each set was presented systematically and consistently with unique, but task-irrelevant, auditory stimuli. All participants had equal exposure to all verbal and nonverbal stimuli as well as all tactile patterns throughout the study. After five days of exposure, participants showed an overall discrimination improvement in both categories, indicating that this facilitative effect is not limited to creating implicit associations between tactile patterns and verbal labels. There was, however, a significantly greater improvement for patterns which were paired with verbal labels when compared to the patterns paired with non-verbal, tonal sequences, indicating that spoken language may still indeed have an advantage over non-spoken auditory input.

Topic Area: Speech Perception

Poster A51 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Novel metaphor processing in a second language

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Creative language is a powerful tool for sharing new and original ideas. Processing creative language such as metaphor requires conceptual expansion--the ability to extend one's understanding of a concept to include new characteristics and associations (Rutter et al., 2012). Previous research has examined conceptual expansion by comparing the processing of literal sentences, nonsense sentences, and novel metaphorical sentences, using behavioral measures (e.g., reaction times or novelty and appropriateness judgments) and neurocognitive measures (e.g., EEG/ERP). ERP studies have found that semantic anomalies in sentences (e.g., The earthquake defrosted the city) tend to elicit a larger N400 amplitude than novel metaphors (e.g., The earthquake inhaled the city) which in turn tend to elicit a larger amplitude than literal sentences (e.g., The earthquake destroyed the city; Jonczyk et al., 2020; Lai et al., 2009; Rutter et al., 2012). As the N400 is taken to index lexical-semantic access (e.g., Kutas & Federmeier, 2011), this implies that lexical-semantic access of metaphors and nonsense constructions is more challenging than of literal

sentences. From a conceptual expansion perspective, an increased N400 response for novel metaphors compared to literal sentences represents an activation in semantic memory and increased effort to make a connection between distantly related concepts (Rutter et al., 2012). As evidenced by these studies, conceptual expansion is cognitively costly, requiring time and effort to integrate distantly related concepts (Abraham et al., 2021; Jonczyk et al., 2020). Most ERP studies on metaphor processing have focused on monolinguals, largely leaving out bilinguals who must comprehend creative thoughts not only in their first but also in their second language (L2). Conceptual expansion in the L2 may either be more effortful or more efficient than in a first language. On one hand, according to the weaker links hypotheses, L2 semantic networks may be more weakly linked together making connecting distant ideas more difficult (Gollan et al., 2008). Alternatively, bilinguals' experience with navigating conceptual representations in two languages and certain properties of L2 networks such as greater connectivity and shorter distances between connections may allow for more efficient conceptual expansion (Borodkin et al., 2016; Kenett & Faust, 2019). Combining behavioral and EEG methods, this study will investigate L2 novel metaphor processing of sixty Mandarin native speakers who learned their L2 English at school. While EEG is being recorded, the bilinguals will read novel metaphorical, literal, and nonsense sentences in L2 English, and will then judge the novelty and appropriateness of each sentence (as in Jonczyk et al., 2020). Participants' creativity will be measured via the Alternate Uses Task (produce creative uses for common objects), in both Mandarin and English. Participants will also complete a language history questionnaire, verbal fluency tasks (in both languages), and English proficiency assessment (Lemhöfer & Broersma, 2012). If L2 conceptual expansion is relatively effortful, metaphors are predicted to elicit an increased N400 amplitude relative to literal sentences. Alternatively, if L2 conceptual expansion is relatively efficient, metaphors are predicted to yield a similar N400 amplitude to literal sentences. Preliminary data will be presented at the conference.

Topic Area: Multilingualism

Poster A52 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

How long is long? M100 response in Bangla tracks number of phonemes not graphemes of glyphs.

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[INTRODUCTION] Electrophysiological responses demonstrate an early effect of word length (M100) and stem-to-whole word transition probability (TP; M170). These effects localize to posterior and anterior left fusiform gyrus (visual word form area) respectively. The M100 is usually taken to reflect lower level visual processing, while the M170 has been interpreted as reflecting early stages of morphological analysis. However, most research on these responses has focused on languages written in alphabetic scripts, with one character roughly corresponding to one phoneme. How universal are the M100/M170 responses, and does the M100 also reflect linguistic analysis, or a psychophysical response to visual complexity? We report on an MEG study on Bangla, a language with an abugida script. In abugidas, one character corresponds to a consonant. Vowel ligatures are written on either side of the consonant, above, or below it. Some consonants have an unwritten "implicit" vowel, allowing some consonant clusters to be represented as a single complex character. Consequently, there are several distinct ways to quantify word length, e.g. প্র(prô) consists of 1 grapheme, 2 glyphs: প(p) and ্র(r), and 3 phonemes: /p/,/r/,/o/. We ask two questions:(1) Which measure of word length best correlates with the M100 response? and (2) Is a stem-to-whole word TP-effect observed in the M170 response? Preliminary results suggest that M100 responses reflect the number of phonemes in the word, suggesting that the M100 response indexes rapid abstract linguistic analysis. [METHODS] MEG recordings were obtained from 22 Bangla speakers(18-62 years,$\bar{X}$=28) as they performed a lexical decision task. Stimuli consisted of 152 morphologically complex words and 152 pseudoword fillers(not reported). Three different measures of length were calculated from indicNLP(966 million words): number of graphemes, number of glyphs (unicode derived, nchar() fn in R), and number of phonemes (native speaker annotated).TP was estimated as the log of lemma frequency to stem frequency.

[RESULTS] 600ms epochs were extracted for each word. We used a two-stage regression analysis in which regressions were fit at each time-point and source point per subject for factors of TP and word length.There were six regressions–TP+word length for 3 definitions of word length in two separate time windows. Spatio-temporal cluster-based permutation tests were conducted on the one-sample t-test values derived from the beta coefficient of the regressions in left fusiform gyrus in the M100(100-130ms) and M170(170-200ms)time window. After correction for multiple comparisons, only one word length cluster was significant($p = 0.01$), corresponding to number of phonemes in posterior left fusiform gyrus from 100ms-130ms. One TP cluster was significant and negatively correlated in anterior left fusiform gyrus from 170ms-200ms($p = 0.04$). No other significant clusters sensitive to any other word length measures were identified. [CONCLUSION] Early visual responses to words suggest rapid analysis of abstract linguistic structure. Our results leverage the complexity of an abugida system to demonstrate that the M100 response is modulated by the number of phonemes in a writing system without a clear one-to-one phoneme-grapheme correspondence, and that the M170 reflects stem-to-word TP, consistent with results for other languages (see Wray et al 2021).

Topic Area: Morphology

Poster A53 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Mu (μ) activity during vowel quantity perception with rhythmic priming

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This paper investigates how regular and irregular rhythmic priming affects the brain processing of speech contrasts when they are maintained in memory prior to response. An electroencephalography (EEG) experiment was performed where participants ($n = 15$) discriminated between syllables in both quiet and noise (-5 dB SNR). Stimuli were two syllable pairs which were either the same or they differed in duration by 45 ms. A vowel quantity contrasts are relevant as they are generally distinctive, salient in noise and encountered in everyday speech. Priming was realized with pink noise pulses that were distributed in the 2.5 s priming window to form a rhythm for the regular primes. The beat of these rhythms was aligned with the second member of the stimulus pair, which was either same or different as the first. Irregular primes included the same number of rhythmic elements, but these were pseudo-randomly distributed within the priming window providing no such beat. Behavioral performance in the discrimination task was high for both priming conditions, and the effect of noise background and priming was not significant. In the neural data, mu (μ) activity derived from EEG data, based on the spectral content of candidate components revealed time-frequency differences in alpha-μ. This occurred during a maintenance period and was in the right hemisphere for primes and the left for syllable pairs. Differences in the spectral content of μ-components were also found for the syllable pairs and the noise background. These results suggest that rhythmic priming can have a bearing on the neural circuitry that is drawn on to process speech. This will be discussed in the context of rhythmic priming, perceptual-phonological effects and continued work on μ-activity that probes the linkage between speech perception and production.

Topic Area: Perception: Auditory

Poster A54 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Spatiotemporal dynamics of concreteness

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Language comprehension relies on rapidly navigating the boundary between concrete words (perceptual: 'table') and abstract words (non-perceptual: 'justice'). Consistent behavioral differences have been found between these categories, such that concrete words are faster to make lexical decisions about and offer processing advantages. Any neurobiological model of human semantics will ultimately need to make reference to the concrete/abstract formatting of conceptual representations. While behavioral effects between concrete/abstract words are consistent, in stark contrast the neurobiological effects differ substantially. Controversy exists over regions of activation corresponding to concrete/abstract words, often due to the range of methodologies and differences in task complexity. There remains no consensus concerning the contribution of nodes in the semantics network to concreteness. Many previous studies have not separated single-word from sentence-level paradigms, confounding potential effects. We present an intracranial investigation in a cohort of epilepsy patients (n = 15) of the spatiotemporal dynamics of concreteness using an orthographic single-word concreteness judgment paradigm. We additionally conducted cortical stimulation mapping in a group of these patients (n = 6) to attribute causality to nodes in the semantic network. Patients were presented with a single word on a screen and asked to judge whether it referred to something you could touch, taste, smell, see or hear. A fixation cross was presented in the center of the screen for 700 ms, after which orthographic single-word exposures lasting 1000 ms were presented. 1500 ms of blank screen followed during which patients had to press either the left arrow (Concrete) or right arrow (Abstract). We recruited a large list of concrete, abstract and 'midscale' words (that occupy the middle of the concreteness scale; e.g. 'magic', 'translation', and for which there is no incorrect answer) from a comprehensive review of databases for concreteness ratings. Data were acquired from either subdural grid electrodes or stereotactically placed depth electrodes. Typical coverage was frontotemporal, dictated by location of the epilepsy in the antero-mesial temporal lobe in the majority of patients. Behavioral performance was high (>80% for all) and only correct trials were analyzed. Analyzing broadband high gamma activity (BGA; 70–150 Hz), we discovered a frontotemporal network for concreteness, implicating mid-fusiform gyrus (mFus), parahippocampal cortex (PHC), inferior frontal gyrus (IFG), orbitofrontal cortex (OFC) and frontal operculum (FO). The earliest effects were found first in OFC, followed by mFus and PHC. Analyzing directionality via amplitude-envelope correlations in BGA, information flowed from OFC to FO, PHC, temporoparietal junction (TPJ) and both aIFG and pIFG (~350 ms for pIFG), and slightly later (~500 ms) from pIFG to OFC and FO. Only in FO at approximately 800–1000 ms did patient subjective responses for midscale words impact BGA, showing greater activity for concrete-rated midscale items. Lastly, we used direct cortical stimulation to attribute causal involvement of certain nodes in this network (ventral temporal, inferior frontal) to concreteness, successfully disrupting judgments for concrete words. Our work unveils the fine spatiotemporal dynamics of the semantic network and affords causal power to our documented concreteness network.

Topic Area: Meaning: Lexical Semantics

Poster A55 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Critical brain regions and tracts for syntax acquisition

Mariacristina Musso[1], Orionas Saprikis[1], Simon Kirsch[1], Volkmar Glauche[1], Cornelius Weiller[1]; [1]Uniklinik Freiburg

Introduction: Friederici et al. (2006) reported that novel finite state grammar (FSG) relates to the phylogenetically ventral system centred in the frontal operculum, while phrase structure grammar (PSG) to the phylogenetically younger dorsal system centred in the pars opercularis of Broca's area. We aimed to investigate if this dissociation could be confirmed in a lesion mapping study in chronic stroke patients. Method: The experiment consisted of three condition-blocks: two tested artificial grammar (AG) acquisition within FSG and PSG, and one tested verbal WM. Correct syllable sequences were generated by FSG or PSG or including at least two of the three target syllables in the WM condition. Incorrect syllables sequence violated the hierarchical dependency of the elements via scrambling or permutation. In the AG conditions, participants performed first a preference classification and, after receiving an implicit-training, a grammatical classification. In the last testing session, the lexicon was changed to test the ability to generalize novel syntactic competence. Support vector regression analysis using the SVRLSMgui package (DeMarco & Turkeltaub, 2018) was used for symptom mapping in 44 left hemispheric stroke patients. Lesion's volume, age, educational age, gender, performance in Corsi, and WM condition were linearly regressed. DTI global tractography from a normative human connectome database was used to visualize the pathways and their cortical termination going through the white matter lesions mapping performance's deficits. Results: As reported in Kirsch et al. (2022), the most relevant predictors for syntax acquisition in each session were grammaticality (grammatical>ungrammatical items) and education. FSG was better than PSG but only within grammatical items in the pre-training sessions, while within ungrammatical items in the post-training sessions. Generalization was possible only in PSG. Worse performance of grammatical preference was localized in the putamen, parieto-temporal cortex, the arcuate fascicle (AF) and capsula-extrema/Unicinatus fascicle (Emc/UF) for grammatical PSG items; in the STG, caudatus and dorsoventral system for grammatical FSG. Worse performance of grammatical classification was localized in the AF for PSG, and in the dorsoventral systems for FSG. More specifically, lesions of STG, Insula, AF, and putamen were associated with poor performance within grammatical PSG; Insula, Putamen, AF, and dorsoventral pathways for grammatical FSG; parietal cortex and Precuneus for ungrammatical PSG; Insula and AF for ungrammatical FSG. Low training contribution (S3>S1) was associated with AF lesion for grammatical PSG; Insula and dorsoventral pathway for grammatical FSG; temporal and dorsal/MDLF pathway for ungrammatical PSG; Insula for ungrammatical FSG. Voxels significantly correlated with generalization's deficits (S4>S3) were localized in the EmC/UF for grammatical PSG, while in the AF for ungrammatical PSG; in the SMG for ungrammatical FSG. Discussion: Both GT required intact dorsal language-systems to be correctly classified after learning. Lesions of the dorsal/dorsoventral system reduced the ability to learn to classify via implicit feedback. Moreover, the AF lesion was associated with deficits of recognizing ungrammatical items when using a novel lexicon. The ventral system was relevant for the intuitive grammatical preference of both GT. PSG required the integrity of the more extensive ventral system including the UF for grammatical preference and generalization.

Topic Area: Syntax

Poster A56 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Cortical Thickness is Related to Variability in Bilingual Language Proficiency

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Historically, research has tried to understand how language networks in the brain develop in monolinguals (i.e., people who know a single language), but increasingly, research is focusing on language network development in bilinguals (i.e., people who know two languages). Research suggests that bilingual experience is associated with grey matter changes such that initial language gains are associated with grey matter expansion and language expertise is associated with grey matter renormalization. Previous studies on language skill development primarily focused on between-subjects, quasi-experimental comparisons of monolinguals and bilinguals. This study proposes a new paradigm to examine language expertise and cortical thickness within bilinguals (n = 215), as well as between bilinguals and monolinguals (n = 145). Cortical thickness was chosen as the measure of grey matter because of its experience-dependent development. Data was combined from eight different studies; thus, language skill was assessed using the Boston Naming Test and/or the Woodcock-Muñoz Language Survey – Revised picture vocabulary subtest along with either the passage comprehension subtest or listening comprehension subtest. Performance on these measures was calculated as a proportion (total correct/total possible), and when participants completed more than one of these measures, their percentages for each measure were averaged to create a total measure of language skill. Several two-tailed general linear models were conducted in each hemisphere to analyze the data for the current study, each with cortical thickness as the outcome variable. Analyses were conducted in all participants with English language skill and language group (monolingual vs. bilinguals) as the predictors and SES as the covariate. Other analyses were conducted within language group, with one model focused on English monolinguals with English language skill as the predictor and SES as the covariate, and the second model focused on Spanish-English bilinguals with English or Spanish proficiency as the predictor, controlling for the other language proficiency, English age of acquisition, and SES. A Monte Carlo simulation was applied to each general linear model to correct for multiple comparisons when determining significant clusters. In general, results highlight variability within bilinguals, finding relationships between cortical thickness and English proficiency that are relatively consistent within monolinguals, but inconsistent within bilinguals. Across all participants, higher levels of proficiency in English—monolinguals' only language and bilinguals' second but stronger language—were negatively related to cortical thickness in various frontal, temporal, and parietal regions. Moreover, there was an interaction between language group and English skills in predicting cortical thickness, such that monolinguals showed a stronger relationship between English proficiency and thickness than bilinguals in the caudal middle frontal gyrus and the superior frontal gyrus. Within bilinguals, language skill in L1 (Spanish) was positively correlated with cortical thickness in frontal and parietal regions, while language skill in L2 (English) was negatively correlated with cortical thickness in frontal regions. Findings also show differing lateralization within the bilingual brain, such that L2 (English) is more left-lateralized than L1 (Spanish). Future directions for cognitive-developmental neuroscience research in bilinguals are suggested.

Topic Area: Multilingualism

Poster A57 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Reduced phonological working memory in autism is associated with altered speech-motor engagement

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During language development, children rapidly learn new vocabulary through the complex coordination of the neural systems that underlie speech perception, working memory, and speech production. Phonological working memory - the ability to maintain and manipulate speech information - is believed to play an important role in language development, and is often disrupted in many developmental communication disorders, including autism and reading disabilities (Macizo et al., 2016; Peter et al., 2011). Clinicians and researchers often use nonword repetition as a measure of phonological working memory, which has high sensitivity and specificity for developmental language disorders (Estes et al., 2007). Autistic individuals, for example, frequently demonstrate worse performance on nonword repetition tasks (Gabig, 2008; Williams et al., 2006). Little is known about why phonological working memory is disrupted in autistic children, or why their nonword repetition difficulties appear unique from those found in other language disorders (Nadig & Mulligan, 2017; Williams et al., 2013). The primary aim of this study was to identify the brain bases of phonological working memory difficulties in autism. The second aim was to ascertain the specificity of the functional brain differences observed in autistic children during nonword repetition. Children with autism ($N = 23$, mean age = 12.2, $SD = 3.4$), children with reading disabilities ($N = 16$, mean age = 11.5, $SD = 3.1$) and typically developing children ($N = 28$, mean age = 11.9, $SD = 3.2$) participated in this functional magnetic resonance imaging (fMRI) study. While in the fMRI scanner, participants repeated nonwords distributed across four syllable loads (2- to 5-syllables). We used complementary univariate and multivariate pattern analyses to examine whether the atypical phonological working memory abilities seen in autism were associated with functional differences in each of the three key brain networks involved in nonword repetition: speech perception, working memory, and speech production. We then investigated whether the neural differences seen in autistic children were also found in a group of nonautistic children with a reading disability. Compared to the neurotypical group, the autism group and the reading disability groups performed worse on the nonword repetition task ($p < 0.0001$ for both comparisons). The univariate analyses (cluster-defining threshold $p < 0.01$, cluster-level FWE-corrected threshold $p < 0.05$) revealed that the autism group, compared to the neurotypical group, had reduced responses to increasing syllable length in the supplementary motor area. The multivariate pattern analyses showed that decoding accuracy between 2- and 5-syllables was significantly higher within the speech production network for the NT group than the autistic group ($t(47) = 2.5$, FDR-corrected p <

0.05). Higher decoding accuracy in autism was associated with less severe autism-related symptoms (R's > 0.3). The atypical motor findings held when ASD and neurotypical groups were equated for language proficiency. The reading disability group with nonword-repetition difficulties, in contrast, did not show such atypicalities in speech-motor functions. Our findings suggest that brain-based alterations in motor planning underlying nonword repetition may uniquely contribute to phonological working memory difficulty in autism.

Topic Area: Disorders: Developmental

Poster A58 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Network models of semantic cognition theories show differential mediation of language production by white matter tracts

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Semantic cognition is critical to language production and comprehension. Patients with semantic impairment due to neural disease have language disabilities that profoundly disrupt daily living. However, the anatomical basis of semantic cognition is as yet poorly understood, with proposed theories implicating left-lateralized regions in the peri-sylvian fissure to a broader network comprising nearly the entire brain. To evaluate the various models of semantic cognition as predictors of language production performance, we used a network neuroscience approach along with behavioral tests. N=31 native English-speaking healthy adults (Age= 25.6 +/- 6 yrs, 13 male) participated in the study. All subjects underwent Diffusion Spectrum Imaging (DSI) scans, with adjacency matrices computed from pairwise region to region streamlines among 234 brain regions reconstructed from tractography within each subject. Each participant completed 2 language tasks: Verb generation and Sentence completion. Networks corresponding to each language model were constructed for each subject: 1. Left inferior fronto-occipital fasciculus (IFOF), 2. Inferior longitudinal fasciculus (ILF), 3. Uncinate fasciculus (UF), 4. Peri-sylvian language network, and 5. Connections from language network to rest of brain. The mean of streamline edge weights, a measure of strength of anatomical network connections, was obtained for each modeled network. A stepwise linear mixed effects modeling approach using Ln(response times) as the behavioral outcome measure was used. For Verb generation, the IFOF ($p<0.001$) and ILF ($p=0.015$) significantly predicted responses. UF, Peri-sylvian language network, and edges from language network to rest of brain were not significant ($p>0.05$). For Sentence completion, models of UF ($p=0.0044$) and Peri-sylvian language network ($p<0.001$) were significant. ILF, IFOF, and edges from language network to rest of brain were not significant ($p>0.05$). This research represents a novel use of network neuroscience to evaluate theories of semantic cognition, identifying relationships between semantically demanding language tasks and specific tracts with connections across the brain. The results corroborate prior fMRI studies on the role of IFOF in semantic processing and retrieval, and the relevance of IFOF and ILF but not UF in Verb generation. Further, a double dissociation between networks predicting Verb generation (IFOF and ILF) and Sentence completion (UF and Peri-sylvian language network) was seen. These findings suggest a neurobiological basis of differential recruitment of language network regions according to the specific semantic processing task.

Topic Area: Computational Approaches

Poster A59 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Reading ability and dynamics of choline levels across early childhood

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Growing evidence shows that brain metabolite levels are related to reading ability1–3 and reading-related skills2,4–6. Specifically, elevated choline, a metabolite involved in membrane synthesis and repair7, has been linked to poorer

reading1 and may reflect higher levels of myelin turnover in poorer readers1. The association between choline and reading skills across development is unclear: some studies have shown effects limited to specific age groups2 or participant sex8. Choline levels decline across infancy9 and into childhood10, so accounting for the dynamic fluctuation of choline levels across early childhood may clarify links to reading. We will investigate relationships between choline levels across early childhood and reading ability in beginning readers. Data will be drawn from a longitudinal study of early childhood brain development11. We expect to include approximately 192 datasets from 46 participants ranging in age from 2.5-7.9 years. Choline levels were measured in the left temporo-parietal region (LTP), a key hub of the reading network, using short echo Point RESolved Spectroscopy (PRESS, TE = 30 ms, TR = 2000 ms, 128 averages, 15 x 20 x 15 mm voxels) acquired on a 3T GE MR750w MR system. T1-weighted anatomical images (210 axial slices; 0.9 x 0.9 x 0.9mm resolution, TR = 8.23 ms, TE = 3.76 ms, flip angle = 12º, matrix size = 512 x 512, inversion time = 540 ms) were acquired and used for placement of MRS voxels and tissue quantification. MRS data has been preprocessed using the FID-A toolbox12 and metabolites have been quantified using LCModel v. 6.313 and corrected for CSF14,15. Word reading and pseudoword decoding were assessed using the Woodcock Reading Mastery Test III16. Sub-test scores at grade 2 will be averaged for a composite reading score. Relationships between choline and reading ability will be tested using latent change score models17. We will address the following questions: (1) Are choline levels related to concurrent reading ability in beginning readers? (2) Does choline measured at the pre-reading stage predict reading outcomes at the beginning reading stage (grade 2)? (3) Are longitudinal changes in choline from pre-reading to beginning reading stages (linear slope) associated with reading ability in beginning readers? We predict that (1) lower choline levels at grade 2 will be associated with higher concurrent reading abilities; (2) lower initial choline levels (at the preschool stage) will be associated with higher reading abilities at grade 2; (3) a more rapid decline in choline across early childhood will be associated with better reading at grade 2. References 1. Pugh. J Neurosci. 2014 2. Kossowski. Sci Rep. 2019 3. Cecil. Brain Res. 2021 4. Lebel. Brain Behav. 2016 5. Bruno. Neuroimage. 2013 6. Del Tufo. Front Psychol. 2018 7. Rae. Neurochem Res. 2014 8. Horowitz-Kraus. Front Hum Neurosci. 2018 9. Blüml. Cereb Cortex. 2013 10. Perdue. OHBM. 2022. (poster) 11. Reynolds. Data Br. 2020 12. Simpson. Magn Reson Med. 2017 13. Provencher. Magn Reson Med. 1993 14. Near. NMR Biomed. 2020 15. Gasparovic. Magn Reson Med. 2006 16. Woodcock. 2011. 17. Kievit. Dev Cogn Neurosci. 2018

Topic Area: Reading

Poster A60 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Semantic Feature Analysis augmented by anodal HD-tDCS: A case series examining functional connectivity and behavior change in aphasia

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Difficulty retrieving the correct phonological information for speech production is a common deficit after left hemisphere stroke causing damage to posterior perisylvian cortical regions. In a recent fMRI study of people with aphasia (PWA) with primarily phonological system damage and preserved semantic function, the left angular gyrus (AG) was activated more when participants correctly read words aloud than when they made errors (Pillay, et al., Journal of Cognitive Neuroscience, 2018). This suggests that activation within the perilesional semantic system promotes or ‘boosts’ phonological retrieval when the phonological retrieval system is damaged. We hypothesized that applying high-definition transcranial direct current stimulation (HD-tDCS) to the AG while patients received semantic-focused speech therapy (Semantic Feature Analysis, SFA) would promote reorganization of semantic networks and increase connectivity between semantic and phonological networks. We used resting-state fMRI (rs-fMRI) and detailed language assessment to examine the persistent changes of this intervention. Four PWA with phonological impairment from chronic left middle cerebral artery stroke received two 10-day cycles of SFA therapy during anodal HD-tDCS (4x1

montage, 2mA, 20 min) to the left AG or sham/control HD-tDCS in a cross-over design. All participants were left-hemisphere dominant for language pre-therapy based on a well-validated fMRI language task protocol. Functional connectivity fMRI and language assessments were completed at 3 times (pre-therapy, 10 weeks after cycle 1, 10 weeks after cycle 2). Participants were trained on words and pictures that were baseline-tested twice using an adaptive procedure to identify items they reliably could not name, and to ensure that the items chosen represented an optimal level of difficulty. Matched untrained lists were created to assess generalization. Twenty minutes of rs-FMRI data from each session were denoised using ICA-AROMA. Pairwise connectivity was computed between Brainnetome atlas parcels comprising the left semantic (Lsem) and phonological (Lphon) networks and their right hemisphere homologs (Rsem and Rphon). After AG-tDCS, significant connectivity increases were observed within Lsem and between left and right Sem networks. Connections between Lsem and Rphon and between Rsem and Rphon became more negative (inhibitory). After sham/control-tDCS, connections increased within Rsem networks and became less inhibitory between Rsem and Rphon networks. Other network changes after either AG or control-tDCS were variable across participants. Mild to moderate gains on untrained items were observed across all participants, with slightly better performance after AG-tDCS (Mean change, words: 38%, pictures: 26%) compared to control/sham cycles (Mean change, words: 27%, pictures: 5%). The study is ongoing, and some procedures are incomplete for two of the participants at the time of submission. These preliminary results suggest that stimulation of a left-hemisphere semantic region during SFA therapy increases intra-hemispheric and inter-hemispheric semantic connections, while inhibiting connections with the right phonological system. These changes were associated with improved performance on untrained reading and picture naming items. Additional data are needed to identify significant correlations between behavioral and functional connectivity changes.

Topic Area: Language Therapy

Poster A61 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Heterogeneous neural responses distributed across the language network revealed by electrocorticography

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A left-lateralized network of frontal and temporal brain regions is specialized for language processing, spoken, written, or signed. Different regions of this ‘language network’ have all been shown to be sensitive to various kinds of linguistic information, from combinatorial sentence structure, to word meanings, to sub-lexical/phonotactic regularities (Fedorenko et al., 2020; Regev et al., 2021). However, whether neural computations are the same across these different brain regions remains debated. A key limitation of many past studies is the poor temporal resolution of fMRI—a dominant imaging modality in language research. Smearing the fine details of neural responses across time potentially obscures important aspects of the neural computations that support language comprehension. To shed light on this debate, we present data from 6 patients with intractable epilepsy, who were implanted with electrodes placed directly on the brain surface and agreed to perform a language task that has been extensively used in past fMRI work. The task included reading sentences, lists of unconnected words, ‘Jabberwocky’ sentences (which contain a syntactic frame made up of function words and functional morphological endings, but in which content words are replaced with nonwords), and lists of unconnected nonwords, followed by a word/nonword memory probe. These data (from n=106 language-selective electrodes, defined by a significant Sentences>Nonwords effect, as in Fedorenko et al., 2016) reveal functionally heterogeneous responses (high gamma power, 70-150Hz range; Crone et al., 1998) to these four conditions. Furthermore, electrodes appear to differ in their temporal dynamics over the course of the 8-word/nonword-long stimulus, and in the degree of their time-locking to the stimulus. To formally evaluate these apparently distinct functional-temporal profiles, we performed k-means clustering on all language-selective electrode responses and identified 4-6 main response types, which together explained over 80% of the variance in the data. One response type showed a strong preference for sentences over all other conditions (presumably supporting sentence structure building) and showed weak stimulus time-locking. Another response type showed stronger responses to sentences and word lists over the other conditions (presumably supporting the processing of word meanings) and more time-locking to the stimulus. Yet another response type showed a relatively strong response to nonwords (presumably sensitive to sub-lexical regularities) and a strong degree of stimulus time-locking. Interestingly, all of these response types were distributed across the various parts of the language network, in both temporal and frontal regions. Notably, in line with previous fMRI reports, no electrode showed stronger responses to the Jabberwocky condition, which aims to isolate syntactic processing, relative to the word-list condition, which targets lexico-semantic processing. These results demonstrate the functional heterogeneity of neural responses in the language network, and highlight the diverse temporal dynamics that may give rise to neural computations needed in order to extract meaning from linguistic input. The mosaic of neural responses across the language network suggests that all regions of the language network have direct access to distinct response types—a property that may be crucial for the function of the language network.

Topic Area: Computational Approaches

Poster A62 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

The heterogeneous engagement of the language network during statistical learning

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Recent behavioral research has demonstrated a reciprocal relationship between prior language experiences and performance during statistical learning (SL). Despite the significant overlap between SL and language in their richness of regularities, it remains unknown whether the neural network involved in language processing is similarly engaged in SL. The current study probes whether individuals recruit the same brain regions equally across language processing and SL tasks. Twenty-two adults completed an auditory SL fMRI task (Schneider et al., 2020) and an auditory language localizer fMRI task (Scott et al., 2017). Group-level univariate analyses revealed neural engagement during SL in regions often associated with language processing. To directly test whether engagement during SL occurred in language-specific regions across individuals, we constructed a set of functional regions of interest (fROI) from the language localizer task by contrasting intact and degraded conditions (similar to Fedorenko et al., 2010). From this parcellation of the language localizer maps, eleven fROIs emerged: two in the left superior temporal gyrus – posterior and anterior, left middle temporal gyrus, left temporal pole, left precentral gyrus, the left inferior frontal gyrus pars opercularis, two in the right superior temporal gyrus – posterior and anterior, right middle temporal gyrus, right temporal pole and right precentral gyrus. Within this subject-specific language network, the bilateral superior and middle temporal gyri were activated during the SL task, showing greater neural activity in response to processing structured versus random syllable sequences. However, due to inter-subject heterogeneity in brain activation during SL, there was no significant conjunction in these same regions across learners. Moreover, each participant's patterns of neural activation were not correlated across the two tasks. Using a search-light multi-voxel pattern similarity analysis approach in the whole brain, we identified a brain region outside of the classic language network, the left supramarginal gyrus (LSMG), that showed significant correlated patterns across the two tasks for 60% of learners. Further investigation of this correlation revealed that, for the 60% of participants who showed cross-task correlation in the LSMG, the LSMG was only actively recruited for the auditory SL task, but not for the language task. Our approaches, relying on rigorous functional localization techniques, confirmed the involvement of language regions during SL. We identified that the bilateral MTG and the left STG, parts of the frontotemporal core-language network (Fedorenko & Thompson-Schill, 2014, Price 2010), are sensitive to embedded regularities in a stream of meaningless syllables. These findings are consistent with previous reports on the activation of temporal cortices in various auditory SL paradigms (McNealy, Mazziotta, & Dapretto, 2006; 2011; Karuza et al, 2013; Plante et al., 2015; Cunillera et al., 2009). In addition to these important confirmatory results, our study contributes to the recent emerging literature on individual differences of SL (e.g., Erickson et al., 2016; Siegelman et al., 2015; 2017), by providing neural evidence for heterogeneous learning patterns across individuals.

Topic Area: Speech Perception

Poster A63 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

A Coordinated Temporal Interplay within the Language Network: Evidence from TMS-EEG during Sentence Processing

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Introduction. Sentence comprehension is supported by the coordinated temporal interplay within a left-dominant brain network, including the posterior inferior frontal gyrus (pIFG), posterior superior temporal gyrus and sulcus (pSTG/STS), and angular gyrus (AG). In two transcranial magnetic stimulation (TMS) experiments, we used a condition-and-perturb approach to investigate how these distinct brain regions interact during auditory sentence processing. Combined with simultaneous electroencephalography (EEG) measurements, our experiments allowed for a time-sensitive investigation of how sentence-based semantic processing (i.e., as reflected by the N400 response) is affected by the combined perturbation of two language-related brain regions (i.e., AG-pIFG and AG-pSTG/STS). Methods. In each TMS-EEG experiment, the neural excitability of left AG was temporarily reduced ("conditioning") using 40 seconds of offline continuous theta burst stimulation (cTBS). Next, native German speakers listened to short sentences (i.e., pronoun-verb-article-noun) in which the semantic expectancy for the sentence final noun was either high (e.g., He drinks the beer) or low (e.g., He sees the beer), depending on the prediction given by the verb. In Experiment 1, we applied three pulses (10 Hz) of online repetitive TMS (rTMS) over either left pIFG or left pSTG/STS at mid-sentence verb onset ("perturb"). In Experiment 2, online rTMS perturbation over left pIFG was shifted to a later point in time (i.e., 150 ms after verb onset). In both experiments, sham stimulation was included as an ineffective control condition. Using linear mixed models, we investigated how rTMS perturbation modulated the N400 response at the mid-sentence verb as well as at the sentence final noun. Results. Both experiments showed that cTBS over left AG ("unifocal perturbation") was not sufficient to affect semantic-based processing, as reflected by a lack of modulation of the N400 response at both the verb and noun position. Nonetheless, cTBS over left AG did sensitize the language network to a disruptive effect of subsequent online rTMS over left pIFG and left pSTG/STS at the mid-sentence verb position. When applied at verb onset, online rTMS over the left pSTG/STS showed functional significance whereas stimulating the left pIFG did not. However, when rTMS was shifted 150 ms later in time, the left pIFG did show a clear functional effect, thereby giving insight into the temporal interplay of regions within the language network. Importantly, both online rTMS effects outlasted the stimulation duration (i.e., mid-sentence verb) and modulated the N400 effect at the sentence final noun, providing causal evidence for verb predictive processing (i.e. predictive coding) during auditory sentence processing. At the behavioral level, no significant modulation of rTMS was found. Conclusion. Together, these findings highlight the joint contribution of left pIFG, left pSTG/STS, and left AG to sentence comprehension, with a clear processing order of left pSTG/STS followed by left pIFG. Consequently, they provide interesting new insight into the temporal dynamics of single word processing in a sentence context. Moreover, our results show that neural markers are more sensitive to modulatory rTMS effects than behavioural measures.

Topic Area: Speech Perception

Poster A64 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

A functional role for perceptual brain systems in processing words with visual meaning

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Findings from neuropsychology and neuroimaging studies suggest that sensory brain regions are relevant for semantic language processing. However, whether perceptual systems of the brain functionally contribute to the processing of words with visual meaning remains controversial. The aim of this study was to investigate whether perceiving visual stimuli (colors and shapes) has a differential effect on working memory for words referring to colors (e.g. green, mauve) and words referring to object form (e.g. square, oval). The two word categories were closely matched for a number of relevant psycholinguistic and semantic variables. Twenty-three neurologically healthy participants performed a serial recall task during which they were presented with 4 words from either the color word category or the form word category and kept these words in memory for a 6 second period. In the interference conditions, participants were presented with either flashing colors or abstract shapes during the memory period. Results of the serial recall task revealed a differential impairment of working memory for color and form words depending on word meaning, with flashing colors primarily interfering with the retention of color words and abstract shapes specifically impairing working memory for words referring to object form. There were no significant differences in memory performance between the two word categories in the control conditions. These results of a semantically-specific working memory impairment for color and form words indicates that processing resources in specific perceptual systems of the brain are shared between perceiving visual information and working memory for words with visual meaning. These findings strengthen the argument that perceptual systems are functionally relevant for semantic language processing.

Topic Area: Meaning: Lexical Semantics

Poster A65 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

The impact of age-related hearing loss on the neuroanatomical network for language: a meta-analysis

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This meta-analysis investigated the association between age-related hearing loss and structural neuroanatomy, specifically changes to grey matter volume across language and speech areas. Hearing loss is associated with increased risk of dementia, a neurodegenerative disease which significantly affects language. Hence, understanding the effects of hearing loss in older age on brain health across language areas is essential. We reviewed studies which compared older participants with hearing loss (HL) to older adults without clinical hearing loss (NH), on neuroanatomical outcomes, specifically grey matter volume as measured by magnetic resonance imaging. A total of five studies met the inclusion criteria, three of which were included in an analysis of whole-brain grey matter volume (HL-group n = 113; NH-group n = 138), and three were included in analyses of lobe wise grey matter volume (HL-group n = 139; NH-group n = 162). Effect-size seed-based d mapping software was employed for whole-brain and lobe-wise analysis of grey matter volume. The analysis indicated there was no significant difference between older adults with HL compared to those with no age-related HL in whole-brain grey matter volume. Due to lacking stereotactic

coordinates, the atrophy of grey matter in specific neural locations could only be conducted at lobe-level. These data indicate that older adults with HL show increased grey matter atrophy in the temporal lobe only (not in occipital, parietal, or frontal), compared to older adults without HL. Overall, the findings endorse regular auditory testing for ≥60-year-olds, as HL co-occurred with atrophy in grey matter across temporal regions. Managing age-related HL, e.g., through hearing aids, may reduce the adverse functional effects of grey matter atrophy in the areas associated with speech and language production and processing. This meta-analysis was pre-registered on PROSPERO (CRD42021265375).

Topic Area: Perception: Auditory

Poster A67 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Semantic decoding of continuous language from non-invasive brain recordings

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A brain-computer interface that decodes continuous language from non-invasive recordings would have many scientific and practical applications. Currently, however, decoders that reconstruct continuous language use invasive recordings from surgically implanted electrodes, while decoders that use non-invasive recordings can only identify stimuli from among a small set of letters, words, or phrases. We introduce a non-invasive decoder that reconstructs continuous natural language from cortical representations of semantic meaning recorded using functional magnetic resonance imaging (fMRI). To overcome the low temporal resolution of fMRI, we used a Bayesian approach that combines a neural network language model and a voxel-wise encoding model. The language model generates linguistically coherent word sequences, and the encoding model predicts how the brain would respond to each sequence. Our decoder then identifies the most likely stimulus by comparing the predicted brain responses to the recorded brain responses. Given novel brain recordings, our decoder generates intelligible word sequences that recover the meaning of perceived speech, imagined speech, and even silent videos, demonstrating that a single language decoder can be applied to a range of semantic tasks. To study how language is represented across the brain, we tested the decoder on different cortical networks, and found that natural language can be separately decoded from multiple cortical networks in each hemisphere. To test whether decoder predictions are modulated by attention, we instructed subjects to attend to a different speaker for each repeat of a multi-speaker stimulus, and found that the decoder selectively reconstructs the attended stimulus. Finally, as brain-computer interfaces should respect mental privacy, we tested whether successful decoding requires subject cooperation. We found that decoders trained on cross-subject data performed substantially worse than decoders trained on within-subject data, suggesting that subject cooperation is necessary to train the decoder. Further, we found that subjects could consciously resist decoding of perceived language by performing a different cognitive task, suggesting that subject cooperation is also necessary to apply the decoder. Our results demonstrate that continuous language can be decoded from non-invasive brain recordings, enabling future multipurpose brain-computer interfaces.

Topic Area: Computational Approaches

Poster A68 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Leveraging EEG decoding to examine automaticity of predictive coding during speech comprehension

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Predictive coding is a critical theory of prediction during language and cognitive processing (Clark, 2013; Friston, 2009; 2010; Friston & Keibel, 2009; Rao & Ballard, 1999). Predictive coding assumes that higher hierarchical cortical levels continuously make top-down predictions of information at lower cortical levels. As new bottom-up sensory information becomes available to lower levels, the brain computes a prediction error – the difference between the top-down predicted input and the actual bottom-up sensory input – which is passed back up to update higher-level representations and allow for better future predictions. Heikel and colleagues (2018) examined predictive coding during auditory sentence processing using a temporal generalization classification method (King & Dehaene, 2014) to decode electroencephalogram (EEG) signals. Based on predictive coding models, Heikel et al. (2018) hypothesized that, in the absence of bottom-up input, the prediction error signal should only contain information about the top-down predicted input. They tested this hypothesis by presenting participants with highly constraining auditory sentences in which critical words were unexpectedly delayed by 1000ms of silence and were either 1) animate or inanimate or 2) concrete or abstract. The EEG signal during this delay was decoded for either animacy or concreteness at significantly above-chance levels in the silent period prior to the onset of that word. These findings support their predictive coding hypothesis that prediction error EEG signals carry specific information about pre-activated features of words in highly constraining spoken sentences. However, this study does not address the question whether semantic features of words are pre-activated under all circumstances. Recent studies indicate that predictive processing effects during language comprehension are graded by task (Brothers et al., 2017) and speaker reliability (Brothers et al., 2019) as measured by the N400 event-related potential (ERP) component. This suggests that facilitation by prediction is not necessarily an automatic process. The present study aims to address this question by manipulating the proportion of sentences with highly predictable (high cloze) and unpredictable (low cloze) target words – either animate or inanimate – to generate 80% high cloze and 20% high cloze conditions. As in the Heikel et al. study (2019), we will use decoding to examine if animacy features of critical words can be reliably decoded in the 1000ms silence before critical word onset. Additionally, we will examine effects of cloze probability and animacy on the amplitude of the N400 to the critical words. If prediction is automatic, then we should see significantly above-chance decoding accuracy in high cloze sentences in both the 80% high cloze and the 20% high cloze conditions. We expect to see reduced posterior N400 amplitude in high cloze relative to low cloze critical words. If animacy features are pre-activated, then we expect differences between animate and inanimate frontal negativity in low cloze sentences, but not in high cloze sentences. However, if facilitation from prediction is graded, then both ERP effects will be mitigated in the 20% high cloze condition. Together these decoding and ERP results would provide evidence that prediction is automatic, but facilitation from prediction is not.

Topic Area: Speech Perception

Poster A69 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Why do we have such difficulty recalling words as we get older? Evidence that hippocampal declines underlie word-finding problems in aging

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We often experience word-finding difficulties as we get older ("What is that word again?"). Deficits of executive function, processing speed, and perceptual abilities have each been posited as explanatory accounts for these problems. However, it remains uncertain whether these accounts best explain the pattern of lexical declines, or are sufficient to explain them. We propose that word-finding declines in aging are largely explained by concomitant declines in declarative memory, in particular hippocampal-related declines. We refer to this novel account as the declarative aging deficit (DAD) hypothesis. It is motivated by prior evidence suggesting first, that word learning and retrieval depend on declarative memory, including the hippocampus, and second, that declarative memory abilities, especially hippocampal metrics and functions, decline strikingly in aging. DAD therefore predicts declines particularly in lexical abilities that depend heavily on the hippocampus. Lexical production (reliant on hippocampal-based recollection) should be more affected than lexical comprehension (which can also rely on perirhinal-based familiarity). Particular problems should be found recalling words that have later ages-of-acquisition, such as newer words in the language (e.g., 'sudoku'), which may have had less time than established words learned earlier in life (e.g. 'pretzel') to undergo systems consolidation, and thus may still rely substantially on the hippocampus. To test DAD we gave (thus far) 118 participants (ages 18-83) picture-naming (production) and word-picture matching (comprehension) tasks of both newer/recently-acquired and established/early-acquired words. Preliminary analyses revealed significant age-related lexical production declines for newer but not established words, while comprehension showed no declines at all. The analyses controlled for word frequency, word length, socio-economic status, education, amount of general lexical input, processing speed, and inhibitory control abilities, while also accounting for words unknown to each participant and screening for hearing/vision and Mild Cognitive Impairment. Moreover, hippocampal volumes (corrected for intracranial volumes) mediated the effect of age on the production of newer but not established words, even with other factors such as executive function and processing speed controlled for. Basic research and translational implications are discussed.

Topic Area: Development

Poster A70 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Is time on our side? A web-based and fMRI investigation of offline speech-motor learning

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Offline periods, whether they are spent in wakeful rest or in sleep, promote the memory consolidation of newly learned motor skills. However, existing models of speech-motor learning focus on active, online practice and the protracted development of the movement component of the speech-motor representation. van Zelst & Earle (2020) hypothesized that components of the speech-motor representation may exhibit distinct offline learning time courses. Here, we present behavioral findings that support this novel framework. We will also present preliminary neuroimaging evidence; collection of this dataset is currently underway. Together these datasets provide new evidence demonstrating the possible neurobiological mechanisms of speech-motor learning. In the web-based behavioral experiment, we examined the effects of offline time on the speech-motor production of a trained vowel contrast. Forty-five typical native speakers of American English aged 18 to 25-years were recruited. Learners logged on between 8:00-9:00AM or 8:00-9:00PM and trained in the production of two non-native Danish vowels, [y] and [ø]. Participants completed baseline assessments and sleep habit questionnaires, followed by the speech sound production training. They then had a 12-hour delay with (SLEEP) or without nocturnal sleep (REST) or proceeded immediately (IMMEDIATE) to a post-training production assessment of Danish vowels in trained ([V]) and untrained ([hVd]) contexts. F1-F2-F3 formants were measured using Praat. Movement accuracy was measured by the Euclidean distances between the F1-F2-F3 values in participant productions recorded during the pre and post assessments, against that of the Danish speaker model. To obtain perceptual ratings of the productions, 29 native Danish speakers were recruited as participants in a web-administered perceptual identification task of the American English speakers' productions. Group differences were analyzed via linear mixed-effects analyses. With Euclidean distance as the dependent variable, the model contained a three-way interaction term between Delay, Time, and Training, and a separate three-way interaction term between Sleep, Time, and Training, with the time of day of training, and Vowel ([y], [ø]) entered as covariates, and Participant as a random effect. Similarly, listener identification accuracy of the target vowel productions was modeled using a logistic generalized mixed-effects model with the same interaction terms and the Experiment 1 participant (talker) and the Experiment 2 participant (listener) modeled as random effects. These analyses yielded two novel findings. First, a post-practice period that includes nocturnal sleep improved

speech-motor movement accuracy without additional practice. Second, the perceptual identification accuracy of native Danish speakers was greatest for the vowel productions of talkers who slept. In the fMRI experiment, while completing in-scanner tasks adapted from the behavioral experiment, participants are scanned immediately following training (IMMEDIATE) or after a 12-hour delay with (SLEEP) or without (REST) nocturnal sleep. After acquiring a 3D T1-weighted anatomical dataset, event-related functional data (45 axial slices of 2mm-thick echo planar images acquired with a multi-band accelerated sequence) are obtained in three runs. We predict that the REST group will evidence increased hippocampal activation, whereas those in our SLEEP group will show increased cortical activation. Neuroimaging will supplement our behavioral findings while highlighting the neurobiological mechanism underlying the establishment of speech-motor representations.

Topic Area: Speech Motor Control

Poster A71 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Does white matter mediate the relationship between SES, other environmental risk factors and reading? A SEM study.

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Environmental effects explain about 44% of the variability in reading skills (Andreola et al., 2020), however the paths that characterize these influences remain little understood. Specifically, while individual level effects of genes on behavior must be routed through the brain, the involvement of brain structure and activity in the relationship between environmental risk factors and reading (related) abilities has been understudied. Socio-Economic Status (SES), one of the most robust environmental risk factors for reading disabilities, has been previously associated with white matter (WM) in the bilateral Inferior and Superior Longitudinal Fasciculi (ILF and SLF) and this relationship is thought to mediate the effects of SES on reading (e.g. Ozernov-Palchik et al., 2018; Zuk et al., 2020; Turesky et al., 2021). Our group previously linked WM microstructure within several tracts (including bilateral ILF and SLF) to reading and phonological processing (PP) and found that PP mediated the relationship between WM and reading (Koirala et al., 2021). This analysis was performed using the Healthy Brain Network (HBN) biobank (Alexander et al., 2017), a large dataset that includes neurobiological, behavioral, and demographic data of over 4,000 children, ages 5-21. Expanding on our previous work, we aim to characterize the complex pathways between SES and reading to test the possible mediation role of the bilateral ILF and SLF and of PP. Further, we will include several additional environmental risk factors such as parental stress and weight at birth as they may relate to SES, WM and reading. Although reports have considered environmental risk factors for reading (see Mascheretti et al., 2018 for a review), their effects are typically tested separately; structural equation modeling (SEM) offers the opportunity to examine multiple risk factors in one model. Furthermore, thanks to its large sample size and given the large age range of participants, the HBN biobank will also afford examination of the mediation pathways for children of different ages using multiple groups SEM. Finally, in addition to traditional diffusion measures, we will examine measures of neurite orientation density and dispersion, which were shown to be more sensitive and specific to different neurite features than traditional diffusivity measures (Zhang et al., 2012). We will use SEM to test a mediation model, using environmental risk factors as predictors and reading (measured by the test of word reading efficiency) as the predicted variable. The mediators to be evaluated will be WM for the bilateral ILF and SLF (measured by Fractional Anisotropy, Orientation Dispersion Index, and Neurite Density Index) and PP (measured by the comprehensive test of phonological processing), an endophenotype more closely related to brain structure than reading. Our model is informed by existing literature on the relationship between environmental risk factors, WM, PP, and reading, and by data driven approaches such as exploratory factor analysis and model fit evaluation. We hypothesize that WM will mediate the effect of SES on

reading, and that this path is further mediated by phonology; additionally, we postulate that environmental effects on WM and reading will be larger for younger (relative to older) children.

Topic Area: Reading

Poster A72 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam A session.

Neural correlates of natural speech errors during continuous picture naming

Angelique Volfart[1], Katie McMahon[1,2], David Howard[3], Greig I. de Zubicaray[1]; [1]Queensland University of Technology, [2]Herston Imaging Research Facility, [3]Newcastle University

The majority of our knowledge about the neuroanatomy of speech errors comes from lesion-symptom mapping (LSM) studies in people with aphasia (PWA) and laboratory paradigms designed to elicit primarily phonological errors in healthy adults, with comparatively little evidence from naturalistic speech production. In this study, we analysed perfusion fMRI data from 24 healthy participants during continuous picture naming and classified their responses into correct and speech error types (e.g., semantic, phonological, omission errors, etc.). Total speech errors engaged a wide set of left-lateralized frontal, parietal and temporal regions that were almost identical to those involved during the production of correct responses. We observed significant perfusion signal decreases in the left posterior middle temporal gyrus (pMTG) and angular gyrus for semantic paraphasias compared to correct trials matched on various psycholinguistic variables. In addition, the left dorsal caudate nucleus showed a significant perfusion signal decrease for omission (i.e., anomic) errors compared with matched correct trials. We did not observe any significant perfusion signal changes in brain regions proposed to be associated with monitoring mechanisms during speech production (e.g., anterior cingulate cortex, superior temporal gyrus). Overall, our findings provide evidence for distinct neural correlates of semantic and omission error types, and indicate that mechanisms responsible for speech errors in healthy participants might vary with those reported for PWA.

Topic Area: Language Production

Poster A73 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

High specificity of top-down modulation in the visual word form area

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Reading requires communication between visual cortex and language regions. The “visual word form area” (VWFA) in ventral occipito-temporal cortex is, like other areas that surround it, optimally driven by particular types of visual stimuli — in this case, written words. It is not completely selective for words, however, and it shows an intriguing pattern of top-down modulations. In this fMRI study we investigated the interaction of bottom-up visual factors and top-down cognitive factors in the VWFA. We presented participants with strings of letters and strings of visually similar shapes. We also manipulated the task demands: for each stimulus type participants did a task in which the stimuli were task-relevant and attended (lexical decision and gap localization, respectively), and a task in which the stimuli were irrelevant and ignored (a fixation color change task). We hypothesized that both stimulus types should evoke larger responses when attended than ignored, throughout visual cortex. The result was more complex: in the VWFA, letter strings evoked much larger responses when they were task-relevant than when they were irrelevant. However, non-letter shapes evoked smaller responses when they were task-relevant than when they were irrelevant. Activity in the VWFA was also correlated with a putative Broca’s area in the left pre-central sulcus, most strongly during the lexical task. These patterns of results were largely absent in all other visual areas. To conclude, we propose that communication between visual cortex and language regions is under voluntary control, and it selectively enhances

the representation of written words in VWFA.

Topic Area: Reading

Poster A74 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Two spatiotemporally distinct cortical networks for sentence reading

Oscar Woolnough[1], Cristian Donos[2], Elliot Murphy[1], Patrick Rollo[1], Zachary Roccaforte[1], Stanislas Dehaene[3], Nitin Tandon[1]; [1]University of Texas Health Science Center at Houston, [2]University of Bucharest, [3]College de France

Reading a sentence entails inferring and integrating meaning at multiple levels by combining the information conveyed by each word. This highly rapid and complex human behavior is believed to be distributed between the inferior frontal gyrus (IFG) and middle temporal gyrus (MTG) in the language dominant hemisphere, yet the relative and distinct contributions of these regions to sentence comprehension are still debated. An important open question remains - how do these two closely interconnected hubs dynamically interact to integrate information across a sentence? To create a high spatiotemporal resolution map of activation across the reading and language networks we used direct intracranial recordings in 27 people, with >2,400 electrodes in the language dominant hemisphere, to measure induced broadband gamma activity (70-150Hz). Each patient read eight-word normal sentences, Jabberwocky sentences, and lists of words and pseudowords presented in rapid serial visual presentation. We tracked activation across mid-fusiform cortex, lateral temporal cortex, IFG and the medial frontal operculum and used linear mixed effects modelling to dissociate contributions from multiple lexical and sentential factors. Examination of the evolution of activity across consecutive stimuli revealed two functionally and spatiotemporally distinct frontotemporal networks, each sensitive to distinct aspects of lexical and syntactic composition. The first distributed network, in which the posterior IFG precedes MTG, demonstrated a slow ramping-up of activity over the duration of a sentence, which was reduced or absent during Jabberwocky and lists, suggesting a role in the composition of sentence-level meaning. In the second network activity in superior temporal gyrus preceded activity in anterior IFG, and this network showed greater phasic activation for each word presented in a list relative to those in sentences, suggesting that sentential context affords a reduction in semantic and/or phonological processing effort. We also tracked the spread of sensitivity to lexical features. Word frequency was strongly represented in mid-fusiform cortex first and later in anterior IFG whereas posterior IFG and lateral temporal cortex did not show substantial modulation by lexical level features. In conclusion, we have identified and characterised at least two spatiotemporally separable frontotemporal language networks utilised during sentence reading. This spatiotemporal dissociation of subregions of the IFG and lateral temporal cortex sheds light on the layered semantic processes evoked by sentence processing and confirms that ramping-up of activity in IFG and MTG constitutes a plausible signature of semantic compositionality.

Topic Area: Reading

Poster A75 *Thursday, October 6, 10:15 am - 12:00 pm EDT, Millennium Hall*

Exploring neurophysiological signatures of novel word learning processes: The role of semantic training and 24-hour consolidation with overnight sleep

LIN Zhou[1], Charles Perfetti; [1]University of Pittsburgh, [2]Learning Research and Development Center, [3]Center for the Neural Basis of Cognition

Exploring neurophysiological signatures of novel word learning processes: The role of semantic training and 24-hour consolidation with overnight sleep Lin Zhou and Charles Perfetti Introduction. Word learning processes, in the context of neurocognitive theories of memory (Davis and Gaskell, 2009), involve an initial rapid acquisition process in episodic memory and then a gradual integration process into the existing lexicon in neocortical long-term memory. This gradual integration process from episodic to the neocortical long-term memory can be affected by various factors,

such as training methods, re-experiencing, rehearsal or sleep processes. Previous research found that after 24 hours of post-learning consolidation with overnight sleep, but not immediately after learning, newly learned words (trained with both form and meaning) induce N400 amplitudes (Bakker et al., 2015a) and power in the theta and beta bands (Bakker et al., 2015b) comparable to those of real words. This suggests that both ERP responses (e.g., N400) and oscillatory responses can be used as indicators in tracing the lexicalization process of newly learned words. The present study extends these findings by further manipulating training methods (form-only vs. form-meaning training) and examining the lexicalization process of newly learned words with different training methods and different post-learning consolidation process (24 hours vs. 0 hour) with the EEG methods. Methods. Adult participants were taught four sets of new visual words on two consecutive days (day 1 vs. day 2) with the training methods (semantic training vs. form-only training) and 24-hour consolidation with overnight sleep (day 1/remote vs. day 2/recent) factorially manipulated, together with two sets of existing real words (e.g., autumn) with their original meaning (e.g., a season lasting from September to November). On each day, half the new words were trained with both form and meaning (i.e., semantic training) and the other half with meaningless string of asterisks (i.e., form-only training). Thus, on day 2, new words learned on day 1 had experienced 24 hours post-learning consolidation with sleep, whereas those learned on day 2 had not. Immediately after learning on day 2, participants were asked to read the newly learned words, existing real words and unfamiliar nonwords while EEGs were recorded. Hypothesis and predictions. Our behavioral experiment with the same design has shown that semantic training, relative to form-only training, benefits the integration of newly learned words into existing knowledge. We hypothesize that newly learned words in the semantic training condition, compared with those in the form-only condition, are read more real-word like, which can be traced with ERPs (e.g., N400) and oscillatory responses (e.g., theta and beta power). Data with 32 participants have been collected and are being analyzed.

Topic Area: Reading

Poster B1 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

The brain in conversation: Mapping the neural correlates of turn-taking, production, and comprehension using fMRI

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INTRODUCTION: Conversation is the most ubiquitous form of language use. A hallmark of conversation is turn-taking, in which speakers rapidly alternate between speaker and listener roles without conscious effort, while simultaneously planning their upcoming turn. Since previous neurolinguistic studies have mainly investigated single or few linguistic processes in isolated environments that lack resemblance to real-world language use, the neurobiology of turn-taking, production, and comprehension during real-time conversation is currently under-explored. In this fMRI investigation, we asked whether turn initiations would activate areas outside the classical perisylvian core language network and whether we would observe differences in activation during conversational production vs. conversational comprehension. METHODS: We utilized a publicly available fMRI dataset in which participants (N = 23) engaged in unscripted conversations via an audio-video link with a confederate outside the scanner. Each conversation (24 per participant) lasted for one minute. Conversational events were defined from the participant's perspective. These events included turn initiations, defined as a 600 ms time window whose offset coincided with the onset of the participant's turn. The duration of turn initiations was based on the reported minimum latency of speech preparation. The other events investigated in this study were production (defined as participant speech), and comprehension (defined as confederate speech). RESULTS: Turn initiations were associated with frontal regions outside of the classical perisylvian core language network. One cluster (2796 voxels, significant with FWE-correction used throughout) was observed in the medial prefrontal cortex bilaterally, spanning from the dorsal portion to the most ventral anterior cingulate cortex. Activation during turn initiations was also observed in the left middle frontal gyrus. Furthermore, both production and comprehension during conversation were associated with core language regions in the bilateral temporal lobes, but activation in the left inferior frontal gyrus (LIFG) was only present for production. Moreover, larger parts of the occipital cortex, and specifically the fusiform face area, were activated in comprehension than in production. DISCUSSION: We suggest that the observed frontal activation during turn initiations reflects sociopragmatic processes involved in intention processing and attentional control – processes that have not previously been localized outside the core perisylvian language network but have been hypothesized to play a crucial role in speech preparation during interaction. Furthermore, we interpret the fusiform face area activation during comprehension as an indication that listeners are aided by their interlocutor's facial gestures specifically when comprehending speech input during real-time conversation. Finally, LIFG activation in conversational production but not comprehension may reflect the syntactic and semantic heuristics at play in conversational comprehension, minimizing the need for a full syntactic parse. The utilization of such heuristics may be a possible prerequisite for consistently meeting the expectations of timing in turn-taking.

Topic Area: Meaning: Discourse and Pragmatics

Poster B2 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

The P600 as a Graded Index of Integration Difficulty

Christoph Aurnhammer[1], Francesca Delogu[1], Harm Brouwer[1], Matthew W. Crocker[1]; [1]Saarland University

While the N400 and P600 are the most salient ERP indices of language processing, it remains under debate which component indexes integration processes (e.g., Brouwer et al., 2017, Rabovsky et al., 2018). A recent study (Aurnhammer et al., 2021) demonstrated their differential sensitivity to how associated a word is to the context (N400 alone) versus how contextually expected it is (N400 and P600). Further, a post-hoc analysis suggested that rather than being a binary index of expectancy violations, the P600 - like the N400 - may actually be sensitive to expectancy in a graded manner. These results are consistent with the view that the N400 indexes retrieval, and the P600 indexes integration. The current experiment directly examines whether the P600 provides a graded index of integration difficulty. As late positivities are difficult to interpret due to spatio-temporal overlap with the N400 component, we sought to minimise N400 differences across conditions by adapting an experimental design ("the lady told the tourist / suitcase", Nieuwland & Van Berkum, 2005), in which both plausible and implausible target words are presented several times in a preceding context paragraph. The absence of an N400-effect for such designs has been attributed to the substantial priming of the targets by their previous repetition (Brouwer et al., 2012), with the original study revealing only a broad positivity for the implausible vs. plausible targets. The current study further includes a condition with intermediate plausibility (B) – as measured in a pre-test – and employs a context, rather than target, manipulation ("the lady dismissed (A) / weighed (B) / signed (C) the tourist"). Importantly, this intermediate condition raises expectations for a more plausible alternative, creating a prediction disconfirmation. This allows us to assess whether such disconfirmations have additional influence on late positivities for somewhat plausible target words beyond what is explained by plausibility alone – and in absence of component overlap with the N400. An initial self-paced reading experiment revealed that reading times on spillover regions are graded for plausibility, but not affected by disconfirmations. In the EEG data, we obtained an earlier negativity for Condition B, which we take to be driven by the prediction disconfirmation, while no N400 difference was observed for either condition B or C relative to baseline. Late positivities were graded for plausibility. An rERP analysis revealed that, while the majority of the parietally distributed late positivities is explained by plausibility, condition B elicited an additional left-frontocentral positivity in response to the presence of an expected alternative, in line with prior research. The absence of any N400-effects of plausibility replicates the previous finding for target words present in the context, consistent with retrieval being facilitated by repetition. In contrast, we do observe graded P600 modulations across three levels of plausibility, consistent with the P600 as integration hypothesis, and contrasting with the P600 as reflecting error detection/correction. These findings reveal a critical novel dimension to the functional interpretation of the P600 with important implications for existing and future neurocognitive experiments and theories.

Topic Area: Meaning: Discourse and Pragmatics

Poster B3 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Neural bases of speech-error detection and correction: MEG and RSA evidence from typical speech and aphasia

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Phonetic distortions are common in the speech of persons with aphasia (PWA), but it is unknown whether their source is primarily perceptual (an insensitivity to errors) or motoric (an inability to correct detected errors). In typical speakers, the auditory system monitors itself for acoustic deviations from intended speech sounds. The M100 evoked response is suppressed to one's own speech in comparison to playback of the same. We previously showed that the magnitude of speaking-induced suppression (SIS) is larger for prototypical vowel productions and smaller for deviant ones; moreover, the smaller the SIS, the more participants corrected their vowel formants towards the median (Niziolek et al., 2013). Thus, the degree of SIS may be a signal that drives speakers to detect and correct deviations before they become full-blown errors. Here, we use this framework to characterize the detection-correction circuit in

PWA who vary in clinical subtype, severity, and lesion. In a MEG study, 15 PWA and 15 age-matched controls spoke the words ‘eat’, ‘Ed’, and ‘add’ 200 times each and listened to playback of their own utterances. We take advantage of each participant’s natural variability in vowel acoustics to identify “center” and “peripheral” trials, in which the first and second formants (F1 and F2) in the first 50 ms are closest to and farthest from, respectively, that vowel’s median. We then calculate SIS for prototypical and deviant productions. If a PWA does not show the typical pattern of less SIS to peripheral vs. central trials, it suggests that their perceptual sensitivity to acoustic deviations is compromised. If a PWA shows the typical pattern of SIS but without the subsequent behavior of acoustic correction, it suggests that their deficit is in motor control. Preliminary results indicate that, whereas SIS is left-lateralized in controls, it is right-lateralized in many PWA. This may indicate reorganization of a critical auditory function after injury. We hypothesize that PWA with more typical SIS patterns in the right hemisphere will show more acoustic evidence of online speech correction. Planned analyses delve deeper into how vowel acoustics explain neural activity. We will perform representational similarity analysis, correlating models of vowel similarity with measures of neural similarity. The acoustic model predicts greater neural similarity for utterances that are closer in F1-F2 space. The deviance model predicts similar neural activity for utterances that are similarly distant from the median, regardless of formant values. Thanks to the spatiotemporal resolution of MEG, we will test these models across the brain as speech perception unfolds. If the acoustic model is a good fit, it suggests the presence of an accurate sensory representation – the basis of intact perception. If the deviance model is a good fit, it suggests the presence of abstract information about proximity to the target sound. We hypothesize that a deviance representation supports error detection and may also be related to online speech correction. Our results may inform the tailoring of aphasia therapy to individual profiles and advance our understanding of neural mechanisms of feedback processing during speech motor control.

Topic Area: Speech Motor Control

Poster B4 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

The role of Uniqueness and Relationality in basic semantic composition: Evidence from neural oscillations

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The Theory of Concept Types (CT) and Determination (Löbner, 2011) distinguishes four CTs based on two inherent conceptual properties of noun concepts, viz. Uniqueness [U] and Relationality [R]: Sortal (a stone [-U][-R]), Individual (the sun [+U][-R]), Relational (his ear [-U][+R]), and Functional (his father [+U][+R]). Each of the CTs requires a certain inherent determiner type. The combination of a given concept with an incongruent determiner results in a shift of the real-world referent of a concept: a stone (Sortal [-U][-R]) – his stone (Relational [-U]→[+R]). The present study used electroencephalography to investigate oscillatory brain activity underlying semantic composition related to the processing of the conceptual features Uniqueness and Relationality. Two objectives were followed: (i) neuronal signatures of inherent Uniqueness and Relationality in congruent conditions, and (ii) the processing cost of shifted values of Uniqueness and Relationality in comparison to identical inherent values. We restricted our hypotheses to only alpha and theta frequency ranges that were reported in studies on argument-verb dependencies (Meyer et al., 2013) and on aspects of semantic relations (Maguire et al., 2010). We hypothesized that the variable inherent values of Uniqueness (definite vs. indefinite) or the shift of Uniqueness would be indexed by theta band power modulations. We expected the variable inherent values or the shift of Relationality to elicit modulation of theta and alpha band activity due to the presence or addition/deletion of a possessor argument. To test our hypotheses, we reanalyzed a subset of data collected by Bekemeier et al., 2019 pertaining to the congruent/incongruent CT conditions. The comparisons between inherent Uniqueness values revealed no significant differences, demonstrating similar semantic composition processes. The comparisons between inherent values of Relationality showed modulations in

alpha and theta power ranges. Comparisons related to shifted Uniqueness in inherently relational concepts reached significance: the shifted negative Uniqueness (a mother (→[-U][+R]) vs. a brother ([-U][+R])) resulted in a stronger early suppression in alpha and theta frequency bands relative to the inherent negative Uniqueness. The shifted positive Uniqueness (the brother (→[+U][+R])) triggered a weaker alpha enhancement and a stronger theta suppression than the inherently positive Uniqueness (his mother ([+U][+R])) in a late time window. The only straightforward positive shift of Relationality (the sun ([+U][-R]) vs. his sun ([+U]→[+R])) elicited a weaker alpha desynchronization relative to the congruent condition. The results can be summarized in the following manner: (i) event-related alpha desynchronization was observed in an early latency (200-600 ms post stimulus/trigger) and was determined by the strength of semantic integration of the phrase constituents (articles over possessive pronouns); (ii) an initial alpha suppression was followed by alpha enhancement (duration of over 1000 ms) if the stimulus structure/complexity required high maintenance in the (verbal) working memory (inherent Relationality with congruent determination being the most demanding); (iii) "old" (articles) vs. "new" (possessive pronouns) information processing was indexed by the modulation of theta power, with the "old" information eliciting the strongest theta suppression. Our results show that even in basic semantic composition there are significant differences driven by inherent conceptual features as Uniqueness and Relationality.

Topic Area: Meaning: Lexical Semantics

Poster B5 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Assessing the role of temporal and frontal regions in syntactic comprehension: Insights from aphasia

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Whether syntactic comprehension, i.e., the ability to assign a hierarchical structure to a sentence in order to successfully interpret its meaning, relies mostly on frontal regions (Friederici, 2017; Hagoort, 2014), e.g., posterior Inferior Frontal Gyrus (pIFG), or on temporal regions (Matchin & Hickock, 2020; Bornkessel-Schlesewsky & Schlesewsky, 2013), e.g., posterior Middle Temporal Gyrus (pMTG), is still debated. Lesion-symptom mapping (LSM) analyses can actively inform this debate by identifying regions that are critical for specific linguistic operations (Bates et al., 2003; Vaidya et al., 2019; Wilson, 2017). With regard to syntactic processing, Dronkers et al. (2004) originally showed that lesions to the pMTG are crucial for lexical/semantic word-level comprehension, and consequently for general comprehension (of different sentence types). Lesions to frontal regions, particularly BA 47 (not BA 44 and 45) were also found to be relevant for the comprehension of relative clauses. More recently, Matchin et al. (2022) showed that the comprehension of non-canonical (object-extracted object clefts, relative clauses, wh- questions) structures were mainly associated with damage to the pMTG, while damage to the pIFG was not implicated. Thus, the role of temporal and frontal regions in syntactic processing remains to be further ascertained. In the current study, we wish to contribute to this debate by analyzing the performance of 150 individuals with post-stroke aphasia on the CYCLE-R test (Curtiss & Yamada, 1988). Data from 64 participants were already reported in Dronkers et al. (2004), while the remaining data were collected subsequently and never published. The subtests Object Clefting ("It's the clown that the girl chases") and Relative Pronouns with Double Function ("The girl who the boy is pushing is happy") involving reversible sentences with an extracted object NP will be grouped under the non-canonical condition. We will also investigate complex structures with no object extraction (subtests: Subject relatives "The girl who is pushing the boy is happy", Object relative clauses "The girl is chasing the clown who is big"), which appeared to involve frontal regions in previous analyses. Performance on the Active Voice Word Order subtest ("The girl is pulling the boy"), which includes similar nouns and verbs, will be considered as a covariate in the analyses (as in Matchin et al., 2022). An LSM analysis with both univariate and multivariate methods will be implemented to detect areas associated with the processing of these two types of complex sentences while controlling for comprehension of simple canonical sentences, as well as

relevant demographic and lesion variables (Ivanova et al., 2021). Dronkers et al. (2004) reported that lesions in temporal regions (anterior BA 22, Superior Temporal Sulcus (STS) BA 39) affected performance on the Object Clefting subtest. Therefore, these regions are expected to play a bigger role compared to frontal regions, such as the pIFG. Frontal regions (such as BA 46 and 47) may play a role in structures with a different type of syntactic complexity, such as relative clauses with no object extraction. Overall, the current study will be informative for advancing neural models of syntax.

Topic Area: Syntax

Poster B6 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Functional connectivity during story listening predicts later reading ability in middle childhood

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Children's early behavioral listening comprehension is highly predictive of their later reading abilities. However, less is known about the underlying neural mechanisms of these established behavioral relationships. To explore these associations, we collected fMRI data from 47 typically developing first-graders (age M = 7.5 years) and tracked their reading comprehension (RC) and word reading (WR) abilities into third grade. During the fMRI session, children listened to 1) coherent narrative and expository passages and 2) a scrambled passage baseline. Compared to the baseline, the listening task elicited expected language comprehension network activity. Next, we investigated the various functional connectivity associations between the language network and other brain regions using a seed-to-voxel connectivity analysis. We were particularly interested in how higher-level comprehension regions, such as the left posterior middle temporal gyrus (pMTG), were functionally connected to the rest of the brain. Activity in the left pMTG was anticorrelated with three default mode network (DMN) regions: the posterior cingulate cortex (PCC), the right angular gyrus (AG), and the right middle frontal gyrus. Interestingly, these associations differentially predicted aspects of later reading ability. The anticorrelation between left pMTG and PCC predicted 18% of the variance in children's third-grade RC ability, while the anticorrelation between left pMTG and right AG predicted 12% of the variance in children's third-grade WR ability. We hypothesize that while listening to coherent speech, the way children's brains activate core comprehension processing regions and inhibit task-irrelevant implicate their later reading abilities. Further analyses will elucidate how the modularity of these two networks may further explain reading development.

Topic Area: Reading

Poster B7 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Tracing the Cognitive Sources of Communicative Challenges in Autism Spectrum Disorder

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Autism Spectrum Disorder (ASD) is diagnosed on the basis of communicative challenges experienced in everyday interactions, yet the cognitive sources of those challenges remain largely unknown. A popular suggestion holds that autistic individuals struggle to predict other people's behaviors, either due to a bottleneck in bottom-up sensory processing or an attenuated sensitivity to top-down priors when perceiving communicative behaviors (e.g., Pellicano & Burr, 2012). However, studies of predictive processing in the perceptual domain have produced mixed results, and

few studies to date have investigated ASD predictive abilities in the context of live social interaction. Using eye-tracking in ASD, this study assesses bottom-up and top-down contributions to interpreting genuinely interactive communicative behaviors. Predictive abilities are assessed while participants solve a series of coordination problems in the two-player “tacit communication game” (Wadge et al., 2019). In each round of this game, players have to jointly reproduce a target configuration of their two given shapes on a digital game board. However, the target configuration is shown to one of the players only, the Sender. Given that the other player, the Receiver, cannot see the target configuration, the Sender needs to move her shape in a way that conveys the location and orientation of the Receiver’s shape. When interpreting everyday ambiguous words and gestures, the Receiver needs to rapidly identify relevant features from the Sender’s movements to infer his target configuration. A benefit of the novel communicative medium is that it offers the possibility to manipulate access to top-down priors during communicative interpretation by introducing coordination problems that are more easily solved in light of previous interactions with the same partner. Furthermore, the digital movements allow for a tight quantitative overlay of eye gaze and communicative behavior in the identification of bottlenecks in bottom-up sensory processing. Preliminary results (20 neurotypical pairs; 18 ASD pairs) suggest that the communicative challenges experienced by autistic individuals cannot be attributed solely to limitations in bottom-up processing, as seen in the matched duration of task-relevant fixations between neurotypical and ASD participants. Second, autistic and neurotypical individuals’ eye gaze behavior exhibited a similar susceptibility to top-down priors established during previous interactions. These initial findings open the way to investigate the cognitive mechanisms that integrate bottom-up and top-down processes to produce accurate inferences about other people’s behavior in ASD.

Topic Area: Meaning: Discourse and Pragmatics

Poster B8 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

High Frequency taVNS Increases Retention of Novel Language Learning in Young Adults

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Although the ability to acquire a novel language and attain fluency in that language is beneficial for a growing number of people, it is significantly more difficult to acquire such skills in adulthood. While traditional in-person and computer training programs can aid in this process, learning is often slow and retention is quite poor. A method for driving long-lasting neural plasticity during language learning would be valuable for those who need or want to achieve fluency in a novel language later in life. However, little is known about biologically-based interventions for language learning. The current study was designed to investigate whether transcutaneous auricular vagus nerve stimulation (taVNS) paired with training is capable of improving learning and retention of words in a new language as compared to sham stimulation. Twenty-nine typically developing young adults completed a one-hour training session in which they learned 30 Palauan nouns while receiving sham, 5 Hz, or 25 Hz stimulation to the left posterior tragus. Participants completed a free-recall translation test immediately after training and seven days later to quantify learning and retention. While there was no effect of stimulation group on translation test performance immediately after training ($ps > 0.12$), there was an effect at retention. Seven days after training, the 25 Hz taVNS group significantly outperformed both the sham ($p = 0.01$) and 5 Hz taVNS groups ($p = 0.048$), with no difference between the sham and 5 Hz taVNS groups ($p = 0.68$). We also evaluated the effect of stimulation intensity on efficacy in an additional 16 participants stimulated at 25 Hz and found no effect of intensity on retention ($p = 0.10$). These results suggest that taVNS may improve retention of novel vocabulary words and that stimulation frequency, but not intensity, may impact efficacy.

Topic Area: Methods

Poster B9 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

The functional separation and compensation between the left anterior and the posterior MFG in Chinese character reading

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The left middle frontal gyrus (MFG) is a region identified in Chinese character reading, which is considered specific to Chinese and responsible for verbal working memory. However, whether the function of the left MFG in Chinese reading is language-specific (verbal) or domain-general (nonverbal) working memory is unclear. The current study addressed this issue by combining the neural correlations (functional near-infrared spectroscopy, fNIRS) and neural causal (transcranial magnetic stimulation, TMS) technologies. Experiment 1 examined the function of left MFG in reading Chinese characters using fNIRS technology. We conducted a factorial design by manipulating the working memory (WM) load (0-back vs 2-back task) for two types of scripts (Chinese characters vs Yi scripts). The anterior MFG (BA46/9) showed a significant main effect of WM, in which it engaged more for 2-back than for 0-back task. In contrast, the posterior MFG (dorsal BA6) showed a significant interaction between script type and WM because it involved working memory only for Chinese characters but not Yi scripts. These results indicate that the left MFG engaged in Chinese character reading due to the working memory. Moreover, the anterior and the posterior part of the left MFG had a distinct function. The anterior MFG was domain-general (both for verbal and nonverbal), and the posterior MFG was language-specific (only for verbal) working memory. To further confirm the above results, Experiment 2 established the neural causality between the activities of the sub-regions of MFG and the language-specific and domain-general working memory. The experiment design was the same as experiment 1. Only the fNIRS data were collected after each participant received an offline continuous theta-burst transcranial magnetic stimulation (cTBS) to virtual damage to the anterior (BA46/9) and the posterior (BA6) MFG observed in experiment 1. When the anterior MFG was damaged, this region showed a significant interaction that the WM effect was observed for nonverbal Yi scripts but not for Chinese characters. Meanwhile, the posterior MFG showed a significant interaction that the WM effect was observed only for nonverbal Yi scripts but not for Chinese characters. It suggested that the virtual damage to the anterior MFG reduced its sensitivity to the language-specific WM but maintained its function of domain-general WM. Furthermore, the reduced function of anterior MFG also reduced the sensitivity of language-specific WM and increased the load of domain-general WM at the posterior MFG. When the posterior MFG was damaged, this region showed a reverse interaction that the WM effect was only significant for nonverbal Yi script but not for Chinese characters. Meanwhile, the anterior MFG remained the main effect of WM. It suggested that the damage to the posterior MFG reduced its sensitivity to the language-specific WM but remained the anterior MFG intact. In sum, the left MFG engaged in the working memory for reading Chinese characters. Its anterior region may be related to the domain-general WM, and the posterior part may be associated with the language-specific verbal WM. The anterior and the posterior sub-region showed the functional separation and compensation in Chinese character reading.

Topic Area: Reading

Poster B11 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Neural decoding of grammatical number within and across languages

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BACKGROUND Grammatical features are an essential part of human language that are used to express numerosity, tense, aspect, and more. Nevertheless, how they are processed in the brain has only recently begun to be investigated (Dunagan et al. 2022; Papageorgiou et al. 2020). A related issue is how these grammatical features are represented across multiple languages in bilingual brains. Multi-voxel pattern analysis (MVPA) can be a useful tool in

this domain to investigate common patterns in brain activity when processing the same grammatical feature across languages (cf. Correia et al. 2015 for lexical semantics.) This study uses MVPA to decode EEG data for grammatical number as well as lexical semantics both within and across different languages. METHODS EEG data from six Korean-English bilinguals (all females, age: 18–29) living in the United States are analyzed in the study (32 channels sampled at 500 Hz; filtered from 1–30 Hz after artifact rejection). Experimental stimuli consist of four nouns (dog, rat, swan, and lion) in singular and plural forms and four verbs (lean, own, fill, and chop) in past and present tense in English and Korean, recorded by three different female speakers. Participants listened to the stimuli during EEG recording. Across ten runs we presented an English block a Korean block alternating in order; In each block we played 24 animal noun stimuli (8 words × 3 speakers) and 24 action verb stimuli (8 words × 3 speakers). Participants decided whether the word they heard is a noun or a verb for 10% of the trials (these were excluded from analysis.) For within-language classification, a Support Vector Machine was trained on 80% of the EEG data (0–500 ms after onset for lexical semantics; 300–800 ms after onset for number which is only available word-finally) per participant to classify between different nouns (e.g. dog(s) vs rat(s)) or between singular versus plural nouns, and tested on the 20% of held-out test data. For between-languages classification, the classifier trained on all noun data from one language was tested on the other language. RESULTS The classifier reached an above-chance accuracy (0.5) in decoding individual nouns for all participants in English (range: 0.52–0.63) and for five participants in Korean (range: 0.52–0.66). Cross-linguistic decoding accuracy was above-chance for four participants (range: 0.51–0.55). For grammatical number decoding, accuracy was above-chance for four participants in both English (range: 0.55–0.68) and Korean (range: 0.52–0.61). Across-languages classification of grammatical number showed an above-chance accuracy for four participants (range: 0.51 - 0.53). DISCUSSION The results of lexical concept decoding replicate Correia et al. (2015), suggesting that processing the same lexical concept in multiple languages yields a common pattern of brain activation that supports neural decoding cross-linguistically as well as within language. Crucially, the results from grammatical number decoding indicate that the neural responses to singular versus plural may also be shared to some extent between languages.

Topic Area: Meaning: Lexical Semantics

Poster B12 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

EEG reflects efficiency but not disengagement in artificial speech segmentation

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Introduction. Segmentation is a well-established statistical learning paradigm with direct correspondences to natural language, but its application to multiple language contexts is less clear. Brief exposure to one artificial speech stream can prevent listeners from learning a second stream if they’re not provided explicit context cues (Gebhart et al., 2009). This primacy phenomenon has been explained by two hypotheses: Over-learning the first structure entrenches participants into a specific pattern that is increasingly difficult to modify (Bulgarelli & Weiss, 2016), or immediately after learning the first structure, participants disengage from the stimulus and fail to sample subsequent input (neural efficiency; Karuza et al., 2016). We analyzed continuous EEG data during an extended familiarization phase to one artificial language to assess whether changes over time in the cortical representation of auditory speech support entrenchment or efficiency accounts of primacy. Methods. Sixteen undergraduate students (mean age 19.4y) at Swarthmore College listened to 11:15 (m:s) of one speech stream (learnable after 5:30: Gebhart et al., 2009, Experiment 1b) while EEG data were recorded from 64 channels sampled at 250 Hz. Immediately afterwards, participants completed sixteen 2-AFC trials comparing words vs. part-words from the stream. The acoustic envelope of the speech stream (rectified hilbert transform of the auditory waveform) contained a 4.26 Hz signal corresponding to the syllable presentation rate. There was no analogous signal in the envelope for word presentation rate (~1.4 Hz), indicating that the learned structure was strictly statistical and not available from the acoustic signal. Within every 30 second interval, we estimated the spectral power of EEG data in the windows 4-4.5 Hz (syllables) and 1.3-1.5 Hz (words), signal coherence between the speech envelope and EEG data in the same windows, and cortical tracking of the broadband speech envelope using mTRF (Crosse et al., 2016). We linearly modeled changes in entrainment to syllable level frequencies and cortical tracking of the envelope as a function of time and behavioral performance. Results & Conclusion. Mean 2-AFC accuracy was 0.781 (SD 0.148). Ten of the participants showed significant individual-level learning (>75%, binomial p<0.05). Changes in EEG spectral power were not well explained by the linear models (all coefficients' p>0.05). A model of signal coherence restricted to the second half of the familiarization phase contained a significant interaction between time and 2-AFC accuracy (p=0.003) which, under simple slopes analysis, indicated that participants with the highest behavioral performance increased coherence to the syllable-level frequency over time. The mTRF analysis, however, pointed to the opposite interaction (p=0.017); the highest-accuracy participants significantly decreased cortical tracking of the acoustic envelope over time. We speculate that participants who learn the language continue to engage with the syllable-level stimulus (coherence at 4.3 Hz), but that this sampling may require less overall effort (envelope tracking; see Zinszer et al., 2022). This explanation would nominally support efficiency but leaves unclear whether any savings in effort actually reduces sampling of distributional regularities from the speech stream.

Topic Area: Multilingualism

Poster B13 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Cortical feedback over long delays into auditory cortices supports real-world language processing

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In natural environments, speech perception and language comprehension unfold over multiple timescales. Linguistic ambiguity is present across these timescales, from 'lower-level' phonology (e.g., 'lack of invariance') to sentence level syntax and semantics. Research suggests that the brain resolves these ambiguities by leveraging contextual information (e.g., observed mouth movements or prior words) to constrain processing through prediction of forthcoming acoustic information. This is consistent with the feedback-dominated anatomical connectivity of auditory cortices. Thus, we hypothesised that early auditory and 'language' regions receive delayed connectivity from the whole brain, over the extended timescales across which language comprehension unfolds 'in the wild'. Furthermore, we expect this to occur in a manner that is sensitive to the temporal extent of available contextual information. We apply a novel technique for estimating the delayed connectivity in milliseconds between regions of the cortex, to the 'Naturalistic Neuroimaging Database' of 86 participants watching one of ten feature-length movies during functional magnetic resonance imaging (movie-fMRI). We define delay as the maximum of the estimated cross-correlation function between the timeseries of each of 770 regions of interest covering the cortex and every other voxel in the brain. We computed aggregate group level statistics across the produced 'delay-maps'. We replicate and extend this analysis using the 'narratives' fMRI database, wherein participants listened to both intact, and scrambled versions of the same story. There was a significant global preference for non-instantaneous functional connectivity across the brain in the movie-fMRI data (whole-brain median across voxels = 1.09 seconds). The longest delays were those feeding bilaterally into the calcarine and central sulcus and the transverse temporal and superior temporal gyri (STG). In auditory cortices, the median delay was 4.86 seconds (M = 5.73; SD = 4.95, Max = 51.38). Delay topographies were stable across the start, middle, and end of movies. Results were replicated in the narratives-fMRI data, with the longest delays again being in auditory cortices (Median = 9.73). Both the duration of delays, and the number of delayed connections feeding into the left STG were reduced for scrambled versus intact stories (Median = -3.25; Count = -18.6%). In two studies we reveal a whole brain gradient of delayed connectivity, wherein the longest delays were typically observed in sensory, motor, and 'language' regions. The temporal extent of delays in putative 'language regions' are sensitive to the temporal extent of available contextual information, as evidenced by their attenuation during scrambled narrative listening. Overall, these results support a model of the neurobiology of language in which contextual information is used to predict acoustic input in early auditory cortices. More generally, results argue against models in which processing in which auditory cortices are the first step in a processing hierarchy that ends in some putative 'higher-level' regions.

Topic Area: Perception: Auditory

Poster B14 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Do faces affect nonnative-accented speech comprehension in children? An ERP investigation

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Spoken language provides listeners with information about the speaker's identity, such as age, sex, or accentedness. Past research indicates that nonnative-accented speech can challenge processing, especially for listeners with limited experience with nonnative-accented speech (e.g., Grey & Van Hell, 2017). Though, the linguistic information encoded by a speaker's accent is not the only cue that listeners can use to identify a native or nonnative speaker. Visual cues such as facial information (e.g., cuing the speaker's ethnicity), may mitigate these effects by providing a salient cue about the speaker's identity (Fernandez & Van Hell, 2019; McGowan, 2015; Li, Yang, Scherf, & Li, 2013; Zheng & Samuel, 2017). When presented with facial information about the speaker, in addition to the spoken sentences, the neural signatures associated with the processing of nonnative-accented speech changed. Specifically, adults showed an N400 response to semantic violations in both accent conditions, similar to the no face cue study. However, with the added face cues, pronoun violations elicited a biphasic Nref-P600 neural response in non-accented speech, and a P600 in nonnative-accented speech (Grey, Cosgrove & Van Hell, 2020). Grammar processing without the speech cues showed no significant ERP effects for nonnative-accented speech indicating that face cues aid comprehension. For children, accented speech processing might present more difficulty than for adult listeners, because the perception process requires them to correctly map the speech stream produced with an unfamiliar accent onto their stored lexical representations at a time they are still developing their mental lexicon. Indeed, behavioral research has found that children do not achieve adult-level performance in nonnative-accented speech comprehension (e.g., Bent et al., 2019). Critically, the neural basis of this relationship between nonnative-accented speech processing and school aged children is largely unexplored. In the present study, we examined whether presenting faces as a cue to nonnative-speaker identity could aid nonnative-accented speech comprehension, particularly for online neural responses to violations. Using ERPs, we had children (aged 9-11) with little exposure to nonnative-accented speech listen to sentences containing a semantic anomaly or pronoun error (and correctly produced counterparts), produced by Chinese-accented and American-accented speakers of English. Prior to listening to Chinese-accented or American-accented speakers (producing the same sentences as above), listeners saw faces congruent with each speaker's accent. As outlined above, non-linguistic cues such as facial information of the speaker aid nonnative-speech comprehension (Grey et al., 2020; McGowan, 2015; Li, Yang, Scherf, & Li, 2013; Zheng & Samuel, 2017). In adults, pronoun violations in Chinese-accented English sentences (as well as American-accented English sentences) elicited a P600 like neural response, indicating face cues aided comprehension. Preliminary analyses of the child data, however, indicate that face presentation did not modulate pronoun processing in nonnative-accented speech: children still did not show a neural response to pronoun violations in nonnative-accented speech (but showed sensitivity to pronoun violations in non-accented speech and semantic violations in both accent conditions). This suggests that adults but not children use faces as a cue to speaker identity to aid nonnative-accented speech comprehension.

Topic Area: Speech Perception

Poster B15 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Predictability effects on auditory word recognition with a pre-primed semantic priming task

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Understanding the mechanisms underlying context effects during language processing is key for adjudicating between neurocognitive frameworks for spoken word recognition, such as Predictive Coding (PC) and Interactive Activation (IA). Of particular interest is whether predictability effects in behavioral and neural responses arise because predicted lexical items lead to ultimately higher activation levels or because they elicit smaller changes in activation. We build on work from Blank and Davis (2016) that used visual repetition priming with noise-vocoded auditory targets (e.g., SING sing vs. XXX sing), in a design necessitating multivariate analysis of the fMRI response to auditory items in order to make differing predictions for PC and IA. Instead, in this study we measure the semantic priming that the primed vs. unprimed auditory item causes (e.g. DUCK duck GOOSE vs. XXX duck GOOSE). This paradigm allows us to analyze how predictability constrains auditory processing by revealing the impact of the visual pre-prime on not only (1) the lexical activation levels that result from hearing the auditory item but also (2) the change in lexical activation that this constitutes relative to a control. We present clear rather than vocoded speech and fully manipulate the status of the visual pre-prime as (a) matching the auditory item, (b) mismatching, or (c) neutral. 204 participants saw a pre-prime that either matched the auditory item (e.g., DUCK), did not match the auditory item (e.g., TABLE) or was neutral (XXX). Participants then heard the auditory item (e.g., duck or an unrelated control, e.g., table), and then made a lexical decision on a semantically related written target (e.g., GOOSE). We found a significant interaction between the status of the pre-prime and the status of the auditory item. In planned pairwise comparisons, the semantic priming effect caused by the auditory item (hypothesized to reflect the change in lexical activation due to hearing the auditory item) was significantly smaller with the matching pre-prime than the mismatching or neutral pre-prime. This arose because, among the control conditions, we observed significantly faster reaction times for match trials (DUCK table GOOSE) than mismatch or neutral trials (TABLE table GOOSE, XXX table GOOSE). When the auditory item and target were semantically related, reaction times were significantly faster across the board, but were not impacted by the pre-prime (i.e., no difference between DUCK duck GOOSE, TABLE duck GOOSE, and XXX duck GOOSE). This pattern raises many questions for further investigation. It is potentially consistent with an account in which typically observed facilitation effects for matching or predictable words occur because these words evoke smaller changes in activation, rather than because they ultimately reach higher lexical activation levels than mismatching or unpredictable words. The paradigm developed in this study and the findings we present here should help distinguish between predictions generated by different models of spoken word recognition and inform future neuroimaging designs, ultimately leading to a deeper mechanistic understanding of prediction and context effects in language processing.

Topic Area: Speech Perception

Poster B16 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Processing Prosodic Politeness in Foreign Accent: an fMRI Study

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Emerging sociolinguistic studies show that when listeners rate utterances varying in prosodic impressions of politeness (e.g., level of sincerity, friendliness), foreign-accented speech tends to be assessed as carrying less emotive meaning than native speech. These perceptual findings suggest that hearing a foreign accent alters the listener’s ability to encode the affective-prosodic meaning of speech acts. Although neuroimaging research has well

documented the critical role of temporal lobes in the perception of accented voice, search for voice-related memory, and encoding of socio-affective vocal cues, it remains unclear to what extent foreign accents affect brain responses associated with processing affective-prosodic speech. To clarify this issue, we created a task containing Japanese honorific utterances varying in Accent [Native (N) vs. Foreign (F)] and Prosodic impression [Sincere (S) vs. Insincere (I)]. During fMRI scanning, 29 participants were instructed to listen to the stimuli utterances, to ensure attention, they were asked to judge whether or not a word had appeared in the previous utterance. In addition, to explore whether individual differences in foreign accent familiarity affect the neural process of encoding affective-prosodic meaning, all listeners filled out an accent rating scale after fMRI scanning. Based on previous perception and neuroimaging findings, we expected that comprehending the affective-prosodic meaning of sincerity would depend on the perception of accent differences. Such an effect would engage brain regions sensitive to accent-prosodic analysis. We also expected that individual differences in foreign accent familiarity would mediate brain responses associated with the retrieval of voice-related memory (e.g., recognizing familiar speakers) during utterance comprehension. Brain imaging data were analyzed using SPM 12 software (cluster level $p < 0.05$ FWE corrected). Based on our hypothesis, we focused on the interaction effect between the type of accent and prosodic impression ([NI vs. NS] > [FI vs. FS]) in the whole-brain group-level analysis. Moreover, we performed a single regression analysis at the whole-brain level for the foreign-accented conditions (FI, FS, and [FI vs. FS]) with the foreign accent familiarity score of each participant. Two major findings emerged. First, the interaction contrast ([NS > NI] > [FS > FI]) elicited a significant response in the right posterior superior temporal cortex. Second, we found that activity in the right medial temporal region was positively correlated with perceived accent familiarity for utterances produced in the foreign accent ([FI > FS] contrast, $p < 0.001$ uncorrected). Taken together, the interaction of impressions formed from a speaker's accent and their mode of prosodic expression provides novel evidence of how the right superior temporal cortex integrates different types of socio-affective vocal cues during speech comprehension. Moreover, the correlation finding suggests that individual differences in accent familiarity modulate the cortical response when processing affective-prosodic meanings expressed by a foreign-language speaker; this process may be mediated by the brain structures associated with the recognition of familiar speakers.

Topic Area: Prosody

Poster B17 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

A multifactorial approach to study bilingualism: Evidence from structural and functional neuroimaging

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Healthy aging is associated with declines in cognitive performance associated with lifelong changes in structural and functional characteristics of the brain. Bilingualism tends to protect against these age-related changes. This study compared brain and behavioral outcomes for cognitively healthy bilingual adults. Unlike previous studies, the effects of bilingualism were examined along a continuum instead of dichotomizing them. This study explores the effects of bilingualism on the cortical surface area and resting-state functional connectivity (rsFC). While the impacts of bilingualism on cognitive processes across the lifespan have been documented, the understanding of bilingualism-related neural substrate is limited. The current study (N = 75; Age range = 30-80 years; Female = 46) investigated structural differences in bilingual participants varying on a continuum of measures of bilingualism. A multifactorial approach to studying bilingualism resulted in 4 latent variables – L2 exposure, L2 proficiency, L2, objective task performance, and L2 age of acquisition (AoA), which were used as measures of bilingualism. We examined global differences in cortical grey matter areas due to bilingualism, age, and other cognitive reserve factors. L2 language exposure predicted the cortical surface area of Rt PCC; cortical grey matter surface area increases with increasing L2 exposure with no influence of age and other cognitive reserve variables. L2 objective task performance and L2 AoA were able to positively predict cortical surface areas of the right orbital frontal and rt superior frontal areas,

accompanied by a negative effect of chronological age. L2 AoA and age negatively impact cortical surface areas of Lt middle temporal, Lt parahippocampal, Rt transverse temporal, and Rt pars orbitalis. L2 objective task performance positively predicts change in cortical surface area of Lt PCC and Lt rostral ACC. Cognitive reserve variables had no impact on cortical surface areas; however, there was a reduction in cortical areas with an increase in chronological age. The interaction between these variables will be discussed in detail. These results suggest that bilinguals showed greater cortical surface areas with an increasing level of bilingualism in key regions related to language and executive control function, regardless of age-related widespread GM deterioration. We also explored the impact of bilingualism on rsFC networks using the four latent variables and found a differential impact of bilingualism on the rsFC matrices while controlling for the effects of age and other cognitive reserve variables. Specifically, rsFC between default mode network and control network varied with different levels and measures of bilingualism. The objective measure of bilingualism positively modulates the rsFC between the left salience ventral attention network and the right salience ventral attention network. The subjective measures of bilingualism showed a differential correlation between the default mode network and the control network. L2 exposure negatively modulates DMN-control network connectivity, and L2 proficiency showed a positive correlation. Such differential nature of the impact of bilingualism on the rsFC between DMN-control networks emphasizes the dynamic nature of bilingualism that is tapped by considering bilingualism on a continuum and using the multifactorial approach to study bilingualism.

Topic Area: Multilingualism

Poster B18 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Attentional effects of speech processing in monolingual and bilingual children and adults

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Considerable research reveals that bilingual individuals navigate the speech landscape differently than those who are functionally monolingual. Studies of speech perception have asked whether good proficiency in a bilingual's two languages allows for fast and efficient recovery of lexical meaning in both languages (Strange, 2011). Late learners of a second language (L2) typically show different perceptual patterns in the L2 because they fall back on first language (L1) speech perception routines, particularly for difficult tasks. Early bilinguals often show comparable speech perception to monolinguals. Several studies, however, suggest processing differences between monolinguals and bilinguals in attention to speech (Datta et al. 2020). We examined electrophysiological responses to determine whether early Spanish-English bilingual listeners process speech differently than American-English monolinguals. Twenty-one adults (7 bilinguals) and 26 five-to seven-year-old children (13 bilingual) listened to the American English 250-ms vowels /ɛ/ and /ɪ/ presented in sequences of 10 stimuli, while brain responses were recorded from 65 scalp electrode sites. The participants ignored the stimuli and watched a muted movie to allow examination of automaticity of processing. The analysis focused on the obligatory auditory evoked potentials (AEPs) to /ɛ/. Monolinguals and bilinguals showed remarkably similar-morphology brain responses. The latencies of AEP peaks (P1, N1, P2, N2 for adults and P100 N2 for children) at fronto-central sites showed nearly identical latencies for monolingual and bilingual groups. However, bilingual compared to monolingual adults showed greater negative amplitude around the N1 latency at frontal sites (Nd attentional effect). In contrast, the bilingual and monolingual children showed highly similar patterns. The pattern of AEPs differed in relation to position in the sequence, indicating repetition effects that were similar across language groups, but differed for adults and children. Results will be discussed in terms of maturation of speech processing and models of prediction and attention.

Topic Area: Multilingualism

Poster B19 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam B session.

Interpretability tools reveal what components of NLP models drive similarity to human brain activations in language processing

Marianne de Heer Kloots[1], Willem Zuidema[1]; [1]University of Amsterdam

To successfully understand natural language, the human brain must integrate information across several representational domains and levels of abstraction. Large neural language models from the Natural Language Processing field process language well enough to be successful at many tasks, while internal activations generated in such models appear to be remarkably predictive of human brain responses during language comprehension. Although encoding models mapping from ANNs to brains are increasingly seen as promising ways to better understand human neural information integration, a problem for using Large Language Models (LLMs) in this approach is the opaque path from training corpora through model architectures to individual brain activity data (as illustrated by e.g. larger untrained architectures performing better than smaller trained ones; Schrimpf et al., 2021). Here, we aim to improve the interpretability of this pipeline by partitioning LLMs into components that have been successful targets of interpretability work in NLP (Rogers et al., 2021). We build on recent studies with Transformer LLMs, which found that better neural predictivity is generally achieved by activations from higher model layers (Caucheteux & King, 2022; Schrimpf et al., 2021). After replicating these results qualitatively, we investigate what model-internal operations make activation patterns at these specific layers more brain-like. In particular, we examine the role of individual attention heads within each layer, and the multi-head attention mechanism regulating information flow between layers. We compare model and brain responses to the same text, using uni- and bidirectional transformer language models (GPT-2 and BERT), Representational Similarity Analysis, and a dataset with fMRI recordings of human story reading (Wehbe et al., 2014). Next to activation vectors for entire model layers, we also extract activations from individual attention heads within each layer. We then study the model-internal behaviour producing these activations, using a metric that quantifies the importance of every input token for each attention head (Kobayashi et al., 2020). We indeed find generally higher brain-similarity with increasing layer depth, though similarity sometimes peaks in earlier layers (1-2) of BERT as well. However, representational similarity is not evenly distributed within model layers: there are big differences in brain-similarity scores between attention heads in the same layer. Additionally, individual head activation patterns sometimes show higher brain-similarity than whole layer activations. Aggregating the model's attention over all heads within layers, we find that earlier layers assign most importance to directly preceding words, whereas later layers integrate information over larger contexts. This aligns with differences in representational similarity when varying the amount of prior context text given to the model as input: almost all layers in both GPT-2 and BERT perform better with small amounts of prior context (8-12 words) compared to none, but only middle and higher layers show some additional benefit for context lengths beyond 16 words. Our work shows that we can successfully isolate smaller components of LLMs that drive much of the similarity between model-internal states and human brain activations. This opens possibilities to investigate whether these components (i.e. specific attention heads) are also most important for the models' linguistic performance.

Topic Area: Computational Approaches

Poster B20 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Does bilingualism lead to nonverbal and verbal cognitive reserve in adults with aphasia?

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A number of studies have found an advantage in cognitive control in bilingual adults compared to monolingual adults (see van den Noort et al., 2019 for a review). Cognitive reserve in bilingualism has also been well-researched (Grant et al., 2014). However, the potential benefits of bilingualism for language function after stroke has received less attention. Limited research indicates that bilingual persons with aphasia (PWA) are more efficient at inhibiting irrelevant nonverbal (Dekhtyar et al., 2020) and verbal (Faroqi-Shah et al., 2018) information compared to monolingual PWA. However, no study has examined both nonverbal and verbal cognitive control across mono- and bi-lingual adults with and without aphasia. Thus, we aimed to replicate and extend previous findings of a bilingual advantage in neurologically intact older adults (NIOA) and PWA for both verbal and nonverbal tasks. Data are collected for ten English monolingual NIOA, 6 Spanish-English bilingual NIOA, 9 English monolingual PWA and 4 Spanish-English bilingual PWA, who each completed both a nonverbal and verbal flanker task. We expect ten participants in each group. BNIOA and BPWA completed the verbal flanker task in both Spanish and English. The congruency effect (CE) is an indicator of cognitive control (i.e., the ability to suppress distractors) and was calculated as the difference in reaction time (RT) between congruent and incongruent trials. Additionally, based on Grundy et al. (2017), the sequential congruency effect (SCE), which measures the influence of the previous trial on the current trial, was examined. Four trial types were created: congruent trials following a congruent trial (cC), congruent trials following an incongruent trial (iC), incongruent trials following a congruent trial (cI), and incongruent trials following an incongruent trial (iI). The SCE was calculated by subtracting the c-flanker effect (the I-C difference following congruent trials) from the i-flanker effect (the I-C difference following incongruent trials). Smaller SCEs indicate increased ability to disengage attention from the previous trial. Preliminary univariate 2 (bilingual vs. monolingual) x 2 (aphasia vs. intact) x 2 (verbal vs. nonverbal) ANOVAs of RT (Sidak alpha-level: $p<.05$) were conducted for both CE and SCE. For CE, there was a main effect of task type, with smaller CEs in the verbal task. There was also an interaction between task type and presence of aphasia, with smaller CEs for NIOA than PWA in the nonverbal task. For SCE, there was a main effect of bilingualism, with smaller SCEs for bilingual than monolingual individuals, and a main effect of aphasia, with smaller SCEs for PWA than NIOA. There was also an interaction between aphasia and task which suggested that the verbal task was driving the difference between PWA and NIOA and showed that PWA have smaller SCEs for the verbal than nonverbal task. These preliminary results confirm the bilingual advantage for disengaging attention (more bilingual participants will clarify this result) and reveal better control for the verbal than nonverbal task. The unexpected juxtaposition of decreased control in the nonverbal task with increased ability to disengage attention in the verbal task accompanying aphasia is worth exploring further.

Topic Area: Multilingualism

Poster B21 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

What is special about (misspelled) logotypes? Examining the brain signature of misspelled logos

Maria Fernandez-Lopez[1], Francisco Rocabado[2], Manuel Perea[1,2], Melanie Labusch[2], Ana Marcet[1], Marta Vergara-Martinez[1]; [1]University of València, [2]Nebrija University

Companies and products are identified by their brand names, typically presented as logotypes (i.e., with a given font style, color, and design). While this graphic information provides a distinctive image that facilitates recognition, it also makes them particularly vulnerable to counterfeiting through misspelled branding (e.g., amzaon). Indeed, they are affected by letter transpositions to a larger degree than common misspelled words (e.g., JUGDE) (see Perea et al., 2021, 2022, for behavioral evidence). Why are logotypes especially susceptible to misspellings? While common words are defined by their orthographic characteristics in written language, logotypes are defined by both their graphic and orthographic characteristics. In this line, neurally-inspired models of visual (common) word recognition (e.g., Dehaene et al., 2005; Grainger et al., 2008) assume that information such as color or lettering style is lost early during the processing of common words. The underlying logic is that word recognition is based on retrieving abstract orthographic characteristics resulting from an explicit learning process. However, logotype identification can be particularly dependent on color and lettering style. As a result, orthographic encoding would play a secondary role, thus making logotypes easily susceptible to letter transposition effects (e.g., Perea et al., 2021). The goal of the present ERP experiment was to uncover the processing of letter position information when recognizing logotypes. Participants were presented with correctly spelled (SAMSUNG) or incorrectly spelled (letter-transposition: SASMUNG; letter-replacement: SARVUNG) logotypes in a semantic categorization task. Participants had to decide whether the brand name's logotype was related to travel or not (e.g., RYANAIR [a low-cost European carrier] vs. SAMSUNG)—the focus was on the no-go responses (i.e., non-travel logos). The ERP results showed higher amplitude for the replaced-letter brand names than for the transposed-letter and correctly-spelled brand names at an early stage of processing (P200). The difference between the replaced-letter vs. transposed-letter and correctly-spelled brand names remained until 600ms. Critically, there were no differences in amplitude between the transposed letter and the correctly-spelled brand names over most scalp electrodes. This pattern of results critically differs from previous results on transposition effects with common words. In a semantic categorization task, Vergara-Martínez et al. (2013) found amplitude differences at around 300ms between the correctly-spelled words (JUDGE) and both the replaced (JUPTE) and transposed (JUGDE) pseudowords. While these differences remained between the replaced-letter and correctly-spelled words until 600ms, they vanished for the transposed and correctly-spelled words between 360-470ms. Notably, at a later window (470-580 ms), both types of pseudowords elicited larger negativities than words. In summary, the present findings place limits on a tenet of the leading word recognition models about an initial confusion in orthographic processing (e.g., letter position encoding) that is eventually resolved. At least for logotypes, this processing does not seem to reach the last orthographic verification stage. Instead, information such as color or lettering style can be more relevant for logotype identification than letter position. Critically, these results challenge those theoretical models, which predict a similar time course in the processing of letter position coding for misspelled logotypes and misspelled common words.

Topic Area: Reading

Poster B22 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam B session.

Left prefrontal regions mediate the influence of executive functioning on sentence processing in primary progressive aphasia

Andrea Gajardo-Vidal[1,2], Diego L. Lorca-Puls[1], Maria Luisa Mandelli[1], Abigail E. Licata[1], Buddhika Ratnasiri[1], Rian Bogley[1], Zachary Miller[1], Bruce Miller[1], Maya Henry[3], Jessica de Leon[1], Maria Luisa Gorno-Tempini[1]; [1]Memory and Aging Center, Department of Neurology, University of California, San Francisco, [2]Faculty of Health Sciences, Universidad del Desarrollo, Chile, [3]Department of Speech, Language, and Hearing Sciences, University of Texas, Austin

Background: Previous neuropsychological studies have shown that executive functioning (EF) contributes to performance on language tasks that pose high cognitive demand. Furthermore, functional neuroimaging studies have provided neurobiological evidence that language tasks involve an interaction between language-related and domain-general executive control regions. Finally, it has been suggested that enhanced activity (or increased connectivity) in executive control networks may support language recovery in stroke patients. In the current study, we sought to investigate cross-sectionally and longitudinally the relationship between EF and language, and the neural substrates of that relationship (if any), in patients with primary progressive aphasia (a neurodegenerative syndrome). Methods: A total of 197 patients with a diagnosis of primary progressive aphasia (PPA) were selected from the UCSF Memory and Aging Center database. We performed four analyses involving behavioral and imaging data. (1) A principal component analysis across all EF tasks with no or minimal verbal output yielded one orthogonal component. Based on this component, we created a composite score of EF tasks, and run a series of correlational analyses between this composite score and representative language tasks. (2) A whole-brain voxel-wise analysis using grey matter images was implemented in the Mediation Toolbox to identify which brain regions mediate the relationship between EF and language. (3) A resting-state fMRI (rs-fMRI) analysis of data from 132 healthy controls was carried out to examine the functional connectivity of the regions identified in our mediation analysis. (4) A mixed ANOVA of longitudinal data from a subset of 83 PPA patients who were tested at two different time points was conducted to evaluate the interaction between EF performance and language decline. Results: (1) Across all language tasks, the sentence comprehension (SentComp, rho = 0.474, p<0.001) and the WAB spontaneous speech total score (SentProd, rho = 0.369, p<0.001) were the most strongly correlated tasks with our EF composite score compared to, for example, object naming (rho = -0.147, p = 0.041) or word reading (rho = 0.181, p = 0.031). (2) Two clusters located within the left middle frontal gyrus (LMFG) and left superior frontal gyrus (LSFG) mediated the relationship between: (i) EF and SentComp and (ii) EF and SentProd. (3) These LMFG and LSFG regions were part of the same fronto-parietal network that previous studies have associated with executive control and shown to be critical for more demanding tasks. (4) The SentComp and SentProd scores of the patients with better EF compared to those with worse EF were significantly better across the two time points and declined significantly less over time, even after controlling for potential confounds such as severity and education. Conclusions: Our results suggest that: (1) EF supports sentence processing in PPA patients; (2) two left prefrontal regions (LMFG and LSFG) mediate the relationship between EF and sentence processing; (3) these regions are part of the fronto-parietal executive control network rather than the classic perisylvian language network; and (4) EF might potentially play a “compensatory” role as language declines.

Topic Area: Disorders: Acquired

Poster B23 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

EEG-based biomarkers of language development in Down syndrome

McKena Geiger[1], Megan Hartney[1], Margaret Hojlo[2], Anna Milliken[2], Nicole Baumer[2], Carol Wilkinson[1]; [1]Labs of Cognitive Neuroscience, Developmental Medicine, Boston Children's Hospital, [2]Down Syndrome Program, Developmental Medicine, Boston Children's Hospital

Introduction: Down syndrome (DS) is the most common cause of intellectual disability; yet little is known about the neurobiological pathways of cognitive and language impairments in DS. While there is well described characterization of language development in DS, the neurobiology underlying challenges in communication is unclear. There is a great need for brain-based biomarkers of language development in DS (1) for use as outcome measures within clinical trials and (2) to better our understanding of the neurobiology driving language delays. Given these language delays are likely initiated during early development, it is important to identify biomarkers in infants and young children with Down syndrome. As a low-cost, non-invasive measure of neural activity, electroencephalography (EEG) is a candidate tool to derive such biomarkers. Aims: (1) To characterize baseline EEG power spectra in children with DS compared to age-, and cognitive-matched comparison groups. (2) To identify neural markers of language development in DS. Design/Methods: Continuous resting state EEG from 26 boys and girls with DS (age 1-4 years) and respective age-matched (n=26) and cognitively-matched (n=26) comparison groups were successfully collected and analyzed. All participants completed the Mullen Scales of Early Learning (MSEL) as a measure of language ability. Power spectra were calculated using a multitaper spectral analysis and then further parametrized into aperiodic (1/f curve) and periodic components using FOOOF. Differences between groups were assessed using a Mann-Whitney U test. Associations between EEG measures and language were evaluated using Pearson Correlation and linear regression, with age as a covariate. Results: Participants with DS showed a significantly decreased aperiodic slope when compared to age-matched participants (p = 0.02), and significantly increased aperiodic gamma power compared to both age- and cognitive-matched comparison groups (p <0.01). After adjusting for age, the decreased aperiodic slope was significantly associated with better language (Adjusted R2= -0.51, p<0.005). Summary: Reduced aperiodic slope and associated increased aperiodic gamma power was observed in preschool aged children with DS. However, reduced aperiodic slope was also associated with better language development, suggesting the increased aperiodic slope may represent compensatory mechanisms.

Topic Area: Disorders: Developmental

Poster B24 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

The organization and lateralization of brain activity in infants and toddlers from birth through five years of age

Stephen Gotts[1], Shawn Milleville[1], Alex Martin[1]; [1]Section on Cognitive Neuropsychology, Laboratory of Brain and Cognition, NIMH/NIH

The cerebral lateralization of language, fine motor coordination and visuospatial abilities in humans has been studied extensively in adults, and direct relationships have been observed between degree of skill in these domains and the degree of brain lateralization (e.g. Gotts et al., 2013). However, less is known about the developmental trajectory of brain lateralization, especially at the earliest ages. In the current study, we use fMRI data from the Baby Connectome project (Howell et al., 2019) to examine the overall organization and lateralization of resting-state brain activity in sleeping infants and toddlers from birth (0 months) through 5 years of age (N = 260, each with 10 minutes of resting-state fMRI data). Organizing age into non-overlapping bins of approximately 50 participants each (0-6 mo., 7-11 mo., 12-16 mo., 17-24 mo, 25-70 mo.), the resting-state data in each bin were parcellated into networks across a range of thresholds using the InfoMap algorithm (as in Persichetti et al., 2021). Using a common threshold (top 10% of connections) that maximized split-half agreement and number of parcels within each age bin, parcellations were found to be highly similar across bins, with 4 large cortical parcels (Occipital, Lateral Temporal, Somatomotor, and Frontal) and 2 subcortical parcels (Basal Ganglia and Thalamus/Cerebellum). The only prominent changes observed across the age bins involved the differential grouping of the posterior cingulate cortex (PCC) and frontal cortex with the lateral temporal cortical parcels. At the youngest ages, these elements remain in separate parcels (0-6 mo.). From 7-11 months and older, the PCC is grouped with the lateral temporal cortex. Only at the oldest ages (25-70 months) was the frontal cortex grouped with the PCC and the lateral temporal parcels as is typical in adulthood, suggestive of the emergence of a language/speech system. Examining continuous effects of age within and across parcels (partialing head motion), prominent and widespread increases in long-range functional connectivity between parcels were observed with age, whereas increased local functional connectivity (within parcel) was only observed in occipital cortex ($P<.028$, $q<.05$ for all). Finally, the lateralization of the cortical parcels was examined using the Segregation (within-across hemisphere correlation) and Integration (within+across hemisphere correlation) metrics developed by Gotts et al. (2013). In contrast to the adult, the strongest lateralization effects were detected with the Integration metric, with left lateralization observed across ages for the PCC, Occipital, and Somatomotor parcels and right lateralization observed for the Frontal parcel. Left lateralization for the PCC parcel (which is part of the larger language system in the adult) was highly significant even for the earliest ages (0-6 mo., $P=.0018$, $q<.05$). Only the Occipital parcels exhibited lateralization with the Segregation metric (rightward) ($P<.0039$, $q<.05$ for all), and neither metric exhibited strong changes in lateralization over this age range. Taken together, the results suggest that much of the early changes in brain organization involve the establishment of long-range functional connections between large scale brain networks, and cerebral lateralization – while detectable from 0-6 months, differs markedly from the adult in both quantity and quality.

Topic Area: Development

Poster B25 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Negotiating the Granularity of Concepts during Communicative Interaction

Miriam Greidanus Romaneli[1], Saskia B. J. Koch[1], Margot Mangnus[1], Kexin Cai[1], Christine Cimpian[1], Sushmita Sadhukha[2], Ivan Toni[1], Jana Bašnáková[1], Arjen Stolk[1,2]; [1]Radboud University, Donders Institute for Brain, Cognition, and Behaviour, [2]Dartmouth College

Human communicative signals elicit stable semantic concepts due to repeated use in a community (Clark, 1996; Levinson, 2000). Yet, in dialogue, people continuously and dynamically adjust the relationship between signals and concepts, including their granularity (i.e. the amount of semantic detail referred to by an individual signal). Here, we build on the suggestion that communicative interaction requires coordinating a shared conceptual space (Stolk et al., 2022) and explore how interlocutors adapt the granularity of signal-meaning mappings in this space, a crucial but unexplored feature of this coordination process. This project expands on behavioral and neural (fMRI) observations obtained in a controlled yet open-ended non-verbal communication game (de Ruiter et al., 2010; Stolk et al., 2013, 2014). Analogous to everyday conversations, the game challenges dyads to construct signals that are referentially contingent on the ongoing communicative interaction, including current signal-meaning relationships. Differently from everyday conversations, communicators have no prior experience with these signals, providing researchers reliable access to signals' referential contingencies. We reasoned that, under these circumstances, the granularity of communicators' concepts can be inferred from the number of meanings mapped onto individual signals. We quantified signals produced by pairs of communicators during real-time non-verbal interactions on a digital game board. In each trial, two players were tasked with jointly reproducing a target configuration of two given shapes, shown to one player only. This required that player to construct a signal using her shape that conveys to her partner the target configuration of his shape. These circumstances drive pairs to converge on a limited but idiosyncratic number of signals among an open-ended set of possibilities, such that different dyads use different signals to refer to the same meaning (i.e. shape configuration; Stolk et al., 2014). Preliminary behavioral results (N=8 dyads, 94 trials/dyad) indicate that, when having to convey a new meaning, some dyads introduce and converge in using unique signals for that meaning while retaining existing signal-meaning mappings. In contrast to these "splitters", so-called "lumpers" introduce and converge in using new signals for both new and existing signal-meaning mappings. These observations suggest that lumper and splitter dyads spontaneously coordinate their conceptual space at different levels of granularity. We plan to test whether this behavioral characterization of conceptual granularity is reflected in the representational dimensionality (RD) of neural activity in the right superior temporal gyrus (rSTG), a cortical area previously found to support conceptual alignment between communicators (Stolk et al., 2014). RD of a neural population has been shown to balance the computational trade-off between generalizability and separability of mental representations (Fusi et al., 2016; Badre et al., 2021). We hypothesize that coarser representations in the meaning space of lumper dyads are supported by lower RD, whereas the finer-grained representations of splitter dyads are paralleled by higher RD in the rSTG. These inquiries will advance our neurocognitive understanding of how communicators negotiate and move between levels of conceptual granularity in their signal-meaning mappings, a fundamental yet largely unexplored aspect of human communicative interaction and language use.

Topic Area: Meaning: Discourse and Pragmatics

Poster B26 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Symbolic vs. Gradient Phonemes

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Are phonemes discrete symbols consisting only of distinctive features (Chomsky & Halle, 1968; Kazanina et al., 2018) or do phonemes contain gradient statistical information about their phonetic properties (Smolensky, Goldrick, & Mathis, 2014)? We addressed this question utilizing the "varying standards" oddball paradigm (Phillips et al., 2000), which assumes that varying the standards within category recruits an abstract phoneme from long-term memory as the memory trace for deviance detection. The resulting MMN therefore reflects the difference between a phoneme and a phonetic oddball. A corollary of this is that not varying the standards ("single-token standards") should favor a memory trace consisting of the phonetic representation of the standards; the resulting MMN should therefore reflect a phonetics-based discrimination. Both phoneme theories are consistent with a within-category MMN, because listeners can discriminate between phonetic variants and detect phonetic gradience (McMurray et al., 2002; Miglietta et al., 2013). However, the symbolic theory predicts that when standards are varied, the MMN should disappear for a within-category deviant (because the phoneme is a proper subset of the phonetic representation). On the other hand, gradient phoneme theories predict a within-category phonetic MMN even with varying standards, as long as the deviant is an outlier relative to the probability distribution of the phoneme. Experiment 1 compared within-category MMN obtained with varying standards vs. single-token standards (as a between-subjects variable). The varying standards condition (N=33) used 42, 48, 55ms VOT [tæ] stimuli. The single-token condition (N=30) used a 48ms VOT [tæ]. Both conditions used a 119ms VOT [tæ] deviant. MMN was computed as the difference in brain response to the deviant minus the same token in a roving standards control condition. MMN was observed in both conditions/groups ($p = .023$), and was not modulated by group ($p = .478$). This rules out the strict interpretation of Phillips et al., (2000) that varying standards recruits a purely symbolic phoneme representation, but is consistent with a theory where the phoneme representation of /t/ contains a Gaussian distribution with a mean VOT of, say, 60ms for [tæ]. In Experiment 2, we asked whether the MMN with varying standards is partially driven by an ad-hoc statistical summary of the standards in addition to experience-based encoding of acoustic statistics. Garrido et al. (2013, 2016) demonstrated with pure tones that MMN to an outlier/deviant is modulated by the statistical distribution of the presented standard stimuli. Adapting the design of Garrido et al. (2013), we presented listeners (N=11) with a 128ms VOT [tæ] deviant embedded in a normal distribution of varying standards with a mean VOT of 64ms and a "wide" standard deviation of 15ms. A second group (N=11) was presented with the same deviant and mean standard but with a "narrow" standard deviation of 5ms. This replicated Experiment 1 with a within-category MMN ($p < .001$), but no difference between the two standard deviation groups was observed. We discuss alternative interpretations of the lack of an effect of different standard deviations of standards, and the theoretical implications of within-phoneme MMN with varying standards.

Topic Area: Speech Perception

Poster B27 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Intact semantic processing of a continuous narrative story during sleep

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Sleep represents an altered state of consciousness, marked by a reversible reduction in responsiveness to the external world. Nonetheless, previous research has shown that the sleeping brain continues to monitor the environment for important salient events and to engage in surprisingly high-level cognitive processes, including semantic processing of individual words. Here, we probed the limits of the sleeping brain's capacity for language, investigating the extent to which a naturally spoken, continuous narrative story is processed during sleep. Participants were exposed to an intact and scrambled narrative story while they either slept or lay awake. A temporal response function (TRF) mapped the relationship between participants' EEG neural responses and the semantic dissimilarity of words within the narrative. During both wake and sleep, a TRF negativity was observed as a function of semantic dissimilarity. This negativity shared similar characteristics to the classic N400 event-related potential, a well-established marker of semantic processing. Importantly, the effect during sleep was similar to that observed during wake, but with a delayed latency. These findings suggest that the sleeping brain is capable of high-level, semantic processing of fully natural, complex narrative speech. Our results provide initial evidence that natural language processing remains remarkably intact during sleep.

Topic Area: Speech Perception

Poster B28 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Event Related Potentials to Native and Nonnative Phoneme Contrasts and Early Reading Abilities in School-Aged Children

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Phonological awareness skills are strongly predictive of word reading abilities in early school aged children, yet their underlying neural mechanisms remain unknown. The mismatch negativity (MMN) response is a highly studied event related potential (ERP) component that is thought to reflect the discrimination of a change in a stream of repeated sounds (Näätänen, 1992). Several studies have investigated the relationship among the MMN response and reading ability in general (Volkmer & Schulte-Körne, 2018). Additionally, researchers have found that a relationship exists between the MMN response to native phonological contrasts and phonological processing skills, specifically phonological awareness, in school-aged children (Linnavalli et al., 2017; Norton et al., 2021). Fewer studies have investigated the relationship between the MMN response recorded to native and nonnative speech contrasts and phonological awareness skills. It is possible that a strong neural commitment to the native language precipitates early phonological awareness. Here we investigate the relationship between the MMN response in school-age children recorded in response to two English phonemic contrasts and two Spanish allophonic contrasts with standardized measures of phonemic awareness. Methods: Thirty-three monolingual 1st and 2nd grade students (Mage= 7.0 yrs, SD = 7 mos) participated in the Comprehensive Test of Phonological Processing Skills, Second Edition (CTOPP-2) as well as 2 passive auditory oddball tasks containing either English (/ta/ and /pa/) or Spanish (/t̪a/ and /d̪a/) contrasts. Stimuli were played within the sound field as children watched a silent movie. Results: Electrode montages and timeframes of interest were chosen based on previous literature on the MMN in young children (Linnavalli et al., 2017; Norton et al., 2021). Preliminary analyses revealed the MMN over a cluster of 6 electrodes within the right central region for both English and Spanish experiments. The difference wave was calculated by subtracting the deviant-standard waveforms within the timeframe of 100-300ms for each contrast separately. Latency within the difference wave for English contrasts was correlated with several standardized scores of phonological awareness on the CTOPP-2 (Phonological Awareness Composite, $r = .42$, $p = 0.01$, Blending Words, $r = .37$, $p = .03$, and Phoneme Isolation, $r = .54$, $p = .01$). There were no significant correlations between latency measures of the difference wave for Spanish contrasts and phonological awareness measures of the CTOPP-2 for the group (Phonological Awareness Composite, $r = -.20$, $p = .27$, Blending Words, $r = -.04$, $p = .84$, and Phoneme Isolation, $r = -.07$, $p = .79$). Discussion: Phonological awareness is critical for reading success and therefore the neural mechanisms which underlie this skill warrants exploration. The MMN response may be a sensitive measure of the neural processes related to efficient auditory and/or phonemic processing that are shared with phonological awareness skills. The nature of the neural commitment to the native language revealed by the MMN and its association with phonological awareness in young children will be discussed.

Topic Area: Speech Perception

Poster B29 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam B session.

Disentangling semantic and domain-general control networks: the role of stimuli versus task process

Victoria Hodgson[1], Matthew Lambon Ralph[1], Rebecca Jackson[1]; [1]University of Cambridge

The semantic control network (SCN) is primarily focused on left inferior frontal and posterior temporal cortices, and is believed to be critical for the effortful, goal-oriented manipulation of meaningful stimuli. It has typically been studied

in isolation from the multiple demand network (MDN), where the core regions implicated are bilateral frontal and parietal areas. Whilst both networks are specialised for the performance of executively demanding tasks, they differ in their reported domain-specificity. The MDN is thought to be domain-general and, therefore, to be activated across a range of challenging cognitive operations regardless of modality or specific cognitive process. In contrast, the SCN is defined on the basis of control processing in the semantic domain alone, regardless of the role of these regions in any other domain. The key regions implicated in each network differ (e.g., implicating dorsal vs. ventral prefrontal cortices, parietal vs. posterior middle temporal areas), yet these two networks appear to overlap in some regions, for instance in the dorsomedial prefrontal cortex and posterior inferior temporal cortex. It remains unclear how best to characterise these overlapping regions, what underlying neural processes they may be supporting, or what it is about the difficult, task-oriented use of semantic knowledge in particular that could prompt a switch to a dedicated semantic control network. This is because these networks are typically compared across, rather than within, studies, and when studies are designed to delineate these networks by comparing semantic and non-semantic stimuli, they may also differ in the types of tasks they utilise, confounding the effect of stimulus by tapping into distinct cognitive processes. We have addressed this by systematically assessing the impact of both the nature of the stimuli and the processing required with fMRI in a factorial design. Stimulus (semantic words vs. meaningless shapes) and task (n-back working memory vs. an “odd-one-out” task, adapted from the Cattell Culture Fair battery) were varied orthogonally within the same study, to create four distinct task-stimulus conditions. Each condition was delivered at two levels of difficulty, so that the regions implicated in demanding control processes could be isolated from domain-specific representation areas, and subsequently compared across the four conditions. This allowed us to assess the independent and interacting effects of task process and stimulus modality on the pattern of activation, within a sample of 32 neurotypical participants. Results indicate that both task and stimulus modality impact activation for difficult tasks, but most importantly, that these two factors interact. The semantic and nonverbal variants of the n-back task revealed little difference in activity. However, when the task involves selection, inhibition and rule-switching, as in the odd-one-out task, there is a much greater effect of modality, with the semantic odd-one-out task more closely resembling the typical SCN regions. This indicates that neither task process nor stimulus are sufficient alone to maximally recruit the SCN; instead, both impact the control regions engaged. These findings clarify the conditions which dictate SCN and MDN recruitment, bringing us closer to understanding the specific cognitive operations that different control areas perform.

Topic Area: Control, Selection, and Executive Processes

Poster B30 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Perception of Audiovisual Pairings Among Heritage Speakers of Spanish

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INTRODUCTION. Visual information can readily influence our perception of speech, as exemplified by the famous McGurk illusion (McGurk & MacDonald, 1976). It has also been found that bilinguals are more influenced by visual mouth movements than their monolingual counterparts when comprehending speech in their second language (Marian et al., 2018). However, it is not well understood how the presence of visual information influences speech perception in bilingual individuals who speak two languages that categorize certain phonemes differently. Here we investigated how the presence of visual mouth movements influence Spanish-English heritage speakers’ percepts along a /va/-/ba/ continuum. The phonemes /v/ and /b/ were selected since Spanish phonology maps the orthographic /v/ onto the /b/ phoneme, whereas English makes a clear distinction between these two phonemes. METHODS. The auditory speech continuum from /va/ to /ba/ comprised five consonant vowel (CV) stimuli. The video stimuli consisted of a speaker producing either /va/ or /ba/. The 5 auditory CVs were paired with each video, producing 10 possible audiovisual combinations (5 CVs x 2 videos). Spanish-English bilingual participants (n=27) were presented with Auditory-Only and Audiovisual trials and reported what they perceived on each trial. Since Spanish phonology maps /v/ onto /b/, we hypothesized that Spanish-English bilinguals would perceive /ba/ more often than /va/, even towards the /va/ end of the /va/-/ba/ continuum. We also hypothesized that the presence of visual mouth-shape information would bias participants' perception of speech tokens along the continuum towards the visually conveyed phoneme. RESULTS. Overall, the CV stimulus step (i.e., along the /va/-/ba/ continuum), but not the AV condition (i.e., visual-va, visual-ba, or auditory-only), significantly affected perception ($p < 0.001$). Collapsing across AV conditions, participants perceived /ba/ more often as the continuum progressed from /va/ towards /ba/, with the most /ba/ responses toward the /ba/-end of the continuum. There was also a significant interaction between the CV stimulus step and AV condition ($p = 0.009$). This interaction was driven by more /ba/ responses occurring when auditory stimuli at the /va/-end of the continuum were paired with visual-ba, compared to visual-va or the auditory-only condition. CONCLUSION. These results suggest that the presence of visual-mouth movements play a significant role in altering bilinguals' speech perception, such that participants will often rely upon the viseme (i.e., visual mouth shape) when reporting what they heard. Follow-up experiments will further explore this effect and compare across Spanish-English bilinguals and English monolinguals to characterize any group differences due to language experience. Additionally, we will investigate whether individual differences in language history demographics among bilingual listeners influence the extent to which visual information modulates their auditory speech perception.

Topic Area: Multilingualism

Poster B31 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam B session.

Changes in Effective Connectivity in the Language and Multiple-Demand Network after Left Temporo-Parietal and Frontal Stroke

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Stroke often severely affects language function. A better understanding of post-stroke language recovery is crucial to identify reorganisation mechanisms and improve clinical interventions. Previous neuroimaging work demonstrated distinct mechanisms during different phases of language reorganisation after stroke: global network disturbance during the acute phase, upregulation of the bilateral domain-general multiple-demand network (MDN) and restitution of perilesional cortex during the subacute phase, and reintegration of left temporal language areas during the chronic phase (1-2). These previous studies further suggest that phase-specific mechanisms depend on individual lesion sites. However, changes in the interactions within and between the language network and MDN during language recovery have not been explored yet. To fill this gap, the present study examined changes in the effective connectivity between core areas of both networks after temporo-parietal and frontal stroke in the left hemisphere. We investigated the directed functional connections and their modulation by intelligible speech (SP) and unintelligible reversed speech (REV) during the acute, subacute, and chronic phases using Dynamic Causal Modelling (DCM) and Parametric Empirical Bayes (PEB) framework (3-4). We performed effective connectivity analyses with a dataset of two patient groups (n=17 in each group) with left temporo-parietal or frontal stroke, and 17 healthy controls. 6 regions-of-interests (ROIs) were selected based on the language-related activation in Stockert et al. (2): bilateral inferior frontal gyrus (IFG), bilateral dorsolateral prefrontal cortex, left posterior temporal lobe (PTL) and left supplementary motor area/ dorsal anterior cingulate cortex. For individual-level analysis, a full model was specified and estimated for each participant. The full model assumed full connectivity via reciprocal connections. The onset of all auditory stimuli was set as driving input to all ROIs, and SP and REV were used as modulatory inputs. At the group level, connection strengths of each subject were entered into a PEB model to compare the differences between patients and controls. Preliminary results suggest that, in general, domain-general regions exerted a facilitatory influence onto language areas during recovery. This facilitatory influence was further increased by both SP and REV. For patients with frontal stroke, in the acute phase, the facilitatory intrinsic connectivity from right to left IFG was increased by SP and REV. In the subacute phase, only REV increased the facilitatory influence from right to left IFG. In the chronic phase, the intrinsic connection from right to left IFG became non-significant, but REV turned the non-significant connection facilitatory, which was similar in controls. As an unexpected finding, we did not observe significant facilitatory interactions between left IFG and left PTL in either patient group. These results support the notion that domain-general areas are crucial for language recovery after stroke. Our preliminary findings further suggest changes in the interaction between language and domain-general areas across the time course of recovery. 1. Saur, D.et al. (2006). Brain, 129, 1371-1384. 2. Stockert, A. et al. (2020). Brain, 143(3), 844-861. 3. Zeidman, P. et al. (2019a). NeuroImage, 200, 174-190. 4. Zeidman, P. et al. (2019b). NeuroImage, 200, 12-25.

Topic Area: Disorders: Acquired

Poster B32 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

HD-tDCS of primary and higher-order motor cortex affects action word processing

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Introduction: Multiple brain areas represent lexical-semantic knowledge. To what extent action-perception areas (e.g., motor cortex) contribute to processing of action-related language (to throw) remains controversial. Here, we used high-definition transcranial direct current stimulation (HD-tDCS) to examine the role of left-hemisphere hand-motor area (HMA) and anterior inferior parietal lobe (aIPL) in action-related word processing compared to non-action words. Further, we investigated stimulation-related effects at three levels of semantic processing: subliminal, implicit, and explicit. Based on previous studies, we expected that HD-tDCS of HMA and aIPL would facilitate action word processing compared to non-action. Methods: Forty-two volunteers participated in the study (27 females; mean age 21.3 years). Participants were randomly assigned to either the HMA or aIPL experiment. For each location, cathodal and sham stimulations were in two counterbalanced sessions for 20 minutes each. Following stimulation subjects completed two tasks: primed lexical decision (LD; measuring subliminal and implicit processing) and semantic similarity judgment (SSJ; measuring explicit processing) task. LD consisted of verbs, nouns, and pronounceable nonwords. Primes and target words were presented one-at-a-time, and participants indicated via button-press whether the target word was real. The prime was either identical to the target word or was a consonant string, presented for 50 milliseconds to measure subliminal priming. SSJ consisted of verb and noun trials, wherein each trial consisted of three words in a triangular arrangement. Participants indicated via button-press which of the bottom two words was most similar in meaning to the top word. For both tasks, half of the verbs were hand/arm actions (to tie), and half were non-action (to view). For nouns, half were manipulable (the ball), and half were nonmanipulable (the cabin). Conditions were matched on numerous psycholinguistic variables. Stimulation-related effects for response times (RT) and accuracies were calculated by subtracting sham from active stimulation performance. One-tailed t-tests were used to examine action vs. non-action verbs and manipulable vs. nonmanipulable nouns, with stimulation-related accuracy, RT, and priming (identity prime minus consonant prime). HMA Results: In LD, stimulation significantly decreased net accuracy for non-action verbs compared to action verbs ($p=0.025$) and improved net accuracy of primed action verbs compared to primed non-action verbs ($p=0.034$). In SSJ, stimulation accelerated RTs for manipulable compared to non-manipulable nouns ($p=0.001$). No other contrasts were significant. aIPL Results: In LD, stimulation significantly improved accuracy of action compared to non-action conditions for both nouns ($p=0.02$) and verbs ($p=0.021$). There was a trend of faster RTs for primed manipulable vs. primed nonmanipulable nouns ($p=0.1$). No other contrasts were significant. Conclusions: Broadly, HMA and aIPL stimulation facilitated action-related word processing compared to non-action. HMA stimulation facilitated action verbs in sub-explicit contexts, suggesting that HMA represents action verbs in semantically shallow tasks. HMA stimulation facilitated manipulable nouns in an explicit task, suggesting that HMA represents manipulable nouns when demands are high. aIPL stimulation facilitated manipulable nouns and action verbs during an implicit, but not explicit task. This suggests that, while aIPL may help represent action language specifically, aIPL and adjacent areas may also subserve general processes related to semantic control/representation.

Topic Area: Meaning: Lexical Semantics

Poster B33 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam B session.

Progression of acoustic, phonemic, lexical and sentential neural features emerge for different speech listening

I.M Dushyanthi Karunathilake[1], Christian Brodbeck[2], Shohini Bhattasali[1], Philip Resnik[1], Jonathan Z. Simon[1]; [1]University of Maryland College Park, [2]University of Connecticut

Understanding speech requires analyzing acoustic waveforms via intermediate abstract representations including, phonemes, words, and ultimately meaning along with other cognitive operations. Recent neurophysiological studies have reported that the brain tracks acoustic and linguistically meaningful units. However, since the speech representation units are usually correlated with each other, and often a small subset of features are analyzed, it is unclear whether these neural tracking accounts for uncaptured variance that has not been modeled, hence, causing the feature responses to be less accurate. Additionally, the way these feature responses are modulated by top-down mechanisms and speech comprehension is not well understood. To address these limitations, we recorded magnetoencephalography (MEG) data from 30 healthy, younger participants while they listened to four types of continuous speech-like passages: speech-envelope modulated noise, narrated English-like non-words, word-scrambled narrative, and true narrative. Using multivariate temporal response function (mTRF) analysis, we show that the cortical response time-locks to emergent features from acoustics to linguistic processes at the sentential level as incremental steps in the processing of speech input occur. Our results show that when the stimulus is unintelligible, the cortical response time-locks only to acoustic features, whereas for intelligible speech, the cortical response time-locks to both acoustic and linguistics features. For the case of narrated non-words, phoneme-based lexical uncertainty generates less activation than for true words, suggesting a lack of predictive coding error. Temporal analysis shows that the non-word onsets do generate smaller early responses than word onsets, but they also generate stronger late responses than word onsets suggesting different neural mechanisms associated with accessing lexico-semantic memory traces. For the scrambled word passages, we find additional responses based on context-independent (unigram) word surprisal, but for true narrative, the responses are additionally driven by context-based word surprisal. The unigram word surprisal responses show strong late peaks for the scrambled word passage, consistent with an N400-like response. The results also show that most language-dependent time-locked responses are left lateralized, whereas lower-level acoustic feature responses are right lateralized or strongly bi-lateral. Taken together, our results show that brain responses to certain linguistic units are influenced by the speech content, the level of processing and speech features that could be attributed to evaluate perception and comprehension.

Topic Area: Perception: Auditory

Poster B34 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

The effects of rhythm priming on syntactic language processing in children

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Introduction: Previous studies have demonstrated a phenomenon called ‘rhythm priming,’ in which listening to a regular rhythm sequence results in improved grammar performance on spoken sentences in typically developing children (Chern et al., 2018) and those with developmental language disorders (Bedoin et al., 2016; Ladányi et al., 2021; Przybylski et al., 2013). The present behavioral study sought to replicate and extend the ‘rhythm priming’ effects using auditory language tasks involving either morphosyntactic or syntactic re-analysis skills, respectively. Methods: 17 typically developing children aged 7-12 years (mean=8.8 years, 5 females) participated in the study. The grammaticality judgment test (GJT) required participants to indicate whether each spoken sentence was grammatically correct or not. The sentence materials were previously used in Chern et al. (2018), and each sentence contained either a past tense or a subject-verb agreement error. In the syntactic re-analysis test (SRT), participants were presented with sentences with center-embedded subject-relative (SR) (e.g., “The boy that reaches the girl is small”) or object-relative (OR) (e.g., “The boy that reaches the girl is small”) clauses and were asked to indicate the gender of the agent. The auditory sentence stimuli were created using Google Text-to-Speech. Each task consisted of 6 blocks. For each block, participants were primed with either a 32 s regular or irregular rhythm sequence followed by 6 (in GJT) or 8 (in SRT) task trials. Regular and irregular rhythm primes were alternated between blocks. Results: Task accuracy on GJT was not different between regular and irregular rhythm priming conditions. In SRT, task accuracy was significantly higher in SR than OR sentences, indicating that participants had more difficulty analyzing the OR structure. Intriguingly, the accuracy on OR sentences was significantly higher in the irregular than in the regular priming condition, contradicting the previous regular rhythm priming effect. Conclusion: While we did not find syntactic facilitation in response to regular rhythm priming in the morphosyntactic tasks, we found that irregular rhythm priming resulted in improved syntactic re-analysis. Follow-up studies are currently underway by replacing the synthetic google speech with natural human voice to resolve the discrepancy and somewhat paradoxical rhythm priming effects observed in the current study.

Topic Area: Language Therapy

Poster B35 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Developmental Continuity in Neural Semantic Representations

Albert Kim[1], Tanya Levari[3], Stefano Anzellotti[2], Joshua Hartshorne[2]; [1]University of Colorado, Boulder, [2]Boston College, [3]Harvard University

When we learn a word, how is this information represented in the mind and brain and how do such representations change with development? The advent of machine learning methods for interpreting brain data promises to revolutionize our search for the answers to this longstanding question. The current work addresses two major barriers to progress to date. First, functional neuroimaging with children is challenging, given children’s limited attention span and tendency to fidget. Second, most work to date has taken a data-driven approach that does not harness the rich theoretical and computational tradition of models of linguistic semantic knowledge. We present the first in a series of studies addressing these issues, making use of a promising new method for recording EEG in children during free listening to engaging stories (Brennan, et al. 2019; Levari & Snedeker, 2018) and applying existing, theory-driven, quantitative representations of word meaning. 27 children (ages 5-10, mean=7.5) and 21 adults listened to a 1594-word recorded excerpt from Matilda, by Roald Dahl (2003). EEG was recorded at 500hz using Brainvision’s Actichamp System with 32 active electrodes placed at International 10-20 System locations and on the left and right mastoids, and filtered to 0.1-40 Hz. Data were epoched from -200ms to 1000ms relative to onset of each critical word and baseline corrected using the pre-stimulus time window (-200–0ms). Ocular artifacts were removed through independent component analysis. Voltage movements greater than 100μV resulted in trial rejection. Analyses focused on ERPs for the 107 distinct verbs and 138 distinct nouns in the excerpt. For types with multiple tokens, we averaged ERPs over tokens. Data were analyzed using Representational Similarity Analysis (RSA; Kriegeskorte et al., 2008). RSA is essentially a correlation of correlations, measuring the degree to which stimuli that are similar under one metric are similar under another. Initial analyses established reliability: separate RSAs for verbs and nouns were significant and well above chance for both children and adults. Interestingly, RSAs comparing children to adults were nearly as strong as RSAs comparing children to other children or adults to other adults, suggesting little developmental change. We next replicated prior findings of systematic relationships between ERPs and neural network word embeddings such as fastText, which capture substantial amounts of lexical semantics and morphosyntax (Bojanowski et al., 2017; He et al., 2022). RSAs were significant for both nouns and verbs for both children and adults, though only between ⅓ and ½ the size of the between-subject RSAs, suggesting word embeddings capture only some of the systematic variability in ERPs. Finally, and critically, RSAs were nearly as strong when using pairwise distances in WordNet (a hierarchical ontology of meaning) or human pairwise similarity judgments (Small World of Words; De Deyne et al., 2019). However, we found no relationship between ERPs for verbs and pairwise similarity in terms of argument structure participation (as recorded in VerbNet; Kipper et al., 2006), despite prior evidence that the latter is highly correlated with semantics.

Topic Area: Meaning: Lexical Semantics

Poster B36 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Do Segment Boundaries Disrupt the Processing of Non-Adjacent Dependencies? Evidence from Neural Frequency Tagging and ERPs

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INTRODUCTION: Language processing requires comprehenders to establish links amongst words. This often results in non-adjacent dependencies (NADs) that can span multiple words. Research on statistical learning (Buiatti et al., 2009; Kabdoben et al., 2015) found that NADs can be inferred from artificial grammars (AG) by children and adults. Here, we ask whether the NAD learning is constrained by the boundaries of multi-word chunks in the stimulus. This tests the prior hypothesis that dependencies do not cross the boundaries of chunks in working memory (Christiansen & Chater, 2005). METHODS: We recorded the EEG while native speakers of German underwent an AG learning experiment. During an initial learning phase, subjects listened to isochronous six-syllable chunks that were presented auditorily in eight 3-min streams. Chunks were interrupted by 80-ms gaps to ensure chunk learning. Importantly, stimuli contained NADs that would span two syllables, either within or across chunks. In the subsequent test phase, participants listened to 144 stimuli that either contained within– or across-chunk NADs or not; subjects also answered a question about whether they heard a certain sequence after each trial. EEG preprocessing was done by applying the Harvard Automated Preprocessing Pipeline (Gabard-Durnam et al., 2018). To assess the learning of chunks and boundaries, we computed Evoked Power (EP) and Inter-trial Phase Coherence (ITPC) for the learning phase. EP and ITPC at the chunk frequency were compared to the neighboring frequency bins via one-way ANOVA. To compare the NAD processing within and across chunks, an ERP analysis was conducted on the data from the test phase. A nonparametric statistical analysis was conducted across all electrodes to compare the ERP to syllables that constitute the second element of an NAD to the ERP to syllables that do not finish an NAD. PREDICTION: For the learning phase, EP and ITPC should show frequency peaks at the chunk frequency. For the testing phase, the difference wave between NADs and non-NADs will be smaller in the across-chunk condition than in the within-chunk condition. RESULTS: Preliminary results from N = 10 are reported here. In the learning phase, EP and ITPC peaks at the chunk frequency were observed, suggesting that participants learn the chunks and boundaries. ERPs in the test phase showed a marginally significant ($p = 0.053$) early negativity in the within-chunk condition, but not the across-chunk condition. In line with the hypothesis, processing of NADs across chunks appears to be harder than within chunks. The results help better understand the relationship between segmentation of speech into memory chunks and the formation of inter-word dependencies. If stable in the full sample, our findings have implications for the interplay of chunking and dependency formation in human language acquisition and processing.

Topic Area: Syntax

Poster B37 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Event-Related Potential (ERP) Evidence and the Continuum of Nativeness: Considering Agreement Processing in Spanish as a Heritage Language.

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Heritage speaker (HS) bilinguals are native speakers of their heritage language (cf. Rothman & Treffers-Daller, 2014). Like homeland speakers of the same language, HSs acquire their heritage language (HL) early and naturalistically. Differently, however, they often do so in a context of significantly reduced input and/or opportunities (over the lifespan) to use the language in a comparatively similar way. It is no surprise then that a substantial amount of research over the past decades has documented significant differences between HS and homeland native speakers (Montrul, 2016, Polinsky, 2018; Polinsky & Scontras, 2020) across a wide array of grammatical domains. Whether or not this is equally true in linguistic processing is not as clear given the disproportionate number of studies utilizing offline behavioral methods. For example, behavioral HS studies would lead us to the conclusion that grammatical gender is vulnerable in Spanish as a HL in the context of the United States (US) (e.g. Montrul, Foote & Perpiñan, 2008). However, will neural signatures during grammatical processing confirm or problematize such a conclusion (see Bayram et al. 2022)? Herein, we seek to begin to fill the gap in neurolinguistic methods applied to HS linguistic processing in an otherwise well-studied domain of grammar. To do this, in this study we focused on grammatical gender processing in Spanish, which has been well researched at both the behavioral and neural (ERP) levels across homeland native Spanish speakers and even L2 learners, but only behaviorally in HSs (no neuroimaging studies exist). Given the significant numbers of homeland native EEG studies on grammatical gender, which converge on at least robust P600 (sometimes accompanied by eLAN), for gender agreement anomalies, we have a solid basis of comparison for the current study. EEG/ERP data was collected from 30 Spanish-English heritage speakers in the US with diverse bilingual experiences. Participants were asked to read a total of 360 sentences in Spanish presented word-by-word, including number and gender agreement violations (concord on the adjective), while their brain activity was being recorded using EEG/ERPs. Preliminary analyses of the neural data reveal clear P600 effects, the brain response generally associated with morphosyntactic error processing (see Morgan-Short, 2014), for both the number and gender agreement conditions (see Figure 1). These preliminary results reveal both systematicity and target processing of these domains of grammar among HSs of Spanish in the US. If the pattern continues to be borne out in the larger sample we target by the time of presentation (n=50/60), these data will provide strong support for the argued need and importance of incorporating online neuroimaging measures of grammatical processing in heritage language bilingual empiricism, to complement offline behavioral measures and, especially, as a checks and balance to them (Bayram et al., 2022). Whereas behavioral studies on grammatical gender in HSs of Spanish in the US often conclude that gender is a particularly vulnerable domain, the present EEG data strongly suggest that gender is robustly represented and deployed for real-time processing qualitatively the same way as in homeland baseline speakers.

Topic Area: Syntax

Poster B38 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Neural systems underlying source- and dimension-based auditory selective attention to naturalistic speech

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When listening to speech, listeners must selectively attend to certain sources (e.g., a particular talker) and also focus on informative acoustic dimensions within a source (e.g., particular frequencies that may be informative for determining what is being said). A common but untested assumption is that source-based selective attention and dimension-based selective attention are supported by common mechanisms. In this ongoing fMRI project, we directly compare source-based and dimension-based auditory selective attention across a naturalistic 'cocktail party' listening task in which two simultaneous audiobook recordings (one read by a male talker, one by a female talker) of Alice's Adventures in Wonderland are presented to place demands on spatial- (source) versus frequency- (dimension) selective auditory attention. All listeners (target N=25) are familiarized with the story prior to an fMRI scan by listening to clear, single-talker recordings of the to-be-attended portion of the story. In half of the fMRI runs, listeners hear speech stimuli spatialized via interaural level differences, such that there is a 6dB RMS left > right ear difference for one talker, with a corresponding right > left ear difference for the other talker. In the other half of runs, talkers are instead spectrally segregated; one talker's voice is band-pass filtered to higher frequencies (1800 to 8000 Hz), and the other's to low frequencies (300 to 1600 Hz). Both spatial and spectral signal processing manipulations result in intelligible speech from both talkers, although listening is challenged by the competing talker. Listeners are instructed to attend to a particular talker (male, female) over the course of each fMRI run and, every 15-30 seconds, the talkers switch locations or spectral bands. To behaviorally assess a listener's ability to selectively attend to a target talker, listeners respond to occasional semantic anomalies in the story (e.g., "And what good is a book without pictures and pink eyes?"). Participants also complete a tonotopy mapping task with non-speech stimuli, which will serve to define frequency-band-selective regions-of-interest. We hypothesize that a comparison of attending to the spectrally segregated talkers will reveal considerable fine cortical spatial segregation within "traditional" tonotopically mappable auditory regions, and also may unveil additional cortical regions where attention to different spectral bands is spatially organized, and are otherwise difficult to characterize with short natural sounds or more sustained artificial tone streams. This comparison also permits us to test the hypothesis that cognitively or linguistically mediated changes in neural activity can be spatially organized in cortex along a fundamental perceptual dimension, frequency. Conversely, and based on past literature, we expect these same regions to exhibit overlapping neural signals associated with spatially segregated talkers. However, we also hypothesize that the larger functional networks associated with these two types of sustained auditory attention may be spatially interdigitated. Overall, this project will clarify the neural mechanisms that support both source-based and dimension-based auditory selective attention in processing of naturalistic speech stimuli.

Topic Area: Perception: Auditory

Poster B39 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Semantic speech networks capture speech abnormalities in psychosis

Caroline Nettekoven[1], Kelly Diederen[2], Oscar Giles[3], Helen Duncan[3], Iain Stenson[3], Julianna Olah[2], Nigel Collier[1], Petra Vértes[1], Tom Spencer[2], Sarah Morgan[1], Philip McGuire[2]; [1]University of Cambridge, [2]King’s College London, [3]The Alan Turing Institute

Background. Deep phenotyping of schizophrenia using speech data could significantly further our understanding of the condition, with the potential to revolutionise healthcare for psychosis. A core symptom of schizophrenia is formal thought disorder, manifesting in subtle changes of the patient's speech which can appear incoherent and disorganized. Graph theoretical tools have been used to measure disorganised syntax in speech transcripts from patients with psychotic disorders. However, these existing graph theoretical tools ignore the semantic content of speech, which has been show to be altered in patients with psychotic disorders. Mapping semantic content of speech as a network and analysing the network using graph theory could be a powerful approach for detailed characterisation of psychosis symptoms. We therefore developed an algorithm that captures the semantic content of transcribed speech as a network. Methods. Our tool uses Natural Language Processing (NLP) to construct speech networks from transcripts of spoken text (e.g. I see a man). Nodes represent entities (e.g. I, man) and edges represent relations between nodes (e.g. see). We have released our tool as a freely available python package, Networks of Transcript Semantics (netts). We used netts to characterise the properties of speech networks from a general public sample and test for group differences in a clinical sample consisting of healthy participants, first episode psychosis patients and subjects at clinical high risk of psychosis. Results. Semantic speech networks from first episode psychosis patients performing a picture description task included more, smaller connected components than those from healthy control subjects, suggesting that the semantic content of speech graphs from patients was more fragmented. The semantic speech networks show robust case-control differences in schizophrenia that are related to symptom severity such that participants with smaller connected components scored higher on the Negative Thought and Language Index scale. A clustering analysis suggested that semantic speech networks captured novel signal not already described by existing NLP measures. Discussion. The semantic speech networks proposed here provide a useful framework for mapping the content of speech in much more detail than previously possible. Because of the richness of information contained in the semantic speech networks, they may also be useful for studying other mental health conditions and use in other fields of research.

Topic Area: Disorders: Developmental

Poster B40 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Verbs’ selectional preferences modulate N400 response in sentence processing

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Introduction: We use naturalistic EEG data to investigate neural responses to selectional preference, a lexical property reflecting how restrictive a verb is about the semantic category of its objects. Prior work shows argument structure guides sentence processing e.g., Boland (2005, 1993); Shapiro et al. (1991), Trueswell et al. (1993), McRae et al. (1998). Here we investigate selectional preference strength (SPS) for direct objects as a top-down predictive cue during sentence processing. Methods: We used preprocessed EEG data from The Alice Datasets (Bhattasali et al., 2020). Participants(n=33) listened to the first chapter of Alice’s Adventure in Wonderland audiobook for approximately 13 mins(2,129 words;84 sentences). 475 verbs in total were identified using the SpaCy POS tagger. Excluding modals, auxiliaries, gerunds, there are 325 verbs attested in the story. We operationalized selectional preferences of a verb as SPS (Resnik, 1996), specifically the Kullback-Liebler divergence between the Wordnet (Miller, 1995) supersense distributions for objects conditioned and not conditioned on the verb. These distributions were approximated using verb-direct object pairs from COCA corpus (Davies, 2008). In contrast to word-based surprisal, SPS represents the degree of constraint placed by the verb on the semantic category of its direct object. We use Eelbrain (Brodbeck et al., 2022) and multivariate temporal response functions (mTRF) (Brodbeck & Simon, 2020) for data analysis. In the baseline model, we controlled for acoustics, word frequency, sequential processing (using a 5gram language model), and a categorical predictor for verbs. The second model had the same predictors plus SPS.Results: In a mass-univariate related-measures t-test, we observe a significant difference between the model with SPS predictor and the baseline mTRF model. Additionally, in a spatio-temporal cluster based t-test we observe a significant negative peak at 350 ms. Discussion: Are expectations about argument structure tracked differently versus other kinds of expectations? Bhattasali & Hale (2019) show when verbs are encountered, processing related to selectional constraints is localized differently from processing related to other expectations. Here we ask, is there also evidence of a distinct role for those verbs’ constraints based on the time course of processing? Our results suggest yes, since SPS of verbs is clearly providing additional predictive information. The N400 response we observe potentially involves information integration: SPS measures the quantity of information a verb provides about the semantic category of its object; higher SPS indicates the verb is more selective about its objects' semantic category and provides additional information about what that upcoming object could be, in contrast to verbs with low selectional preference strength. This view can be interpreted as consistent with prior work connecting higher information integration cost with N400 effects (Lau et al. 2008, Frank et al., 2013). Alternatively, with highly selective verbs we could be observing preactivation for the object as reflected by the N400 (Chow et al., 2016; DeLong et al., 2005). Conclusion: Our results suggest that implicit knowledge about the semantic class of verbs' objects plays a distinct role during sentence processing and selectivity of verbs gives rise to an N400 response.

Topic Area: Computational Approaches

Poster B41 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam B session.

Using fMRI to study language regions in a conversational context

Halie Olson[1], Emily Chen[1], Kirsten Lydic[1], Somaia Saba[1], Rebecca Saxe[1]; [1]MIT

Language is encountered and produced in complex, dynamic, and social contexts – such as conversations. Although language comprehension builds on information acquired over time, previous neuroimaging evidence found that language regions are no more sensitive to narratives than isolated sentences (Blank & Fedorenko, NeuroImage, 2020). In this study, we asked whether language brain regions respond distinctively to sentences that occur in dialogue, reflecting the embedding of those sentences in the conversational context, or respond to them as independent sentences. We scanned 20 adults using functional MRI on two novel language tasks, as well as an independent language localizer (Scott et al, Cog Neuro, 2017) and theory of mind localizer (Dodell-Feder et al, NeuroImage, 2011). In Experiment 1, participants watched 20-second edited audiovisual clips of Sesame Street during which either two puppets speak to each other (dialogue), or a single puppet addresses the viewer (monologue), while the auditory speech is played either forwards or backwards. Individually-defined language regions showed robust responses to forward versus backwards speech, but did not discriminate dialogue versus monologue. Specific responses to sentences embedded within a dialogic context (interaction contrast: [dialogue forwards – monologue forwards] – [dialogue backwards – monologue backwards]) were observed outside language regions, in right superior temporal sulcus and bilateral temporal poles. In Experiment 2, participants watched 1-3 minutes of continuous back-and-forth dialogue in which one character speaks in backwards speech, while the other speaks forward. Which character speaks in forward versus backwards speech, in each video, was flipped for half of the participants. We compared the time courses in participants who heard the same version of the stimuli (e.g., the same characters forward vs. backward) to participants who heard the flipped version of the stimuli (e.g., opposite characters forward vs. backward). In language regions, only the linguistic input mattered: these regions' timecourses of response to a given video were positively correlated when the auditory stream was aligned, and not correlated when the auditory stream was flipped. By contrast in regions defined by the theory of mind localizer, like right temporoparietal junction, the timecourses of response to a given video were positively correlated both for the aligned, and for the flipped, auditory stream. Together, both experiments show that during exposure to naturalistic multi-modal dialogue, left-hemisphere language regions respond specifically to temporally local linguistic features, whereas right-hemisphere social regions respond to the social and conversational context of language that emerge over longer timescales.

Topic Area: Meaning: Discourse and Pragmatics

Poster B42 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

How distinct are Syntactic and Semantic Representations in the Brain During Sentence Comprehension?

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Recent neuroscience studies explored how multiple brain regions in a language network can be associated with syntactic and semantic representations of the stimulus words or sentences or naturalistic stimuli. Few recent papers have also obtained purely syntactic embeddings using constituency trees and fine-grained word syntactic features to show that these embeddings can indeed significantly predict many regions of the language system. However, previous works did not explore the explicit representation of syntactic features that fully encode the information present in dependency trees mainly for three reasons: (i) types of dependencies are not used, (ii) random walks cannot encode graph structure very well, and (iii) it is much harder to interpret the constituency tree-based embeddings when compared to simple fine-grained syntactic features. Moreover, most existing syntax studies have focused only on a few subjects involved in reading English text. In this study, we explicitly introduce syntactic word embeddings obtained from graph convolutional networks (GCN): (i) which utilizes the dependency context of a word that encodes information about the syntactic structure of sentences, (ii) remove the prior information of context embeddings by providing random initialization as node features. Using the features of pretrained syntactic embeddings and story text (reading and listening stories), we model the brain representation of syntax for reading and listening comprehension. First, we find that our syntactic structure-based features from GCN explain additional variance in the brain activity across multiple regions of the language system. At the same time, we see that regions in the language network are well-predicted by syntactic features during story listening compared to reading. We also notice that both syntax and semantics are overlapped and distributed in the language system for reading and listening than those suggested by classical studies (syntax is specific to Brodmann area 44). Overall, for both reading and listening stories, syntactic structure-based features from GCN consist of very low semantic information similar to constituency tree-based embeddings. It is reasonable to assume that any additional variance predicted by the syntactic embeddings from GCN compared to the BERT semantic feature spaces is mainly due to their syntactic information.

Topic Area: Syntax

Poster B43 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Constructing a Lexical Representation: The Role of Semantic Meaning Identification and Word Class

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Learning a new word involves incrementally constructing a lexical representation for the word, eventually reaching a point where the word’s representation is robust enough to be easily accessed and retrieved. A lexical representation is thought to at least include information about the word’s phonological form, semantic meaning, and grammatical features (e.g., word class). While it would seem that lexical representations with both form and meaning information would be more robust than form alone, studies have reported mixed findings. Word class has also been shown to affect the development of lexical representations, with greater difficulty typically shown for verbs than for nouns, but why these differences occur is not well understood. One reason for this obscurity might be that the robustness of a word’s representation is often measured using solely behavioral methods, which requires the representation to be highly developed. Electroencephalography (EEG), however, can provide insight into the process of lexical representation development, revealing representations that are still developing and otherwise inaccessible. This study investigates how the word class of a new word and identification of the word’s meaning during an incidental semantic learning task (ISLT) affect the robustness of the word’s representation. Behavioral and EEG data were collected from 53 English-monolingual adults as they completed an experimental ISLT followed by a word recognition task (WRT). Participants completed either the Noun (n = 31) or Verb (n = 22) condition, in which the only major difference was the word class of the target word. In the ISLT, participants heard 100 sentence triplets. All sentences in the triplet ended with the same nonword that replaced a target word. Half of the sentence triplets were constructed to support identification of the target word's meaning and half were constructed to not. After each triplet, the participant was asked to provide a meaning for the nonword if they believed one existed. Each response was classified offline for meaning identification, disregarding whether meaning identification was supported or not. For the WRT, completed directly after the ISLT, participants heard 200 nonwords, 100 of which they had heard previously in the ISLT and 100 of which were novel, and they indicated whether they recognized each nonword. Behavioral analyses of lexical representation robustness via recognition accuracy revealed the unexpected finding that identifying a meaning for the nonword did not facilitate explicit recognition of it later, regardless of word class, $F(5, 62.93) = 1.18$, $p = .331$. The ongoing ERP analysis focuses on the N400 ERP component as a measure of semantic processing. We predict ERP patterns to diverge from the behavioral findings, revealing more robust representations for words, especially nouns, for which meanings were identified. Such findings would demonstrate the incremental process of word learning, support the argument that implicit measures such as EEG can better tap into lexical representations that are early in development and consequently less robust, and suggest that meaning identification and word class have subtle effects that might only be detected at implicit levels in the early stages of the creation of a lexical representation.

Topic Area: Meaning: Lexical Semantics

Poster B45 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Speech Act and Prosody Interaction during Listening Comprehension in L2ers: Evidence from an ERP Study

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During interpersonal communication, listeners must quickly evaluate verbal and vocal cues to elicit an integrated meaning about the utterance and about the speaker, including a representation of the speaker's intent or speech act (SA) (Hellbernd and Sammler, 2016). In this study, we investigated the time-course and neural responses underlying a listener's ability to evaluate SA from combined verbal and vocal cues. We recorded real-time brain responses as listeners heard three different types of SA utterances conveying three kinds of prosodic or intonation patterns, which follow immediately after the preceding relevant discourse contexts; Regel and Gunter, 2017; Steinhauer, 2003). Seventeen Korean learners of English with an advanced level of English proficiency participated in this experiment. The experimental materials for our ERP study consisted of three different types of sentences (declarative (D), question (Q), and reprimanding/complimenting (RC)) with their corresponding prosodic patterns. Type A: The prescription didn't match my name. The doctor who made that mistake is Lavender. Type B: I didn't catch her name. Is her name Lavender? Type C: We cannot accept any mistakes in the process. But you made one, Lavender. The stimuli were presented auditorily. ERPs were measured at the critical elements such as Lavender in each type. In comparison between 'correctly used' three SA types, Type B was less negative than Type A and C in the N400 area. In analyses of the three types. there was a significant effect of type at the 150-250 ms interval, due to the difference between Type A and B; a marginal effect of type in the 250-500 ms, due to the difference between Type A and B; and a significant effect of type in the 500-700 ms, due to the difference between Type A and B. The combined results show characteristic prosodic feature configurations for three different SAs that were reliably recognized by L2 listeners. Interestingly, identification of SAs was contingent on their type, and the difficulty in this process varied. Across types, Q-prosody SAs were easier to recognize than D- and RC-prosody ones. Within each type, (i) normal D-prosody SAs were more difficult to comprehend than anomalous Q-prosody ones; (ii) normal Q-prosody SAs were less difficult to process than anomalous D-prosody ones in the earlier interval, but the former registered difficulty in the later interval; (iii) normal RC-prosody SAs were less difficult to detect than the other two types of SAs. Overall, the data demonstrate that speakers' SAs are represented in the prosodic signal which can, thus, determine the success of interpersonal communication.

Topic Area: Prosody

Poster B46 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Cortical folding of the left superior temporal cortex associated with acoustic edge perception in developmental dyslexia

Ting Qi[1], Yulia Oganian[2,3], Maria Luisa Mandelli[1], Christa Watson Pereira[1], Abigail Licata[1], Rian Bogley[1], Nicole Yabut[1], Matthew Neylan[1], Edward Chang[2], Maria Luisa Gorno-Tempini[1]; [1]Department of Neurology, University of California San Francisco, United States, [2]Department of Neurological Surgery, University of California San Francisco, United States, [3]Center for Integrative Neuroscience, University of Tübingen, Tübingen, Germany

Developmental dyslexia (DD) is a neurodevelopmental reading disorder, generally associated with phonological deficits and often non-speech auditory impairments. For instance, perception of acoustic edges in sound amplitude modulations, a critical cue to syllable structure, is reported to impair in some DD cohorts. Yet, little is known about the brain basis of auditory deficits in DD. Here, we examined the relationship between acoustic edge perception in DD and anatomical structures of the superior temporal gyrus (STG), a region strongly implicated in phonological and acoustic edge processing. Participants (50 children with DD, aged 7-15y) completed an amplitude rise-time discrimination task (RT) to assess acoustic edge perception, alongside a battery of phonological and reading tests. Brain surface measures were obtained from T1-weighted images, and T2-weighted images were also included to estimate myelin content for a subgroup of children. We found that RT performance positively correlated with both reading and phonological abilities. Crucially, a higher local gyrification index in the left posterior STG (pSTG) was associated with better RT performance, but was not related to phonological abilities. This suggests independent contributions of the STG to non-verbal auditory deficits in DD. In addition, the local gyrification index of the left pSTG decreased with increasing myelin content, which is suggestive of the hypermyelination of the left pSTG in DD. Overall, our results show that the neurodevelopment of the left temporoparietal region may underlie individual variations in auditory processing in DD. This constitutes the first evidence linking behavioral auditory deficits and brain structure in DD, providing a path towards understanding individual variability in DD.

Topic Area: Disorders: Developmental

Poster B47 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Oink and Moo Lead to a Right Spatial Bias: The Influence of Iconicity on Line Bisection.

Vijayachandra Ramachandra[1], Angela Genter, Kelli Moreno, Kirsten Van Louvender, Sara Moore; [1]Marywood University

A majority of words in a language are generally ‘arbitrary’ (de Saussure, 1916). However, a number of words in languages like Japanese and several words in English such as “meow”, “splash”, “trill”, “moo”, etc. are non-arbitrary (or iconic) (Perniss, Thompson, & Vigliocco, 2010). It is well established that the left hemisphere is dominant for processing words but a recent neuroimaging investigation in Japanese showed that unlike arbitrary words which are processed in the left hemisphere, iconic words show high levels of activation in the right hemisphere, which is generally involved in processing non-verbal sounds (Kanero et al., 2014). In the current study, we carried out two experiments using visual and tactile line bisection tasks in response to arbitrary and iconic auditory stimuli. Line bisection tasks have been used to indirectly measure hemispheric processing of information (see work by Heilman and collaborators). In each of the two experiments of the current study, 20 healthy young right-handed adults (10 men and 10 women) between 18 and 25 years who did not have any sensory or neurological issues participated. In

the first experiment, participants (n=20) were asked to bisect 56 horizontal straight lines (21 cm long X 2 mm) at their mid points while listening to different types of auditory stimuli presented randomly – neutral (nasal /m/ consonant), arbitrary words (e.g., air, food, etc.), sensory words (e.g., sniff, mushy, etc.), onomatopoeic words produced without emotions (e.g., oink, moo, etc.), onomatopoeic words with emotions (oink, moo, etc. produced with emotions), and environmental sounds. In the second experiment, different set of participants (n=20), who were blind folded were asked to identify the midpoint of a wooden rod while listening to the same set of stimuli presented in experiment 1. When young typical adults bisect a line, they usually show a more left-side deviation from the midline (pseudoneglect). As expected, we observed the pseudoneglect phenomenon for neutral stimuli in both experiments 1 and 2. The results of the first experiment where we used visual line bisection showed that when compared to the deviations for the neutral stimuli, our participants showed no greater right or left bias for sensory words, arbitrary words and onomatopoeic words indicating that these stimuli had no effect on the spatial allocation of attention as measured by a visual line bisection task. In other words, these stimuli did not lead to a significant hemispheric activation. On the contrary, when compared to the deviations for the neutral stimuli, our participants showed more right bias for onomatopoeic words with emotions and environmental sounds. This indicates a more left hemisphere processing for these stimuli (hemisphere opposite to the side of bias was more activated). The results of the tactile line bisection (experiment 2) were the same as the visual line bisection task (experiment 1) except that in the second experiment there were more significant deviations to the right even for onomatopoeic words without emotions. Comparison of these results with the recent neuroimaging study in Japanese, future directions, and implications for aphasia therapy will also be discussed.

Topic Area: Meaning: Lexical Semantics

Poster B49 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Diabetes, Brain Health, and Long-Term Language Related-Treatment Gains in Post-Stroke Aphasia

Rebecca Roth[1], Natalie Busby[2], Janina Wilmskoetter[3], Deena Blackett[3], Ezequiel Gleichgerrcht[3], Chris Rorden[2], Roger Newman-Norlund[2], Argye Hillis[4], Dirk den Ouden[2], Julius Fridriksson[2], Leonardo Bonilha[1]; [1]Emory University, [2]University of South Carolina, [3]Medical University of South Carolina, [4]Johns Hopkins University

Background: In chronic post-stroke aphasia, language improvements following speech therapy are variable and can only be partially explained by the stroke lesion. Brain tissue integrity beyond the stroke lesion (brain health) may influence language recovery and depends on cardiovascular risk factors, notably diabetes. Importantly, stroke survivors commonly present with cardiovascular risk factors (e.g., diabetes, hypertension), which increase risk for recurrent strokes and decrease the likelihood of recovery post-stroke. Diabetes is also independently associated with progressive declines in cognitive ability and poorer neurological outcomes among older adults post-stroke. In this study, we examined the impact of diabetes on brain health and language recovery in aphasia. Method: Seventy-five participants with chronic post-stroke aphasia underwent three weeks of semantic and three weeks of phonological language therapy. Participants had a variety of aphasia types (assessed by WAB-R), including Broca's aphasia (48%), followed by Anomic aphasia (26%), Conduction aphasia (16%), Global aphasia (5%), Wernicke's aphasia (4%), and Transcortical motor aphasia (1%). Participants were administered the Philadelphia Naming Test (PNT) at baseline, one month following treatment, and 6 months following treatment. To quantify brain health, we measured the integrity of long-range white matter fibers from each participant's whole brain connectome created from baseline diffusion tensor imaging. We then examined the relationship among diabetes, pre-treatment integrity of long-range white matter fibers, and changes in naming accuracy from baseline to 1 month and 6 months post treatment. We applied statistical moderation analyses to determine the impact of diabetes (moderator) on the relationship between long-range white matter fibers outside of the stroke lesion (independent variable) and long-term treatment-related language gains (dependent variable). Results: Controlling for age, lesion volume, and baseline PNT performance, diabetes moderated the relationship between proportion of long-range fibers and naming improvement at 1 and 6 months. For those without diabetes (n=54), there was a positive relationship integrity of long-range fibers and naming improvement (1 month: $t = 2.2017$, $p = .0311$, 6 months: $t = 3.1609$, $p = .0023$). The same relationship was not observed among individuals with diabetes (n=21). Discussion: Our results indicate that higher proportion of long-range fibers is associated with long-term treatment related naming improvement in aphasia; however, only among individuals without diabetes. These results show the importance of post-stroke structural white matter architectural integrity in aphasia recovery related to diabetes status. Our results have clinical implications, stressing the importance of cardiovascular risk factors in patient counseling and treatment planning. Conclusion: Our results contribute to the broad brain health perspective of language recovery, showing the importance of healthy, residual brain tissue in post-stroke aphasia. Our results also pave the way for future research further probing the neurobiological changes associated with diabetes in individuals with aphasia.

Topic Area: Disorders: Acquired

Poster B50 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Using RIFT to study the role of lower frequency oscillations in sensory processing and audiovisual integration

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During communication in real-life settings, our brain needs to integrate auditory information (such as speech) with visual information (visible speech, co-speech gestures) in order to form a unified percept. In addition, in order to efficiently understand another person, we need to select the relevant sources of information while preventing interference from irrelevant events (other people talking, meaningless movements). In the current study, we use rapid invisible frequency tagging (RIFT) and magnetoencephalography (MEG) to investigate whether the integration and interaction of audiovisual information might be supported by low-frequency phase synchronization between regions. We presented participants with videos of an actress uttering action verbs (auditory; tagged at 58Hz) accompanied with iconic gestures. To manipulate spatial attention, we included an attentional cue and presented the visual information with different tagging frequencies left and right of fixation (visual; attended stimulus tagged at 65Hz; unattended stimulus tagged at 63 Hz). Integration difficulty was manipulated by lower-order auditory factors (clear/degraded speech) and higher-order visual factors (congruent/incongruent gesture). Results indicated that gestures hindered comprehension when the actress performed a mismatching gesture and speech was degraded. In the MEG, we identified spectral peaks at the individual (58/63/65Hz) tagging frequencies. Beamformer source analyses indicated strongest coherence between a dummy modulation signal at occipital regions for the visually tagged signals (63 and 65 Hz) with stronger coherence for the attended frequency (65 Hz) when speech was clear and stronger coherence for the unattended frequency (63 Hz) when speech was degraded. For the auditory tagged signal (58 Hz) coherence was strongest at temporal regions, specifically when speech was degraded. To evaluate whether the integration of audiovisual information is supported by low-frequency phase synchronization, we used those (subject-specific) sensory regions to evaluate source-level connectivity between four virtual channels (left visual, right visual, left auditory, right auditory). Moreover, we observed an intermodulation frequency (7 Hz) as the result of the interaction between the attended visual frequency-tagged signal (65 Hz) and the auditory frequency tagged signal (58 Hz). Linking lower-frequency phase to the ease or success of lower-order audiovisual integration, this study aimed to investigate the dynamic routing of information during audiovisual integration and the information flow between relevant brain areas. Combining rapid invisible frequency tagging with multiple sources of audiovisual information enabled us to investigate the brain’s response to multiple competing stimuli and their integration, and in turn lays the groundwork for future studies using more natural communication paradigms.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster B51 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Neural Correlates of Impaired Recognition of Emotion in Speech in Primary Progressive Aphasia (PPA)

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Introduction Primary Progressive Aphasia (PPA) is a clinical syndrome caused by neurodegenerative disease. The most prominent clinical feature is decline in language skills in the earlier stages. Emerging research suggests some people with dementia experience aprosodia, which is impaired recognition/expression of prosodic features (e.g., pitch, volume, rate) used to convey emotions in speech. Based on our work in right hemisphere (RH) stroke we developed a three-stage model of receptive emotional prosody consisting of three processing stages (Stage 1: acoustic analysis; Stage 2: analyzing abstract representations of acoustic characteristics that convey emotion; Stage 3: semantic processing), which also interact with domain-general emotion recognition. Impaired emotional prosody in patients with dementia causes communication breakdowns with severe consequences including depression, and increased disruptive behaviors. However, few studies have investigated emotional prosody deficits in PPA. We aimed to: 1) to investigate receptive emotional prosody in PPA, 2) to examine the processes underlying receptive aprosodia in PPA, and 3) to investigate how atrophy contributed to specific impairments. Methods Participants: We enrolled 33 participants with PPA (mean age = 69.2 years). Procedure: MPRAGE scans were acquired in a subset of 23 patients. The whole brain was automatically segmented into regions of interest (ROIs). ROI volumes were calculated using MRICloud. Prosody Testing: Participants were given six behavioral assessments. Emotional prosody recognition was assessed by asking participants to choose the emotion of the speaker based on their tone of voice in producing 25 pseudoword sentences. Participants were also tested on each of the three stages of prosodic processing, as well as recognition of emotional facial expressions to assess presence of multi-modal emotion recognition deficits. Analysis: K-medoids analysis was used to identify different performance profiles by entering accuracy on each of the behavioral tests. The relationship between ROIs involved in receptive emotional prosody, and each stage of the three-stage receptive prosody model, was modelled using Least Absolute Shrinkage and Selection Operator (LASSO) regression for each behavioral test. Volumes of seven RH ROIs, and seven LH homologues, all normalized by cerebral volume, were entered into the LASSO models, along with the ratio of cerebral to intracranial volume (to control for inter-individual differences in brain size), and age. Results The k-medoids analysis identified three patient clusters. Cluster 2 had the most severely impaired emotion recognition in speech and facial expressions, and semantic processing of emotional words (stage 3). Cluster 1 also had impaired emotion recognition in speech and faces, but experienced stage 2 deficits. Most participants in Cluster 3 did not have impaired emotion recognition of speech or faces. LASSO analyses indicated that several LH and RH regions were important for emotion recognition, and each prosodic stage. Important regions for receptive prosody included right inferior frontal gyrus and basal ganglia. Discussion Many participants with PPA had impaired recognition of emotion in speech and faces. Impaired emotion recognition was characterized by different patterns of deficits of the three-stage model of receptive prosody. Although patients in clusters 1 and 2 both had impaired emotion recognition, they would likely benefit from different treatment approaches.

Topic Area: Disorders: Acquired

Poster B52 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

A systematic review of treatment-induced neuroplasticity following anomia rehabilitation

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Studies have shown the efficacy of anomia rehabilitation, both in the short- and long-term (e.g., Breitenstein et al., 2017), and there is a growing body of evidence reporting on neural changes associated with treatment-induced recovery from anomia. However, these patterns of neural change vary widely, and the specific mechanisms underlying treatment-induced neuroplasticity remain unclear (Kiran et al., 2019). The present is a systematic review of the literature reporting pre- to post-treatment changes in brain structure and/or function that are associated with naming improvement. Electronic searches of six databases were conducted, including CINAHL, Cochrane Trials, Embase, Ovid MEDLINE, MEDLINE-in-Process and PsycINFO. Two independent raters assessed all abstracts and full texts against pre-specified inclusion criteria. Single-case, case-series and group studies were accepted if they reported original data on adult participants (aged ≥ 18 years) with post-stroke aphasia and conducted magnetic resonance imaging (MRI) pre- and post- behavioural anomia treatment. Initial search results yielded 2302 unique citations. A total of 33 studies were accepted for review: 21 single-case or case-series designs (N=62), and 12 group studies (N=161). Most studies employed a functional MRI (fMRI) approach: event-related (n=21), block (n=10) and resting-state fMRI (n=3). Two studies employed diffusion MRI. The quality of reporting neuroimaging procedures, appraised by two independent raters, was variable across studies. Whereas sequence characteristics were adequately described, studies were heterogeneous in their reporting of image preprocessing and statistical analysis procedures. Study characteristics and main results (including whole-brain stereotactic coordinates) were extracted. Data synthesis focused primarily on whole-brain contrasts showing neural changes after therapy, particularly those correlated with naming improvement. A variety of therapy techniques were administered, including phonological and/or semantic cueing, naming plus movement therapy, and constraint-induced language therapy. All studies reported pre- to post-treatment improvements in naming. Only two group studies reporting whole-brain data directly associated these naming improvements with neural activation changes. Our findings suggest that anomia therapy induced functional activation changes primarily in the left-hemisphere, within- and outside of the naming network. Also, increased functional connectivity between left hemisphere regions was associated with language improvement. Across studies, most consistent increases in activation following therapy were in the bilateral precunei, which may be important to anomia rehabilitation. Our findings also suggest that treatment-induced neural changes may be specific to the type of treatment administered. Phonological treatment studies primarily reported activation in dorsal stream structures, whereas semantic and constraint-induced treatment studies primarily reported activation of the left middle frontal gyrus and basal ganglia. Combined naming plus gesture treatments which were designed to activate the right hemisphere (i.e., with left hand movements), primarily reported rightward shifts in activation, particularly in the right motor and premotor regions. In other treatment types, a leftward shift in activation was observed post- compared to pre-treatment. The present review underscores the heterogeneity of MRI results in the literature. It is important for future research to make direct links between the neural- and behavioural changes induced by anomia therapy. In addition, future use of standardized MRI procedures may improve the interpretability of findings in aphasia rehabilitation research.

Topic Area: Language Therapy

Poster B53 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Convergence of cortical language networks for heteromodal speech production

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Lexical access describes the process involved in the mapping between conceptual representations and phonology and is an integral component of speech production. While various brain regions have been to hypothesized to support separable language processes, the complete cortical language network and its functional mapping to lexical access remain unclear. We used electrocorticography (ECoG) to identify cortical brain networks involved in lexical cognition in the context of heteromodal sensory input modalities with convergent design. Data were obtained from patients with epilepsy who underwent intracranial electrode implantation. Recordings were acquired during three cued naming tasks where patients were asked to name objects in response to pictures (n=120; 16,284 electrodes), auditory descriptions (n=82; 11,215 electrodes), and orthographic descriptions (n=68; 9,282 electrodes). High gamma power (65-115 Hz) was used to measure cortical engagement throughout the tasks. Electrode recording zones were defined on the cortical surface, and each patient's cortical surface was aligned to a standardized surface via a nonlinear, surface-based transformation. Surface-based mixed-effects multilevel analysis (SB-MEMA) was used to estimate group-level high gamma activity for each task. SB-MEMA maps were used to identify regions with significant group-level activation and compared across tasks. Analyses showed heteromodal activity in the the left inferior frontal gyrus (IFG), the left middle fusiform gyrus (mFus), and the left intraparietal sulcus (IPS) following initial sensory processing in response to pictures, auditory descriptions, and orthographic descriptions. Peak activation of mFus occurred 150 ms prior to stimulus offset for auditory (% change = 15.2%, $p < 10^{-6}$) and orthographic (% change = 21.4%, $p < 10^{-6}$) naming and at 350 ms following picture onset (% change = 39.0%, $p < 10^{-6}$) for visual naming. Peak activation of IPS occurred just prior to stimulus offset for auditory (% change = 38.1%, $p = 7.7*10^{-5}$) and orthographic (% change = 27.5%, $p = 0.008$) naming and at 450 ms following picture onset (% change = 43.0%, $p < 10^{-6}$) for visual naming. Peak activation of IFG also occurred just prior to stimulus offset for auditory (% change = 30.1%, $p < 10^{-6}$) and orthographic (% change = 40.1%, $p = 10^{-6}$) naming and at 500 ms following picture onset (% change = 36.4%, $p < 10^{-6}$) for visual naming. Additionally, there was heteromodal activity in the left posterior middle temporal gyrus (pMTG) for auditory and orthographic descriptions but not for pictures with peak activation occurring prior to the convergence of all three tasks at 250 ms before stimulus offset for auditory (% change = 34.1%, $p < 10^{-6}$) and orthographic (% change = 25.5%, $p = 0.0035$) naming. These results reveal that a shared, heteromodal brain network consisting of IFG, mFus, and IPS supports lexical access. Furthermore, our findings also implicate the role of pMTG in phonological access as opposed to lexical retrieval. Altogether, this work further characterizes the functional roles of key brain regions within language networks and provides important insights that are critical to the development of improved treatment methods for speech-related disorders.

Topic Area: Language Production

Poster B54 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam B session.

Concurrent Transcranial Direct Current Stimulation and task-fMRI to Discern Auditory Lexical Decision Processing in Chronic Aphasics

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Transcranial direct current stimulation (tDCS) is a form of non-invasive brain stimulation used to improve language functions after stroke. Despite the promising effects of tDCS in stroke rehabilitation, it remains unclear how tDCS modulates brain systems during language tasks. This study aims to characterize the acute tDCS effects on language-related neural activity using a unique paradigm involving concurrent in-scanner tDCS and a lexical decision (LD) task-fMRI on chronic persons with aphasia (PWA). The tDCS influence on language-network brain activity and behavioral outcomes is assessed by comparing active and placebo sham-tDCS. This pilot study recruited three male English-speaking right-handed PWA (~23±14 months post-ischemic stroke, ~60±5 years old) with left hemisphere lesions including the inferior frontal gyrus (IFG) for subject-1 (S1), the precentral gyrus for subject-2 (S2), and the superior temporal gyrus for subject-3 (S3). All participants underwent an auditory LD task involving word and nonword recognition during two blinded sessions of either sham or active-tDCS. The tDCS electrodes were bilaterally placed on the IFG (F7/F8, 1mA for 20min). Functional images were processed independently for active and sham conditions to obtain a task-specific hemodynamic response function that uniquely characterizes LD processing during active and sham stimulation. General linear model tests contrasting active versus sham conditions were thresholded by a T-statistic of 3.296 ($p<0.001$, FWE cluster-wise corrected range of 2.4-4 cc), and balanced for sensitivity across sessions for each participant. The accuracy and reaction time (RT) of in-scanner LD behavioral performance was quantified by calculating the percent difference between active and sham sessions. Results showed that active-tDCS increased activation of the right inferior temporal gyrus (R-ITG) for S1 resulted in a 58.0% increase in accuracy and 19.3% faster RT for real word recognition compared to the sham condition. Active-tDCS also increased activation of the left angular gyrus (L-AG) during nonword recognition. Contrastingly, active-tDCS did not facilitate language performance for S2. Instead, sham-tDCS showed greater activation of the right postcentral gyrus resulting in an 11.5% increase in accuracy and 3.4% faster RT for word recognition. Lastly, active-tDCS increased activation of the left supramarginal gyrus for S3 without facilitating language performance. Instead, sham-tDCS resulted in a 20.8% increase in word recognition accuracy and a 21.7% increase in accuracy and 7.8% faster RT for nonword recognition. Collectively, the results suggest that immediate facilitation of language function occurred when active-tDCS was applied directly over the lesional/peri-lesional cortices as observed in S1. This direct stimulation facilitated the activation of language areas such as the R-ITG and L-AG. Stimulation of intact bilateral IFG, such as in S2 and S3, elevated neural recruitment of complementary task-related functions involving motor control and semantic decoding without facilitating improved lexical decision making. Our preliminary neuroimaging results and behavioral analysis demonstrate that tDCS-induced neural recruitment is influenced by lesion location and that lesion-specific stimulation most effectively recruits language areas. This provides support for individualized treatment planning for optimal tDCS rehabilitation in PWA. Future work will involve analyzing resting-state functional networks for LD processing and quantifying the hemodynamic parameters for a more comprehensive understanding.

Topic Area: Methods

Poster B55 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam B session.

From Sounds to Words: Evidence for Lexical Representations Distinct from Nonwords

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Recent advances in the application of intracranial neurophysiology and neural decoding to map sensitivity to features in the superior temporal gyri have created a solid grounding for our understanding of the earliest stages of speech categorization. In contrast, there is still a lack of consensus on questions as basic as how words are represented and in what way this word-level representation influences downstream processing. Evidence from behavioral, modeling and neuroimaging experiments demonstrate that nonwords produce similar effects as words across a wide range of measurements, suggesting similar underlying representations. To identify brain regions that are selectively sensitive to words but not nonwords, we performed a neural decoding study using a unique transfer design that allowed direct comparisons between training based on words and nonwords while controlling for phonological similarity. We recorded MEG and EEG from 20 native English speakers as they listened to presentations from six distinct phonological neighborhoods and made judgments about whether the stimuli were English words. Neighborhoods included both word and nonword phonological neighbors of a set of CVC hub words. All participants achieved greater than 80% accuracy on the task. We generated a set of 39 functionally unique ROIs based on MEG activity in the period from 100-500 ms post-stimulus onset. For each ROI, we trained support vector machine classifiers to discriminate between presentations from each neighborhood in a pairwise, transfer-learning design. We hypothesize that classifiers trained to distinguish between phonological neighbors of hub words (e.g. poog and taid) should also be able to distinguish those words (pig and toad) without additional training. Neural decoding results were integrated into Granger causality-based effective connectivity analyses to examine how regions that achieved significant classification performance interacted with other regions. A widespread group of regions showed early (~100-350 ms) decoding performance during stimulus presentation. This group included several ROIs in the temporal lobe, as well as ROIs in articulatory regions of the pre- and post-central gyri. These early decoding windows were not sensitive to lexicality (as they occurred before the presentation was completed and thus prior to any judgment as to lexical presence could be made). A later decoding regime (~400-500 ms) showed sensitivity to lexicality in a subset of temporal lobe ROIs, including the left pMTG and intermediate regions of the superior, middle, and inferior temporal gyri in the right hemisphere. Granger causality analyses show that the word-evoked activity in these regions significantly influences the decoding accuracy within this subset of regions compared to nonword-evoked activity. As these patterns of brain activity both decode and effectuate downstream processing in networked temporal lobe regions, they can be described as representations which are sensitive to both phonological content and lexicality. Thus, while nonwords do activate language network resources, they do so via representations that are substantively different than words even at relatively early stages of the language network.

Topic Area: Speech Perception

Poster B56 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Speech variability is mediated by auditory error sensitivity

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Introduction: Previous work has shown that speakers adjust their vowel formant variability when exposed to real-time auditory perturbations that increase (outward-pushing) or decrease (inward-pushing) their perceived variability, suggesting that speech variability is actively regulated. Simulations using a state-space model of motor behaviour identified two distinct mechanisms that could lead to the observed increase in variability: a direct increase in controlled variability or an increase in the sensitivity to auditory errors, which would amplify the corrective changes from one trial to the next. Here, we aim to distinguish these mechanisms by examining how these perturbations affect neural responsiveness to errors as measured by magnetoencephalography (MEG). Based on the model simulation, we hypothesise that exposure to only the outward-pushing perturbation will result in an increased sensitivity to auditory error. Methods: Acoustic, MEG, and structural MRI data were collected from 8 participants (data collection ongoing; target sample size is 15). In each of 3 separate sessions (control, inward-pushing and outward-pushing perturbation, order counterbalanced), participants produced and listened to playback of the stimulus words ease, add and odd during 3 phases (baseline, exposure and test; perturbation applied only during exposure phase). As a neural measure of auditory error sensitivity, we use the magnitude of speaking-induced suppression (SIS). SIS is calculated by subtracting the peak auditory evoked response (M100) to subjects’ own speech from the peak response to playback of the same acoustic stimuli, and is thought to arise from the cancellation of incoming auditory feedback during speaking by a prediction of that feedback. Such suppression is diminished when the incoming feedback has been altered to create a mismatch (i.e. prediction error). Thus, the magnitude of SIS has been argued to reflect neural sensitivity to auditory prediction error: speakers who are more sensitive to the auditory errors would generate less suppression. Results: Consistent with previous behavioral results, both inward and outward perturbations caused participants to increase their produced variability during the exposure phase. At the neural level, SIS in left auditory cortex was attenuated only after exposure to outward perturbations (decrease of 20.5 ± 14.7% s.e.), suggesting speakers became more sensitive to auditory errors in this condition. Conversely, SIS increased by 10.6% (± 15.7 s.e.) after exposure to inward-pushing perturbations, and by 31.4% (± 33.3 s.e.) in a control session with no perturbations. We also plan to examine whether the change in neural responsiveness to errors (i.e. SIS) is correlated with the change in behavioural variability. Conclusion: Auditory cortical responses to speech productions were less suppressed after perturbations that increase perceived variability, supporting our hypothesis that the increase in produced variability induced by this perturbation is mediated by a change in auditory error sensitivity. The current results not only enhance our basic understanding of the speech motor system, but also establish the validity of modulating the nervous system's sensitivity to errors by alterations of perceived variability. Modifying error sensitivity has the potential to enhance speech motor learning and rehabilitation.

Topic Area: Speech Motor Control

Poster B57 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam B session.

Assessing Parallel Word Processing in Deaf Readers with an ERP Flanker Paradigm

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While much of reading occurs serially – words are read one after the other – we can also process lexical information across multiple words at once. Evidence for parallel reading processes in hearing people comes from flanker studies, which observe altered behavioral and ERP responses when related or unrelated words are presented on either side of (i.e., flanking) the target word. Those changes are called parafoveal-on-foveal (PoF) orthographic integration effects, in which orthographic information in the parafovea influences the cognitive processing of words in the fovea (the center of vision). Flanker studies have not yet been used with the deaf population; however, nonlinguistic psychophysical and linguistic eye-tracking experiments have shown that deaf people have a wider perceptual span across the visual field in both reading-based and nonlinguistic tasks. For nonlinguistic tasks, this effect is hypothesized to be a compensatory change due to deafness as visual attentional resources are reallocated toward the periphery to compensate for the loss of peripheral auditory information. Such a reallocation of nonlinguistic visual attentional resources may influence higher-level reading behavior by enhancing the perceptual influence of upcoming words that appear in the parafovea. In this ERP study, we presented a lexical decision task in which the centrally presented target word (or pseudoword) was sometimes accompanied by flanker words (or pseudowords) which were either identical to or different from the target item. We had two goals: (1) to replicate results from a previous ERP study using the lexical flanker paradigm (Snell et al., 2019), and (2) to examine how these results extend to the deaf population. Deaf ASL signers were compared with hearing non-signers matched on age and reading skill. In an early (50-150ms) window, larger negativities were observed for both flanker conditions compared to the no flanker condition in both groups, likely reflecting the added complexity of the flanked arrays (three words rather than one). In line with Snell et al. (2019), we found differences between the identical-flanker and different-flanker condition beginning after ~200ms and continuing past 600ms, with a larger N250 and N400 when flankers were different from the target. These findings support the hypotheses that the N250 and N400 respectively reflect abstract sublexical and lexicosemantic processing independent of the relative word location in the visual field. The N250 was even greater for different- vs. no-flanker conditions, as in Snell et al. (2019), indicating greater sublexical competition arising from the presence of flankers regardless of flanker identity. The presence of PoF effects after 200ms supports the parallel reading hypothesis at the sublexical (bigram) and lexicosemantic levels of word processing. Both deaf and hearing readers showed clear PoF effects, but the N250 for different vs. identical flankers emerged earlier for deaf readers, which might indicate more fine-grained orthographic processing of parafoveal words for deaf readers, as opposed to processing at the bigram and whole-word levels for hearing readers. (Snell, J., Meade, G., Meeter, M., Holcomb, P., & Grainger, J. (2019). An electrophysiological investigation of orthographic spatial integration in reading.

Neuropsychologia, 129, 276–283.)

Topic Area: Signed Language and Gesture

Poster B58 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Decoding features of speech production using intracranial stereo-electroencephalography

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The speech production network is distributed across a wide expanse of lateral frontal and temporal cortical areas in the brain. A lesion in one or more locations of this network can result in the inability to produce speech, as seen with aphasic patients. Brain-computer interfaces (BCI) continue to be widely studied as a tool for restoring speech. However, most speech BCIs have been limited to use neural activity from only the speech motor cortex, which may not be adequate for the high variability in location and spread of lesions among the aphasic patient population. BCIs using stereo-electroencephalography (sEEG) have the potential to provide widespread coverage spanning multiple regions within the speech production network. However, less is known about the speech decoding potential of sEEG. We recorded neural population activity from 7 subjects with distributed sEEG electrode coverage while they read sentences aloud. These sentences were divided into individual speech components (phonemes, place of articulation, and manner of articulation), and the neural recordings were annotated with the onset and offset of each of these components. Using linear discriminant analysis, we built a classification model to decode each speech component from the broadband high-gamma power (70-150 Hz) of the neural activity. Each classifier was evaluated using 5-fold nested cross-validation, where 80% of the data was used to train and optimize the model parameters, and the remaining 20% was used to compute the model performance. The average classification accuracy across all subjects was significantly above chance for phonemes (5.4% across 38 phonemes), place of articulation (18.1% across 9 labels), and manner of articulation (26.5% across 5 labels). One subject repeated the task three times, resulting in the highest number of component labels for model training and subsequently the highest accuracies. From this longest dataset, we achieved an accuracy of 8.7% for phonemes, 26.9% for place of articulation, and 34.2% for manner of articulation. Furthermore, we also classified 36 words with an accuracy of 12.3% from this dataset. Across all subjects, the electrodes that contributed the most discriminatory information to the classifiers were located in multiple distributed cortical sites, including sensorimotor cortex, inferior frontal gyrus, mid-fusiform cortex, and auditory cortex. While some of these electrodes were close to the cortical surface, we also observed many contributing electrodes deeper in the gyri and sulci regions distributed across the dominant and non-dominant language hemispheres. These results demonstrate that decoding components of speech production involves contributions from multiple cortical regions. A distributed coverage can capture neural correlates of multiple speech components simultaneously, providing more information to build a diverse vocabulary of words for a speech BCI user. While this widespread coverage is not easily attainable by subdural electrode grids commonly used for speech BCIs, intracranial depth electrodes provide a safer alternative for accessing multiple areas across the brain.

Topic Area: Speech Motor Control

Poster B59 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Multimodal behavioral and electrophysiological measures in agrammatic patients reveal a complex relationship between cognitive control and sentence processing

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One feature of agrammatism, a sub-profile of aphasia, is difficulty understanding sentences. Traditionally, this difficulty was thought to arise from overreliance on semantics and a failure to process sentences syntactically ("Syntactic Deficit" hypothesis). Using contrastive cases and multimodal measures, we tested the alternative hypothesis that sentence comprehension difficulty might arise from deficits in cognitive control because such deficits undermine one's ability to choose between competing interpretations ("Cognitive Control" hypothesis. Thothathiri et al., 2018). Four patients with chronic aphasia (>6 months post-onset) following a left hemisphere stroke participated: P30 71(F), P99 57(M), P100 74(F), P69 61(M). P30, P99, and P100 met all agrammatism screening criteria – (1) above chance lexical comprehension and at chance reversible sentence comprehension in the Philadelphia sentence comprehension battery, (2) better performance on canonical than non-canonical sentences in an expanded sentence comprehension task, (3) Western Aphasia Battery fluency<5, and (4) Northwestern Assessment of Verbs and Sentences sentence production score<4. P69 was used as a comparison patient because s/he showed higher WAB fluency (=9) and NAVS sentence production (=12) and above-chance reversible Actives comprehension. Patients completed (1) a sentence-picture matching task where we manipulated conflict between syntax and semantics (Active-Implausible/Conflict: The robber handcuffed the cop; Active-Plausible/No-conflict: The cop handcuffed the robber), and (2) a sentence plausibility judgment task (Saffran et al., 1998) where the syntax did or did not conflict with verb argument constraints (Verb-Impossible/Conflict: The equation taught the presenter; Verb-Possible/No-conflict: The surgeon taught the lesson). Additionally, patients completed a battery of cognitive control (e.g., Stroop, Auditory Stroop), short-term memory (e.g., digit span), and working memory (e.g., backwards digit span) tasks. We tested two patients (P99 and P100) further using electrophysiology and eye-tracking because they showed contrastive cognitive control profiles but similar sentence comprehension impairments. Contrary to the Syntactic Deficit hypothesis, not all agrammatic patients performed poorly when semantic cues conflicted with syntax. P30 performed similarly to the comparison patient P69, showing above-chance performance. Only P99 and P100 showed impairment in the critical conflict conditions. P99 was impaired in Stroop and the processing of conflict sentences, consistent with the Cognitive Control hypothesis. However, the results unexpectedly revealed that P100 was impaired too despite not showing deficits in the Stroop tasks. Follow-up testing revealed a differentiation between reactive (P99) and proactive (P100) cognitive control deficits in the two patients (AX-CPT. Braver, 2012). ERP results also revealed contrastive patterns, with P100 showing a P600 in response to conflict (like healthy adults) and P99 not. Our multimodal investigation of contrastive agrammatic patients revealed that (1) only some agrammatic patients struggle with overriding semantics with syntax; (2) different cognitive control deficits might impact sentence processing in different ways; and (3) online processing measures like ERP can reveal differences between agrammatic patients who perform similarly on offline behavioral measures. Our full dataset and analysis, including eye-tracking data and performance on other kinds of garden-path sentences, will shed further light on the complex relationship between cognitive control, online sentence processing, and offline sentence comprehension.

Topic Area: Control, Selection, and Executive Processes

Poster B60 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Morpho-Phonologically Based Treatment for Hebrew Speaking Individuals with Aphasia: An fMRI Study

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Introduction Anomia is a common characteristic in all types of aphasia. Despite the extensive knowledge that has been accumulated on aphasia therapy, there are no naming treatments developed for Hebrew. Hebrew is a Semitic language with rich morphology, in which most words are composed of intertwined roots and patterns. Words sharing the same root are often semantically related (Dotan & Friedmann, 2015). Studies have shown the prominent role of the root morpheme in access to Hebrew words. The aim of our study is to examine the effects of a new root-based treatment on naming abilities in Hebrew speaking individuals with aphasia and its brain correlates using fMRI. *Methods* We designed a morpho-phonologically-based treatment in Hebrew, composed of three steps: 1) Increasing morpho-phonological awareness to the semantic-morpho-phonological relations between words sharing a root. 2) Identification of morpho-phonological relations among words sharing a root, and; 3) Picture naming in a sentence completion task, containing a verb with a shared root (Kraizer & Novogrodsky, 2012). *Participants*: Twelve adults (7 females; mean age 61.75 years, range 29-82) with chronic post-stroke aphasia and significant anomia following a single left hemisphere (LH) stroke. All were native Hebrew-speakers, right-handed, with no other neurological history. *Procedure*: Three pre-treatment naming assessments were administrated of morphologically complex words (root+pattern). Based on each participants' naming performance, 30 treated words and 30 untreated words were chosen with matched levels of naming accuracy. Each participant received twenty bi-weekly treatment sessions, followed by three post-treatment naming assessments, and a follow-up assessment 10 weeks post-treatment. Treatment was delivered frontally to four participants, and online to the other eight participants, due to the Covid-19 pandemic, but was otherwise identical. Four participants were also scanned using fMRI before and after the treatment, while performing a picture naming task of treated and untreated words. *Results* Treated Words: all participants but one (11/12) demonstrated significant improvement from pre to post treatment. This improvement was preserved in the 10-week follow-up assessment for all eleven participants. Interestingly, three patients also showed a significant improvement from post-test to the follow-up session. Untreated Words: Six participant significantly improved in naming untreated words following the treatment, a change that was significantly maintained for two of them in the follow-up session. fMRI: Preliminary analysis shows increased activation in language areas from pre- to post treatment both in treated and untreated words. Interestingly, the changes in activation were mainly due to increased activation in left hemisphere posterior language regions (superior temporal gyrus, middle temporal gyrus, angular gyrus) as compared to anterior regions (inferior frontal gyrus, middle frontal gyrus, supplementary motor area). *Conclusions* Following the morpho-phonological naming treatment all patients improved in naming the treated words and some participants demonstrated generalization to untreated words. These improvements were accompanied by increased brain activation post treatment, mainly due to increased activation in left posterior language regions. These initial results point to the potential effectiveness of the treatment for Hebrew speaking individuals with aphasia, accompanied by brain plasticity within regions that are involved in lexico-semantic processing.

Topic Area: Language Therapy

Poster B61 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Transformer language models partly predict retrieval interference effects

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INTRODUCTION: Transformer language models successfully predict facilitatory interference effects for agreement processing [7]. We ask here whether they can capture the interaction between retrieval interference and expectations [2]. Surprisal values from GPT2 [1, 6] are compared against human EEG data for Mandarin noun-phrase (NP) ellipsis. We find that interference effects on the P600 are modulated by target predictability, but this modulation is not captured by GPT2. METHODS: Mandarin NP ellipsis requires retrieving an antecedent NP upon encountering a number-classifier sequence with matching semantic features. We manipulate the target antecedent NP to be either a semantic match (Grammatical) or mismatch (Ungrammatical) to the classifier. For example, the classifier CL-Jian (件)

categorizes shirts and luggage ([+Jian, -Ben]), and CL-Ben (本) categorizes books ([+Ben, -Jian]). We modulate interference using a distractor NP that is either a semantic match (High Interference) or mismatch (Low Interference) to the classifier. Lastly, the lexical-semantic expectation of the antecedent is modulated by varying the main verb to be either compatible with both the antecedent and distractor NP (Low Expectation), or only the antecedent (High Expectation). For example, “bring” is compatible with “shirt”, “luggage” and “book”, but “wear” is only compatible with “shirt”. 44 sentence sets with this 2x2x2 design were presented with 104 fillers using RSVP to N=30 Mandarin speakers during EEG recording. Data were epoched −300 to 1000 ms around the critical number-classifier sequence, and artifacts removed with ICA and visual inspection (0.1%–19% removal rate). Statistical analysis was conducted on centro-posterior electrodes from 650–800 ms with a non-parametric permutation test [4]. Surprisal, -log2(Pr(w | context), of the critical word was computed from Chinese GPT2. RESULTS: EEG data show a three-way interaction between grammaticality, interference and expectation. In Ungrammatical conditions, the P600 was decreased in High vs. Low Interference, when Expectation was High only (678–748 ms; $p < .05$). We thus replicate the facilitatory interference [8] with an additional modulation by expectation. GPT2 shows only a two-way interaction between grammaticality and interference ($F(1, 43) = 36.74$, $p < .001$), without an Expectation modulation ($F(1, 43) = 1.77$, $p = 0.19$). In Ungrammatical conditions, High Interference shows lower surprisal than Low Interference, regardless of Expectation (Low-High = 0.876, $p < .01$). No reliable differences surfaced for Grammatical conditions (Low-High = 0.028, $p = 0.99$). Indeed, a single-trial analysis found no reliable contribution of GPT2 surprisal to the P600 response, consistent with e.g. [3]. CONCLUSION: Although Transformer language models predict facilitatory interference effect in Mandarin ellipsis processing, they do not capture the modulation of expectation on interference. Such modulation is observed with EEG data and follows from a cue-based retrieval theory with preferential cue-weighting [5]. Specifically, facilitatory interference only surfaces when the preferred structural cues are neutralized by prediction error caused by a highly predictable antecedent mismatching the retrieval cues. The across-the-board facilitatory interference effect by GPT2 suggests a lack of such cue preference. Supporting figures, tables, and references are available at: https://drive.google.com/file/d/1ms_egozDfuluvEUDtO2w0Uw9r2bkv_-Q/view?usp=sharing

Topic Area: Syntax

Poster B62 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

The neuroanatomy of developmental language disorder

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Developmental language disorder (DLD) is a common neurodevelopmental disorder whose adverse impacts continue into adulthood. However, its neural substrates remain unclear. To address this lacuna we systematically identified and quantitatively synthesized neuroanatomical studies of DLD. Analyses of structural brain data (22 papers, 577 participants) revealed highly consistent anomalies in the basal ganglia (100% of studies that examined this structure, weighted by study sample sizes; 99.8% permutation-based likelihood that the anomaly clustering was not due to chance). These anomalies were further localized to the neostriatum, in particular the anterior portion (again 100% and 99.8%). No other structure showed as consistent abnormalities, including frontal cortex (82.6% weighted proportion; 97.7% permutation-based likelihood), which showed the next highest rate of abnormalities. The structural abnormalities were distributed similarly across the two hemispheres. As expected given the task-dependence of activation, functional neuroimaging data (11 papers, 414 participants) yielded less consistency. Nevertheless, the highest weighted proportion of functional imaging anomalies also occurred in the basal ganglia (80.9%; 97.2%), with the parietal lobes showing a similar rate (80.0%; 98.2%). Functional imaging abnormalities were found at similar proportions across the hemispheres with the exception of the basal ganglia, which showed a higher rate of anomalies

in the right than left side. Multiple sensitivity analyses revealed that both the structural and functional neuroanatomical patterns were robust. The findings are likely more reliable and generalizable than single study results, since the number of participants is by definition larger than in any one study in the synthesis, and because the diversity of the included studies suggests greater generalizability of the findings. The results reveal clear patterns regarding the neuroanatomy of DLD. A key finding is that DLD is associated with striking structural neuroanatomical consistency, despite the etiological and behavioral diversity linked to the disorder. We suggest that, analogous to the acquired aphasias, DLD may be best explained by its pattern of neuroanatomical abnormalities, rather than by etiological (e.g., genetic polymorphism or toxic insult) or linguistic/cognitive factors, even if these may also contribute to the phenotype of the disorder. Indeed, one such neuroanatomical account has previously been proposed, the Procedural circuit Deficit Hypothesis (PDH), which largely—though not completely—predicted the pattern of observed abnormalities, in particular in the basal ganglia. The results are interpreted with respect to the PDH and other explanatory accounts of DLD. We discuss limitations as well as basic research and translational implications both for DLD and for language more generally.

Topic Area: Disorders: Developmental

Poster B64 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Modulation of pupil dilation and alpha power during masked speech perception reveal distinct neural mechanisms contributing to listening effort

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Listening effort, or the cognitive effort exerted by an individual to process target speech under challenging conditions, is dissociable from task performance (Winn & Teece, 2021). Because many everyday communication situations involve background noise/speech (e.g., noisy restaurants, family gatherings), measuring listening effort under such conditions can provide important insight into the effect of masking on the listener. However, the study of listening effort is complicated by the finding that measurements of effort obtained through different physiological approaches (e.g., pupil size vs alpha power) are rarely correlated with one another (Alhanbali et al, 2019). This suggests that these psychophysiological indices may be sensitive to different mechanisms underlying the multidimensional construct of listening effort. The aim of this study was to compare the effort elicited by noise conditions producing primarily energetic masking (masking due to target-masker spectrotemporal overlap) to the effort elicited by an intelligible speech masking condition producing primarily informational masking (additional masking due to listener uncertainty/confusion), by examining changes in pupil size and alpha power. Fifteen young, normal hearing participants listened to target sentences while ignoring masker stimuli. Three different masking conditions were included: an intelligible speech masking condition; a speech-shaped, speech envelope-modulated noise masking condition; and a speech-shaped, unmodulated noise masking condition. We first used individual adaptive tracking to estimate the target-to-masker ratio (TMR) at which each participant could report 75% of the target words correctly, in each condition. Stimulus intensities were then held constant at these 75%-correct TMRs while both pupil size (via pupillometry) and neural alpha power (via EEG) were measured. This approach allowed for comparing these two physiological estimates of listening effort while controlling performance levels across participants and conditions. A 1 x 3 repeated measures ANOVA revealed a significant within-subject effect of condition on peak pupil size, $F(2,28) = 7.79$, $p < 0.01$. Post-hoc comparisons revealed that the speech masking condition elicited a significantly greater peak pupil size than either of the noise masking conditions (both $p < 0.05$). In terms of alpha power, a 1 x 3 repeated measures ANOVA revealed a significant within-subject effect of condition, $F(2,26) = 4.53$, $p < 0.05$. In contrast to the pupil size results, post-hoc comparisons revealed that the unmodulated noise masking condition elicited significantly greater alpha power than the speech masking condition ($p < 0.01$). Results suggest that pupil dilation may be more sensitive to the effort required to distinguish between highly confusable target and masker speech in a high-

informational masking condition, whereas alpha power may be more sensitive to the effort required to perceptually "fill in" unavailable portions of the target signal in a high-energetic masking condition. Work supported by: NIH K99DC018829 (PI: Villard), NIH R01DC013286 (PI: Kidd), and a Plural Publishing Research Scholarship (Alam).

Topic Area: Speech Perception

Poster B65 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Multilingual experience affects resting state functional connectivity in (cognitive) aging

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At least under conditions of active engagement, multilingualism has been observed to affect brain structure and function across the lifespan (Bialystok, 2021). It has been associated with increases in compensatory mechanisms towards age-related neurocognitive decline, leading to a more favorable trajectory of cognitive aging (CA) (for review see Gallo et al., 2022). However, the majority of research examining effects of bi-/multilingualism on CA has typically operationalized bilingualism as a dichotomous variable, despite it being a heterogeneous individual experience (DeLuca et al., 2019). Furthermore, little of the relevant research has included middle-aged individuals, an important transitional period in the lifespan between peak cognition and older age where it becomes typically degraded. Thus, our understanding of how multilingualism affects the trajectory of neural decline across the adult lifespan is limited. Of course, multilingualism is not the only cognitively demanding activity in which individuals differentially engage: several other lifestyle factors have been found to affect the trajectory of CA (e.g., exercise, diet, education, etc). However, multilingualism has rarely been compared while accounting for these other factors to examine whether it independently contributes to resilience against symptoms of CA. The present study aimed to address these issues simultaneously by examining effects of multilingualism on CA across a large age range of adults while taking into account various other lifestyle factors. We used resting state electroencephalography (rs-EEG) as a measure of neurocognitive function. Specifically, rs-EEG coherence has been previously found to index increased reserve against CA (Fleck et al., 2017) and to be modulated by degree of engagement in bilingual experience in young adults (e.g., Pereira Soares et al., 2021). A cohort of multilingual native speakers of Norwegian with high proficiency in English, (preliminary analysis n = 20, projected n = 100; mage = 57.1, SD = 11.8, range 45-82) were administered a battery of demographic questionnaires tapping into bilingualism and various other lifestyle experiences. A rs-EEG recording was also taken. Continuous measures of multilingual engagement were calculated from the Language History Questionnaire 3.0 (Li et al., 2020), including a multilingual diversity score (MLD) which is based on the language entropy measure (e.g., Gullifer & Titone, 2019). Rs-EEG data were analyzed by calculating coherence between a series of electrode regions for a set of frequency bands (following Bice et al., 2019; Pereira Soares et al., 2021). Functional coherence measures were entered into linear regression models with the demographic variables. A base model first specified age and lifestyle scores as main effects. Follow-up models including interaction terms of MLD score with age were run and compared to the base models. Preliminary results showed significant interactions of MLD score and age on several coherence measures. Specifically, higher MLD scores corresponded to increased high-beta brain coherence between the anterior left and right electrode clusters (LFT and RFT) in more advanced age. The present pattern of results indicate that degree of multilingual engagement impacts functional coherence across the adult lifespan, and crucially appears to be an independent contributor to increased reserves against effects of CA.

Topic Area: Multilingualism

Poster B66 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Implicit, automatic semantic word categorisation as revealed by fast periodic

visual stimulation

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Conceptual knowledge allows the categorisation of items according to their meaning beyond their physical similarities. This ability to respond to different stimuli (e.g., a leek, a cabbage, etc.) based on similar semantic representations (e.g., all vegetables) is particularly important for language processing, because word meaning and the stimulus form are unrelated. The neural basis of this core human ability is debated and is complicated by the strong reliance of most neural measures on explicit tasks, involving many non-semantic processes. Here we establish an implicit method, i.e., fast periodic visual stimulation (FPVS) coupled with electroencephalography (EEG), to study conceptual categorisation processes with written word stimuli. In a first experiment, fourteen neurotypical participants were presented with different written words belonging to the same semantic category (e.g., different animals) alternating at 4Hz rate. Words from a different semantic category (e.g., different cities) appeared every 4 stimuli (i.e., at 1Hz). Following a few minutes of recording, objective electrophysiological responses at 1Hz, highlighting the human brain's ability to implicitly categorize stimuli belonging to distinct conceptual categories, were found over the left occipito-temporal region. Topographic differences were observed depending on whether the periodic change involved living items, associated with relatively more ventro-temporal activity as compared to non-living items associated with relatively more dorsal posterior activity (Volfart et al., 2021). In a second, control experiment, we addressed whether the periodic EEG responses could be (partly) generated simply from the rare presentation of specific stimuli as oddball among more frequently presented stimuli, irrespective of their semantic categories, (i.e., a statistical learning effect; De Rosa et al., 2022). We tested seventeen neurotypical participants with the condition providing the largest amplitudes in the first experiment (cities/animals), manipulating the number of base/alternate stimuli (either 8 base and 8 alternate stimuli [8x8] or 24 base and alternate stimuli [24x24]) and the conceptual category consistency (with [CC] or without [NCC], e.g., in the 24x24 NCC condition, base stimuli were words of 12 animals and 12 cities, and alternate stimuli were different words of 12 animals and 12 cities). With 8 stimuli, we found significant left occipito-temporal 1Hz responses even in the NCC condition, reflecting a statistical learning effect. While a significantly larger number of significant electrodes were found in the CC condition, there was no overall amplitude difference between CC and NCC conditions over the key brain region. However, critically, with 24 stimuli, there was no significant occipito-temporal 1Hz response in the NCC condition anymore, while the response even increased for the CC condition. These observations indicate that statistical learning effects alone can elicit spurious EEG responses at 1Hz in paradigms with small stimulus sets, but they are not as robust as conceptual category effects and disappear when larger stimulus sets are used. Overall, this study demonstrates the validity and high sensitivity of an implicit frequency-tagged marker of word-based semantic memory abilities.

Topic Area: Meaning: Lexical Semantics

Poster B67 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Decoding the time course of acoustic, lexical, syntactic and semantic features with MEG during story listening

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[INTRODUCTION] Language comprehension requires construction of multiple levels of representations, including perception (e.g., acoustic), lexical (e.g., frequency), syntax (e.g., parsing strategy), semantic (e.g., social), etc. Previous studies have identified cortical locations of neural activity related to these different levels of representations. However, the temporal sequence of processing from sensory input to language comprehension remains unclear.

Here we address two research questions: 1) what type of features are encoded by the MEG signal; 2) how these encoded features emerge over time? [METHODS] Magnetoencephalography (MEG) activity from 12 Mandarin-speaking adults was recorded during listening of ~6 hours of stories. Here we consider 17 word-by-word features including 1 acoustic feature (i.e., audio envelope), 2 lexical features (i.e., word frequency and word length), 7 syntactic features (i.e., word position in a sentence, content word indicator, depth in a tree, distance from head word, node counts from top-down, bottom-up and left-corner parsing strategies), and 7 semantic features (i.e., social, vision, action, emotional arousal, emotional polarities, time and space with scores ranging from 1 to 7 which were crowdsourced to 30 participants). We conducted a data-driven decoding method which deciphers a specific feature from the MEG sensor data at each time point. To eliminate the effect of correlations among different features, we used the back-to-back ridge regression model to evaluate the accuracy of the joint decoding models in predicting each modeled feature. Group level significant results were calculated by using a one-sample permutation cluster test. [RESULTS] First, the acoustic feature was reliably decodable from a sequence of neural responses unfolding before ~100ms and after ~260ms after word onset. Second, lexical features were mainly decodable between ~180ms to ~460ms after word onset. Third, syntactic features of content word, tree depth, top-down and bottom-up parsing could be successfully decoded at a very long-time window from ~0ms to ~800ms after word onset; word position could be decoded at ~510ms; left-corner parsing was decodable around 290ms and 710ms; distance from head word was decodable around 240ms and 730ms. Lastly, semantic features of social and action could be discriminated around 450ms and 310ms respectively; vision feature was decodable during multiple small time-windows at 80ms, 250ms, 350ms, 450ms, 550ms; emotional arousal was decodable from 200ms to 430ms. We didn't find significant effects of the time feature, space feature and emotional polarities. [CONCLUSIONS] We successfully decipher from MEG activity multiple levels of representations comprising lower-level auditory and lexical features to higher-level syntactic and semantic. The acoustic feature has a huge impulse on brain responses at each word onset, while lexical features are activated and reactivated during the whole-time window. This implies that lower-level features would have influences on word processing even if higher-level features are activated. Interestingly, syntactic features are encoded in a long time-window, while semantic features are only encoded at a certain time point, indicating different mechanism of syntactic and semantic processing.

Topic Area: Computational Approaches

Poster B68 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Dynamic, multi-core-periphery architectures support the neurobiology of language in the real-world

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Existing models of the neurobiology of language assume a static architecture that cannot adequately explain language processing because they do not address how the brain uses context. Yet, context is necessary for resolving ambiguity at various levels of linguistic analyses, e.g., through using co-speech gestures or observable objects, and this likely involves a whole-brain and dynamically changing distribution of regions (given that context is ever changing). Unlike more fixed architectures, core-periphery organizations can account for the dynamic use of context. These involve core sets of highly connected nodes and a group of loosely connected peripheral nodes. We hypothesized that the brain has a core-periphery architecture during a naturalistic language processing (where context is available), with cores corresponding to 'language regions' and peripheries the rest of the brain. We analyzed functional magnetic resonance imaging (fMRI) data from participants who watched movies. For each participant, we constructed a whole-brain network by building adjacency matrices at sliding time windows. The adjacency matrix for each window was created based on the pairwise Pearson's correlation coefficient for every voxel. Voxel-wise core-periphery configurations were identified using a new fast algorithm we developed. Spatial independent components analysis was done to determine stable group-level configurations. To further understand the interrelationships between nodes, we partitioned adjacency matrices into communities such that the connectivity of nodes in the same community is higher than the connectivity between communities. We performed a mixed effects model analysis to find communities that overlapped brain regions sensitive to spoken words in the movies. The number of core nodes varied across time windows and participants, covering ~3-7% of gray matter voxels. On average across participants, the core-periphery structures changed every ~2-3 minutes, resulting in 54.7 core configurations detected throughout the movie. More core figurations were found at the individual level than at the group level. Most stable core nodes were in sensorimotor regions (e.g., primary visual and auditory cortices), language-sensitive regions, and some regions in the putative 'default mode network' (e.g., angular gyrus). Individual-level community configurations changed every ~10 minutes, whereas group-level communities varied less frequently and showed very low similarity with individual-level communities. On average across participants and movies, the most stable temporal community configuration consisted of 5 communities, which corresponded to central sulcus, temporal, occipital, prefrontal, and subcortical regions. Voxels in 'language' regions contributed to 5.3% of the stable core nodes of the communities. About 50% of voxels in areas outside 'language' regions acted as periphery nodes linked to these 'language' core nodes. Traditional (e.g., 'dual-stream') models of the neurobiology of language suggest a static and modular organization of language processing regions, limited to a small portion of the brain. To the contrary, our results suggest a highly flexible core-periphery network architecture, where 'language regions' act as connectivity hubs that integrate and share multimodal information with periphery areas. This model might account for the variability and complexity of real-world language processing where context is available for use and offers new insights into potential regions as targets of novel individualized speech therapies.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster B69 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

ERPs indicators of word reading during text comprehension: word-to-text integration or lexical retrieval?

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Readers build a situation model to represent text information, updating the model incrementally. Event structures—the temporal order, location, and causal relations of activities—are central to situation models and our focus here. ERP studies of word-to-text integration, linking the current word to the prior text, provide a window on these incremental processes. Both the N400 and P600 have been found to reflect these processes. A reduction in the N400 that depends on the presence of an antecedent has been interpreted as indicating the ease of integration. However, this interpretation is challenged by data showing that meaning priming, rather than integration, is responsible for the N400 reduction. These results are based on simple two-sentence texts with repetitive event structures and event-defining words, and strong priming situations (Delogu et al., 2019). Priming is powerful in the N400 and could mask effects of other aspects of text processing. Our study aims to examine whether the N400 can indeed reflect integration processing when longer story-like texts are used, and priming is reduced. To achieve this goal, we developed 4-5 sentence narrative texts and controlled the integration opportunity by manipulating the event structure in two ERP experiments. The second experiment extracts the two sentences from the story that convey the event structure in order to separate the effects of a longer, more engaging narrative from other effects produced only by whether the event structure is congruent or incongruent. We recorded EEGs of college students while they read passages presented as whole sentences (1st and final sentences) or word by word (two middle sentences). We compared ERP components on nouns (e.g., menu) in various positions in the second of these two middle sentences across three conditions: 1) the preceding sentence has an antecedent (e.g., restaurant), and event structure information is congruent; 2) the preceding sentence has an antecedent (e.g., restaurant), but event structure information is incongruent; 3) the preceding sentence describes event-unrelated activities. Critically, 1) and 2) contain exactly the same priming potential and differ only on whether the protagonist has entered (congruent) or left (incongruent) the restaurant when "opened the menu" is read. Thus, only if the N400 is sensitive to event structure congruence should a difference in N400 be observed. In the second experiment, different participants will read the middle two sentences of stories of the first experiment with ERPs recorded. Data collection is complete on the first experiment with analysis in progress. The second experiment will be completed this summer. If a robust N400 effect is found between the first two conditions describing related events (1 vs.2), we conclude that the N400 can reflect mental-model-based integration beyond mere meaning access. A failure to find an N400 difference between these two conditions (provided both differ from condition 3) coupled with a P600 difference will add evidence to the argument that only the latter reflects integration. Results from the current two ERP experiments will allow a more precise interpretation of ERP components during text reading.

Topic Area: Reading

Poster B70 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Recovery from aphasia in the first year after stroke

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Most individuals who experience aphasia after a stroke recover to some extent, with the majority of gains taking place in the first year. The nature and timecourse of this recovery process is only partially understood, especially its dependence on lesion location and extent, which are the most important determinants of outcome. The aim of this study was to provide a comprehensive description of patterns of recovery from aphasia in the first year after stroke. We recruited 334 patients with acute left hemisphere supratentorial ischemic or hemorrhagic stroke, and evaluated their speech and language function within 5 days using the Quick Aphasia Battery. At this initial timepoint, 218 patients presented with aphasia. Individuals with aphasia were followed longitudinally, with follow-up evaluations of speech and language at 1 month, 3 months, and 1 year post stroke, wherever possible. Lesions were manually delineated based on acute clinical MRI or CT imaging. Patients with and without aphasia were divided into 13 groups of individuals with similar, commonly occurring patterns of brain damage. Trajectories of recovery were then investigated as a function of group (i.e., lesion location and extent) and speech/language domain (overall language function, word comprehension, sentence comprehension, word finding, grammatical construction, phonological encoding, speech motor programming, speech motor execution, and reading). We found that aphasia is dynamic, multidimensional, and gradated, with little explanatory role for aphasia subtypes or binary concepts such as fluency. Patients with circumscribed frontal lesions recovered well, consistent with some previous observations. More surprisingly, most patients with larger frontal lesions extending into the parietal or temporal lobes also recovered well, as did patients with relatively circumscribed temporal, temporoparietal, or parietal lesions. Persistent moderate or severe deficits were common only in patients with extensive damage throughout the middle cerebral artery distribution, or extensive temporoparietal damage. The relatively good recovery observed in almost all groups, despite core language regions being damaged in many cases, supports a network concept of aphasia recovery, in which all but the largest lesions leave enough of the large scale network intact to provide a substrate for recovery. There were striking differences between speech/language domains in their rates of recovery and their relationships to overall language function, suggesting that specific domains differ in the extent to which they are redundantly represented throughout the language network, as opposed to depending on specialized cortical substrates. Our findings will enable clinicians to estimate the likely course of recovery for individual patients, as well as the uncertainty of these predictions, based on acutely observable neurological factors.

Topic Area: Disorders: Acquired

Poster B71 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Replicating the Ambiguity Advantage in MEG Using a Novel Method for Quantifying Number of Senses

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[INTRODUCTION] Previous lexical decision studies have reported an “ambiguity advantage” whereby words with multiple meanings and/or senses are recognized faster than unambiguous words (Rubenstein, Garfield, Millikan 1970; others). Further studies have argued that this effect is not homogenous–rather, multiple senses are facilatory and multiple meanings are potentially inhibitory (Rodd, Gaskell, Marslen-Wilson 2002; Beretta, Fiorentino, Poeppel 2005; others). However, one limitation of these studies is the method of deriving the number of senses and meanings; they are generally based on human-generated resources with little empirical motivation. In this study, we quantify words’ number of senses using unsupervised methods to reduce human bias. Additionally, we verify that this measure replicates the “ambiguity advantage” found previously and is a better predictor of brain activity than traditionally used variables. [METHODS] During a visual lexical decision task, we recorded brain activity from 21 adults using magnetoencephalography (MEG). The stimuli were 631 monomorphemic, monosyllabic, noun-verb ambiguous English words having a lexical decision accuracy > 80% plus 631 matched non-words. [NUMBER OF SENSES MEASURE] We derive our number of senses using BERT, which learns context-sensitive word representations. For each of our stimuli, we sampled 1000 sentences (or all sentences if there were fewer than 1000 occurrences) from Wikipedia, and retrieved the contextualized embedding of that word in each context. Next, we applied a hierarchical clustering algorithm to the resulting embeddings to estimate the number of senses (clusters) each word has. As a comparison, we also retrieved the number of senses for a given word from WordNet and the Wordsmyth online dictionary. Correlations among all predictors were below r=0.15, except WordNet and log frequency (r=0.52). [RESULTS] We tested three models for comparison in an ROI containing left middle and superior temporal gyri. Test statistics were computed over activation levels (dSPM) at each time point, and cluster permutation tests were conducted to identify significant clusters. Test statistics were t-values resulting from one-tailed t-tests over beta coefficients resulting from regressions at each time point and source per subject (dSPM ~ log(Lexical Frequency) + Number of Senses, 300-400ms). In the Wordsmyth model, frequency neared significance in LMTG (p=0.057, 300-400ms) and there was no effect of number of senses. In the WordNet model, frequency was facilitatory in LMTG (p=0.048, 300-400ms) and there was no effect of number of senses. In the BERT model, frequency neared significance in LMTG (p=0.081, 300-400ms) and number of senses was facilitatory in LMTG (p=0.038, 300-400ms). [CONCLUSION] Our computationally derived measure of number of senses is the only significant predictor of our brain data, outperforming more traditional measures. This suggests that cognitively valid estimations of senses can be acquired in an unsupervised manner without resorting to human-annotation or curation. Additionally, we replicate the “ambiguity advantage”, finding that words with more senses elicit less brain activity. Before SNL, we will derive a continuous measure quantifying words’ sense relatedness in order to further probe the potential differing effects of meanings and senses on word recognition.

Topic Area: Meaning: Lexical Semantics

Poster B72 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam B session.

Distinct prefrontal networks for semantic integration and articulatory planning

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The spatiotemporal neural dynamics in frontal cortex underlying speech production and word retrieval remain poorly understood. Traditionally, the inferior frontal gyrus (IFG) has been implicated in various aspects of language processing including articulatory, syntactic, and semantic processes (Frederici, 2012; Hickok & Poeppel, 2007). Growing evidence has implicated the posterior MFG (area 55b) and dorsal precentral gyrus as critical for language (Chang, 2020; Ozker, 2022). In order to investigate the spatiotemporal dynamics of speech articulation and semantic integration, we leveraged a battery of language production tasks within a cohort of 24 neurosurgical patients undergoing Electrocorticographic monitoring. We hypothesized that articulatory preparation, lexical retrieval, and semantic integration may not be localized to one region but rather may be distributed in nature. All participants underwent the same tasks including picture naming, word reading, auditory naming, auditory word repetition, and auditory sentence completion, designed to produce the same unique 50 words in each task but with a distinct route of retrieval (randomly interspersed within the block). Focusing on high gamma broadband (70-150 Hz), we reported the spatiotemporal dynamics across peri-sylvian cortices locked to language perception and articulation. A region of interest analysis provided unique profiles of task-related neural recruitment per region during perception and production across all significant electrodes (sustained activity for over 100ms compared to baseline, t-test $p<0.001$). The neural profiles replicated previous temporal dynamics for sensory perception (STG and occipital cortices), speech planning (IFG), and motor execution (pre- and post- central gyri). However, we found specific enhancement in IFG and MFG related to semantic load. In order to test how distributed these networks were, we employed an unsupervised clustering approach to uncover dynamics in a data driven manner without an anatomical bias. This approach revealed two new networks in frontal cortex with differentiated articulatory and semantic specificity. One cluster of electrodes, centered in IFG and precentral cortices, showed comparable activity prior to speech onset across all tasks. The second cluster, centered on the border of IFG and MFG, showed strong task-selectivity prior to articulation with significantly greater (t-test, $p<0.001$) activity for tasks requiring semantic access. In order to investigate the nature of these two clusters, we performed representational similarity analysis across the auditory naming and sentence completion tasks. Neural covariance across time locked to perception in the semantic cluster was highly correlated with the semantic embeddings of the changing auditory stimuli (based on the last 3 layers of a deep neural network GPT-2 model, spearman correlation $p<0.001$ rho= 0.53 and 0.27, respectively for each task) which quickly diminished as speech production onset approached. The articulatory cluster, however, was strongly correlated with phonetic information rather than semantic embeddings prior to speech onset across tasks. Our results suggest two distinct language production components distributed across frontal cortices, a preparatory motor-related component agnostic to task, and a component recruited specifically as semantic integration is required.

Topic Area: Language Production

Poster B73 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Grammar in 'agrammatical' aphasia: What's intact?

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Aphasia following cerebro-vascular accidents has been a primary source of insight for models of language in the brain. However, deviant language patterns in aphasia may reflect processing limitations and cognitive impairment more than language impairment per se. Here we sought to obtain new evidence from spontaneous speech for the intactness of grammatical knowledge in aphasia, operationalized as the preservation of the basic hierarchical structure of syntactic projections. Speech obtained with the AphasiaBank protocol was analyzed from 20 people with Broca's aphasia (BA) and 20 matched non-brain-damaged controls. We quantified (i) marking of Aspect, Tense, and Modality (A-T-M), which are located at specific (high) layers of the syntactic hierarchy and ordered in relation to one another ([M…[T…[A…]]]); (ii) hierarchies of clausal units ([C…[C]]); (iii) discourse markers embedding clauses, located at the highest layer of the hierarchy; and (iv) attachment of adjuncts at different heights of a given hierarchical syntactic structure. Supplementary evidence was obtained from a typology of errors and from pauses subcategorized according to their hierarchical syntactic position. Results showed that groups did not quantitatively differ on rates of either Aspect or Modality but underproduced Tense and embedded clauses. Evidence for compensatory effects was seen in both of the latter two cases. While all adjunct types were underproduced in BA, and pauses overproduced, both showed the same relative proportions within both groups. Errors were largely restricted to omissions, of a kind that would also be expected in condensed neurotypical speech. Overall, these patterns support the hypothesis of intactness of grammatical knowledge in BA, questioning it as a disease model of language impairment.

Topic Area: Disorders: Acquired

Poster B74 *Thursday, October 6, 6:30 - 8:30 pm EDT, Millennium Hall*

Inferential process of lexical access as evidenced by a mismatch negativity study

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Perception is an inferential process rather than emerging from a purely sensory operation. To derive an optimal interpretation of incoming data, the brain unifies sensory input with prior knowledge and experiences. Research into the neural origins of perception asserts a generative model where top-down predictions modulate the processing of bottom-up sensory input, and principally, stimuli that are predicted elicit a reduced neural response. Despite becoming increasingly influential in cognitive neuroscience, the precise account of these predictive models of perception remains debated. In this study, we aim to contribute to the debate at issue by investigating how neural circuits rely on present and past predictions to facilitate speech perception. Specifically, we look into inferential process of lexical access as involving simultaneous predictions at different domains, inter alia, phonological and semantic. As a working model, we chose prosody that codes not only phonological but also semantic information by special voice modulations, and as such, offers a unified model of bottom-up sensory and top-down inferential processes. Using the Mismatch Negativity (MMN) ERP component that is often referred to as a signature of predictive coding in auditory modality, we examined neural responses to deviations in lexical stress pattern, a structural property of a word that specifies which syllable in the word is more salient, in a passive auditory oddball paradigm. The stimuli were spoken Dutch words, which are segmentally identical but contrastive in their stress patterns, as in canon [ˈkaːnɔn] 'cannon' vs kanon [kaːˈnɔn] 'canon', and pseudo-words, imitating the acoustics of words such as tanon* [ˈtaːnɔn] vs. [taːˈnɔn]. While operating only at the phonological level in pseudo-words, lexical stress pattern leads to a semantic category change besides phonological variation in words. The preliminary results from nineteen native speakers of Dutch indicate MMN responses to both words and pseudo-words. The MMN response to pseudo-words might reflect a prediction error based on the most recent phonological input, which in turn can be explained through neural adaptation and local inhibition of cortical activation. The MMN response to words, on the other hand, is best justified by the unification of previously established semantic memory traces with phonological information. This evidence denotes simultaneous inference from sensory and cognitive sources, and a combination of predictive and integrative functions for a meaningful representation of speech.

Topic Area: Prosody

Poster C1 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Rapid brain network exchanges support the learning of new scientific information: a high-resolution, fused MRI/EEG analytical framework

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To adequately comprehend a written passage, the brain needs to rapidly communicate across multiple systems with the end-goal of storing relevant information in long-term memory. However, due to methodological limitations of single imaging modalities, it is difficult to get a full picture of both where and when these brain interactions occur on the millisecond and millimeter scale. The present pilot study identifies a real-time system of interacting brain networks that support reading and learning from scientific texts. We examined typical adults as they read medical passages in the MRI and, in a separate session, while EEG data was collected. Using a novel application of joint independent component analysis (jICA), we were able to identify corresponding spatial and temporal signals, and consequently track functional networks of passage reading with a high degree of spatial and temporal specificity. Through this “fused” data analysis approach, we isolated the neural progression in the 1000 ms following comprehension of scientific information, and identified how these processes differed between material that was learned vs. not learned (i.e. information recalled after the passage session was complete). Our pilot results reveal that comprehending scientific information is associated with rapid communication between the canonical language network, comprehension areas in the default mode network, domain-general executive and error regions, and hippocampal memory areas. When subjects read information that they later accurately recalled, they showed early activation differences in comprehension regions immediately following the sentence, and these differences were then followed by a later reduction in the long-term memory network. To our knowledge, this is the first study to use a fused analytical approach to gain a high-resolution picture of passage comprehension and related learning. Through this approach, we hope to lay the groundwork for brain-based interventions to enhance learning outcomes in passage comprehension.

Topic Area: Meaning: Discourse and Pragmatics

Poster C2 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Metacognition of language and domain-general abilities after stroke

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Metacognition is the ability to reflect about one’s cognitive and behavioral processes (Nelson and Narens, 1994). It has been suggested that if a patient is aware of their own mistakes, they may be more likely to try to correct them (Robertson and Murre, 1999). Thus, metacognition may well play a crucial role in patients’ recovery. However, the assessment of this ability is usually not part of the set of functions evaluated after stroke. In this longitudinal study, we investigate the extent to which metacognition of language and domain-general abilities is impaired and its involvement on recovery. Methods. Participants: Thirteen (2 female, age: 52-84 years (M=67.77, sd=8.07) patients that had suffered from a first ischemic stroke either in the left or right hemisphere, no more than one week prior, accepted to participate in the first session and continue with the follow-up (LHS: n=4; RHS: n=9). Six participants for

the non-brain damaged (NBD) group, matched in age, sex, education and linguistic profile with the clinical groups, were also recruited. Design and Material: We assess metacognition of domain-general and linguistic abilities after stroke at four time points(TP): within the first week after stroke (TP1), three to four weeks post-stroke (TP2), three months after stroke (TP3), and six months post-stroke (TP4). Subjects in the NBD group are tested in only one session. Participants are administered a set of linguistic (LNG) and domain-general tests (DG: Raven's Colored Progressive Matrices, Digit and Visual Spans) and asked to provide a confidence rating based on a visual scale at the end of each trial (1="very sure", 4="unsure"). One point is given for each correct confidence judgment: when participants report high confidence in trials answered correctly and low confidence in those answered incorrectly. Results: Average of correct confidence judgments show that the NBD group performed better than patients in the linguistic (M=0.98, sd=0.11) and the DG battery (M=0.88, sd=0.32), respectively. Between the brain damaged participants the RH group (LNG TP1: M=0.97, sd=0.14, TP2: M=0.96, sd=0.19; DG TP1: M=0.78 , sd=0.41 , TP2: M=0.77, sd=0.41) performed better than the LH group (LNG TP1: M=0.92, sd=0.26, TP2: M=0.93, sd=0.24; DG TP1: M=0.74 , sd=0.43 , TP2: M=0.71, sd=0.45) at judging their responses in both batteries and TPs. Conclusion: Preliminary data from the small sample presented here show that metacognition is impaired following a first ischemic stroke and appear to indicate that this might be more prominent after LH stroke. Although, the three groups performed similarly in the metacognitive assessment of their responses in the linguistic tasks, a greater difference is seen in their judgments in the DG abilities, where LH and RH participants showed poorer self-awareness of their mistakes. Changes in their metacognitive ability from TP1 to TP2 are not observed. As data collection is ongoing, the analysis of a bigger sample including patients with more evident language deficits and follow-up assessments months after the stroke will allow us to determine whether changes in metacognition are related with performance in linguistic and non-linguistic functions over time during recovery from stroke.

Topic Area: Disorders: Acquired

Poster C3 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Repeatedly experiencing the McGurk Effect drives long-lasting changes in auditory-only speech perception

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Auditory information from the voice of the talker and visual information from the face of the talker provide independent cues about the contents of speech. Cue conflict resulting from audiovisual incongruency can produce unexpected percepts. In the McGurk effect, integration of auditory "ba" and visual "ga" can produce a "da" percept. We report the surprising finding that repeatedly experiencing the McGurk effect results in long-lasting, exemplar-specific changes during auditory-only speech perception. Thirty online participants completed a 16-day experimental protocol. On day 1 ("pre-test") participants reported their perception of 27 auditory-only recordings of "ba", "da" and "ga" syllables from eighteen different talkers, including talkers AM and AN. On days 2 to 15 ("training") participants viewed one minute of McGurk syllables (auditory "ba"+visual "ga") spoken by talkers AM and AN. On day 16 ("post-test") participants reported their perception of the same 27 auditory-only recordings presented during the pre-test. In the pre-test, accuracy was uniformly high, indicating that participants were attentive to the stimuli; "ba" recordings from talkers AM and AN were always perceived as "ba". During training, McGurk stimuli were perceived as "da" on 35% of presentations, with considerable variability across participants (range 0% to 100%). In the post-test, participants accurately reported the identity of the auditory-only syllables with two exceptions. Surprisingly, many participants (12/30; 40%) reported at least one "da" percept in response to the auditory-only "ba" recordings from talkers AM and AN, even though no visual information was presented. For these 12 participants, the rate of McGurk effect during training was four-fold higher than for other participants (66% vs. 14%, p=0.0000042). Our interpretation of these results is that repeatedly experiencing the McGurk effect remapped participants' representation of the auditory component of the McGurk stimulus. The error signal provided by experiencing the McGurk effect led participants to adjust their internal representations so that what was initially perceived as a "ba" became mapped to the "da" region of perceptual space, allowing multisensory integration circuits to minimize the incongruity between the encoded auditory and visual cues. Participants who did not experience the McGurk effect did not show any perceptual remapping during the post-test, demonstrating that simple exposure was not sufficient and the error signal required experiencing the McGurk effect. The phenomenon was specific to individual talkers; the "ba" recordings of talkers AM and AN were perceived as "da", while "ba" recordings from other talkers were unaffected. Importantly, the remapping was unsupervised, since no experimenter feedback was given at any time. The remapped internal representation persisted, so that even when the visual information was absent, auditory "ba" continued to be perceived as "da". The perceptual change endured in two additional testing sessions conducted two weeks and four weeks after the post-test. The long duration and talker-specificity of the phenomenon suggests a possible link to learning the accent of non-native speakers. While initially non-native speakers can be difficult to understand, after repeated interactions, perceivers acquire and retain the ability to understand the accent.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster C4 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Sentence Context and Working Memory Load: Tracking Context Maintenance with ERPs

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Introduction: Language comprehension relies in part on specialized processes, like word decoding, but also on non-linguistic cognitive functions such as working memory. Working memory refers to the mental representation of limited amounts of information that is currently in attentional focus. Working memory is central to language processing and comprehension, as it allows us to keep the current language context in mind, and to use that developing context representation to interpret incoming words. Electrophysiological studies of working memory in which an array of items (such as non-word letter sequences) is briefly displayed to participants and then held in memory over a delay period have observed a slow, negative-going wave (NSW) during the delay (Ruchkin et al., 1990; 1992; 1997). The amplitude of the NSW is thought to reflect the mental representation of the items in working memory, such that a larger amplitude corresponds to higher working memory load. The goal of this study was to use the NSW to investigate changes in working memory load as a function of sentence context, measured during the pause between sentences. Methods: In this study, 30 healthy adult participants listened to sentence pairs while EEG was recorded. The relative working memory load of a sentence can be quantified in a number of different ways. Here, we compared ERPs time-locked to the onset of the pause after Sentence 1 (analogous to the delay period of a working memory experiment) as a function of the following Sentence 1 characteristics: duration (Short vs. Long), predictiveness (Not Predictive vs. Predictive of a specific word), ease of reading (Low Gunning-Fog Index (Easier) vs. High Gunning-Fog Index (Harder)), and average word frequency (Higher Frequency content vs. Lower Frequency content). Previous studies have found the NSW to be broadly distributed across electrode sites, but following from the pattern observed by Ruchkin et al. 1997 in response to auditory stimuli, we focused our analyses on 8 fronto-central electrodes (F3, F4, FC1, FC2, C3, C4, FZ, CZ). Results: The results showed a significant difference in ERP amplitude during the pause between Sentence 1 and Sentence 2 as a function of duration (larger NSW for long than short Sentence 1 trials; $p<0.05$), predictiveness (larger NSW for Sentence 1 trials strongly predictive of a specific word than for unpredictable Sentence 1 trials; $p<0.05$ and ease of reading (larger NSW for relatively difficult to read Sentence 1 trials than for relatively easy to read Sentence 1 trials; $p<0.05$). The comparison as a function of average Sentence 1 word frequency was not statistically significant. Conclusions: These results suggest that the NSW, an ERP component typically associated with working memory maintenance during a delay period following intentional manipulations of working memory load, can be used to track changes in working memory load that result from variability in several

different aspects of language context. The results demonstrate the sensitivity of this neural marker of working memory operations during the comprehension of naturally produced speech.

Topic Area: Control, Selection, and Executive Processes

Poster C5 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Stimulation of the dorsal speech stream improves speech perception performance in adults of all ages

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Normal aging has been associated with increasing difficulties to perceive speech in noise (SPiN). Several studies have shown that this age-related decline can occur in the absence of hearing loss, and that it is associated with changes in the structure and the activity of speech processing areas of the brain [1]. In a previous study, we showed that SPiN could be improved by applying excitatory transcranial magnetic stimulation (TMS) over the left ventral premotor cortex (PMv) [2]. Our results also showed that individuals with lower baseline performance showed the most improvement. These results await replication, however. The objectives of the present study were therefore 1) to confirm whether TMS applied to regions of the dorsal speech stream can improve SPiN performance in young to older adults, and 2) to evaluate the contribution of age, baseline performance, brain structure and brain activity to TMS-induced performance gains in order to understand the mechanisms of action. METHOD. 30 right-handed healthy adults aged 20 to 80 years will be recruited. An auditory syllable discrimination test was used to evaluate SPiN (0 dB SPL). The syllables were pronounced by a fixed talker (low variability condition) or by eight different talkers (high variability condition). MR images were acquired to measure brain structure and activity. Three regions of the left dorsal stream (PMv, superior temporal gyrus – STG, superior temporal sulcus – STS) [3] were used as targets based on each participant BOLD signal pattern while performing the SPiN test in the MRI scanner. A sham stimulation was also included. In the lab, the SPiN test was administered after each stimulation (real or sham). Linear mixed models were computed on a preliminary sample of 16 participants aged 21 to 73 years old ($M = 52.01$) to examine the effects of age, baseline performance, and talker variability on accuracy and reaction time gains (post TMS – baseline). RESULTS. The results indicate that participants with lower baseline performance showed the most improvement on accuracy (main effect, $F(1, 66) = 111.08$, $p = <.001$). Participants with longer baseline reaction times (RT) showed stronger reductions after TMS to the STG or the PMv (Target x Baseline, $F(2, 75) = 3.90$, $p = .025$). An age effect was found after TMS to PMv, in the multiple talker condition: younger adults showed more improvement in accuracy than older adults (Age x Target x Talker variability: $F(2, 66) = 5.20$, $p = 0.008$). CONCLUSION. The results replicate our recent study suggesting that those with lower performance benefit more from TMS. This supports the relevance of further investigating TMS as a potential rehabilitation tool to reduce SPiN difficulties in aging. The final results, which will include the structure and activity within the targeted regions, will clarify the mechanisms of action. [1] Tremblay, Brisson & Deschamps (2021). Neuroimage. [2] Brisson & Tremblay (2021). B&L. [3] Hickock & Poeppel (2007). Nat Rev Neurosci.

Topic Area: Speech Perception

Poster C6 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

The Influence of Concreteness of Morphome on the Integration of Compound Words：Evidence from Event-Related Potential

Wenqi Cai[1], Yun Qi[1], Fakun Chen[1], Rui Zhang[1], Xiaojuan Wang[1], Jianfeng Yang[1]; [1]Shaanxi Normal University

Previous electrophysiological studies offered ample evidence of the activation of morpho-semantic information in the early stage of visual compound word recognition. However, the neurophysiological mechanisms underlying subsequent integration after morpho-semantic activation have not been fully elucidated yet. In particular, little is known about what and how morpho-semantic information involves in semantic integration processing. With the event-related potential (ERP) technology and a within-participants design of 2 (morphemic concreteness: concrete vs. abstract) × 2 (semantic transparency: transparent vs. opaque), the present study investigated the neural dynamic activation process of morphemic perceptual-motor features and how they are involved in semantic integration processing, to further reveal the essence of morpho-semantic integration. Participants were instructed to complete a visual lexical decision task. ERP results found that the concreteness effect appeared in both the first and second morphemes processing, preliminarily proving the activation of perceptual-motor features in morphemic decomposition. Specifically, the first concrete morphemes induced a smaller P250 amplitude than the first abstract morphemes in the right electrode sites; the second concrete morphemes induced a smaller N400 amplitude than the second abstract morphemes in the posterior electrode sites. Semantic transparency effect was found in the second morpheme processing, manifested in that transparent compound words evoked smaller N400 amplitude than opaque compound words in the whole-brain electrodes sites. It suggested that the activation of the meaning of transparent morphe- mes could facilitate the compound processing because the integrated meaning was relatively similar to the stored meaning, while the integrated meaning conflicted with the stored meaning in the processing opaque compound words. More importantly, there was a significant interaction between semantic transparency and morphemic concreteness in the processing of second morphemes, manifested in that transparent compound words containing concrete morphemes induced smaller N400 amplitude than transparent compound words containing abstract morphemes, and exhibited no significant difference in amplitude between opaque compounds containing concrete morphemes and opaque compounds containing abstract morphemes. The results showed that the perceptual-motor features of morphemes were involved in the coherent morpho-semantic integration and abundant perceptual-motor features of morphemes facilitated the acquisition and integration of whole-word semantic representations. Transparent compound words containing concrete morphemes activated more perceptual-motor features which overlapped with whole-word features, thus the integration of perceptual-motor features of morphemes could further facilitate the acquisition of whole-word semantic representations. The results provided direct evidence for the involvement of morpheme perceptual-motor features in morpho-semantic integration processing at the neurophysiological level, and enriched the neural mechanism research of visual compound word representation processing.

Topic Area: Meaning: Lexical Semantics

Poster C7 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Brain activity in Hindi & Nepali reflects language-adapted processing strategies

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[INTRODUCTION] A major goal of the cognitive neuroscience of language is to identify the neural substrates of syntax. However, “syntax” covers an array of processes and representations that vary between languages. Here, we leverage similarities and differences between two subject-object-verb languages with different agreement systems, Hindi and Nepali. In Hindi, verbs agree with the first NP that does not have a case suffix (‘bare’). In Nepali, verbs agree with the subject regardless of case. In two parallel MEG studies, we show that case features affect MEG activity in anterior perisylvan frontotemporal regions in both languages before the verb. In Nepali, only object NP case affects this activity. In Hindi, activity in right regions demonstrate an interaction of subject and object case, with greater negative activity in sentences with one bare NP. We suggest right frontotemporal regions facilitate selection of an agreement controller. Broadly, these results demonstrate that comprehenders make maximal use of available information as a function of the language-specific syntactic rules, which is directly reflected in brain activity. [METHODS] MEG activity of

22 Hindi and 18 Nepali speakers was continuously recorded. Participants read 46 (Hindi) and 50 (Nepali) three-word sentences per condition distributed in a within-subjects 2×2×2 design, manipulating SubjC (ERG/BARE), ObjC (DAT/BARE), and Verb Cloze (HIGH/LOW). Verb Cloze was included as an "N400" design as a validity check. Each phrase was presented using rapid serial visual presentation (RSVP) and involved a picture verification task. [RESULTS] Regressions by participant were conducted in object NP (0ms–1000ms) and verb (1000ms–2000ms) time windows, consisting of the critical manipulations (object NP: SubjC × ObjC; verb: Verb Cloze) and nuisance variables. One-sample t-tests were conducted over the resulting beta values, and spatiotemporal cluster tests were conducted over t-values in 3 time windows (object NP: 300-600ms; 600-900ms; verb: 300-500ms) in bilateral frontotemporal regions (object NP time window) and left temporal lobe (verb time window). We then fit a linear mixed effects model to the activity in each for both languages for each cluster, including factors of interest (object NP: SubjC × ObjC; verb: Verb Cloze), a between-subject factor Language and its interactions, and random effects. [OBJECT NP] A cluster ($p < 0.0001$) located in right anterior temporal, inferior frontal, and ventromedial prefrontal cortex ~500ms post-NP onset showed greater negative activity in conditions with one bare NP in Hindi, reflected as a three-way interaction between SubjC×ObjC×Language ($p = 0.01$). A spatially and temporally overlapping cluster ($p < 0.001$) showed a main effect of object case, with greater positive activity for bare object NPs in both languages ($p = 0.02$). [VERB] A cluster ($p = 0.01$) located in left anterior inferior temporal lobe ~400ms showed a main effect of Verb Cloze ($p < 0.01$). [CONCLUSION] Superficially-similar structures may provide different information to the comprehender depending on the grammatical rules of their language. Brain activity reflects how comprehenders make maximal use of this information.

Topic Area: Syntax

Poster C8 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Selective neuronal tuning to spoken words in the dorsal auditory stream

Lillian Chang[1], Srikanth Damera[1], Xiong Jiang[1], Josef Rauschecker[1], Maximilian Riesenhuber[1]; [1]Georgetown University Medical Center

Cortical models of auditory processing (Rauschecker & Scott, Nat Neurosci, 2009; Hickok & Poeppel, Nat Rev Neurosci, 2007) propose a dual-stream architecture consisting of anteroventral and dorsal streams, respectively. In the context of auditory speech processing, the ventral, "what" pathway is specialized for spoken word recognition, and recent evidence supports the existence of an auditory word form area (AWFA) in the anterior superior temporal cortex (aSTC) that contains neuronal populations tightly tuned to whole spoken words (DeWitt & Rauschecker, PNAS, 2012; Damera et al., Soc Neurobiol Lang, 2019). The AWFA parallels the well-established visual word form area (VWFA), an analogous region with lexical representations for written words in the ventral visual stream. In contrast, the dorsal, "how" stream is thought to subserve speech production through the mapping of speech sounds to their motor articulations (Rauschecker, Hearing Res, 2011; Hickok et al., Neuron, 2011; Chevillet et al., J Neurosci, 2013). Two key areas in the dorsal stream hierarchy for sensorimotor integration of auditory speech are the posterior superior temporal cortex (pSTC) and the premotor cortex (PMC; Wilson et al. Nat Neurosci, 2004). We previously reported effective connectivity from the pSTC to the PMC when listening to speech sounds, thought to reflect the mapping of these sounds to their motor articulations (Chevillet et al., J Neurosci, 2013). We here hypothesized a hierarchical representation for auditory words in the dorsal auditory stream, with a sublexical representation in the pSTC (paralleling our earlier finding of a sublexical representation for written words in the pSTC, Glezer et al., NeuroImage, 2016; Brain Lang, 2019) and a lexical representation in the PMC. To test our hypotheses, we first conducted localizer scans to identify the pSTC and PMC ROI individually in each of N=23 subjects. We then conducted two fMRI rapid adaptation (fMRI-RA) experiments with auditorily presented real words (RWs) and novel pseudowords (PWs; i.e., unfamiliar nonwords), respectively. In these experiments, two words of a single stimuli category (RW or PW) were presented in quick succession; they could be identical (SAME), differ by a single phoneme (1PH), or share no phonemes at all (DIFF). Supporting our hypotheses, we found patterns of release from adaptation in the PMC compatible with an auditory lexicon in the dorsal stream, with significant adaptation effects for RWs (SAME vs. DIFF: $p=0.0013$; SAME vs. 1PH: $p<0.001$; but no significant differences between 1PH and DIFF, $p=0.547$, indicating full release from adaptation already for two words differing by a single phoneme) but not for PWs, replicating our earlier results for the AWFA in the anteroventral stream. In contrast, there was a gradual release from adaptation in the pSTC compatible with a sublexical representation (SAME vs. 1PH: $p<0.001$; 1PH vs. DIFF: $p=0.021$; SAME vs. DIFF: $p<0.001$). Our findings therefore support the the proposed "inverse" model mapping speech sounds to their motor articulations in the dorsal auditory stream, starting with sublexical representation in the pSTC and culminating in an articulatory lexicon in the PMC.

Topic Area: Speech Perception

Poster C9 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Deriving syntactic structure from novel noun-noun compounds

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Noun-noun compounds (NNCs, e.g., 'orange juice') are expressions generated from two root nouns (generally, modifier: 'orange', and head: 'juice') that act as one complex noun. While known NNCs' meaning is learned, the interpretation of novel NNCs (e.g., 'coffee tension') relies on deriving the relation between the word constituents in the absence of syntactic cues. Previous studies investigating relational NNCs (i.e., NNCs where the nouns have a predicating relation), exclusively focused on the categories of relations that link the meanings of the constituent nouns (e.g., location relation: 'mountain cloud'; cause relation: 'college headache'). In our study, we adopted an approach that specifically investigates the syntactic relations between nouns in novel relational NNCs. In NNCs, the head is the subject of the underlying 'sentence', which can be in the active voice (e.g., 'headache tension' is: 'tension that causes a headache') or in the passive voice (e.g., 'coffee tension' is: 'tension that is caused by coffee'). Here, we asked whether lexical-semantic features of NNCs (i.e., differences in frequency, agentivity and imageability between the constituents, and semantic similarity) predict their specific syntactic interpretation (i.e., active/passive). To address this question, we created a stimulus set consisting of 438 novel NNCs that span the distributions of the above linguistic features. In an online behavioral study, we collected free interpretations of our NNCs dataset from 147 participants (~20 participants for each NNC), along with RTs and eye-movements. Participants' free interpretations show that agentivity and imageability are significant predictors of active/passive voice. In particular, the higher the agentivity difference between modifier and head, the more likely the underlying sentence is built in the passive voice. In addition, when both the head and modifier have high imageability, the underlying sentence is more likely built in the passive voice, suggesting that perceptual properties might also guide syntactic interpretation. None of the other lexical-semantic features were significant predictors of the syntactic relations. The RTs and eye-movement results show that participants spent more time and made more eye-movements between the two words when building the underlying structure in the passive voice. We interpret these results in light of the 'agent-first' strategy in sentence processing, which suggests that sentential subjects tend to be interpreted as agents: we hypothesize that heads of NNCs (which are subjects of the underlying sentence) are initially interpreted as agents, and only later reanalyzed as patients/themes, when the modifier has relatively higher agentivity compared to the head. Overall, our findings demonstrate that syntactic relations between the nouns in NNCs are determined by constituents' agentivity and imageability. Furthermore, behavioral results suggest that the thematic role of the head is reanalyzed in the context of passive interpretation.

Topic Area: Syntax

Poster C10 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Longitudinal analysis of speech and language measures of patients with mild

cognitive impairment and amyloid positivity

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Introduction: Previous studies have shown that patients with mild cognitive impairment (MCI) show language impairments, including deficits in lexical semantic retrieval, word comprehension, and verbal fluency. However, previous studies on language impairment in MCI rarely use a biological definition of MCI due to Alzheimer's disease (AD), indicated by amyloid-beta positive (Aβ+) biomarkers, limiting the validity of language measures for longitudinal monitoring of disease progression in AD. In this study, we investigated longitudinal speech samples provided by patients with MCI Aβ+ to examine how their language performance changes over time compared to that of cognitively normal (CN) volunteers. Methods: We analyzed longitudinal speech samples of digitized picture descriptions produced by 117 CN participants and 11 patients with MCI who were Aβ+ based on CSF Aβ42 levels (<192). Groups were matched on age and sex ratio, but not on education level ($p=0.033$). Recordings were orthographically transcribed and analyzed with our automated lexical and acoustic pipelines. The lexical pipeline tagged part-of-speech (POS) of all words and rated words for several lexical measures (e.g., concreteness, frequency). The acoustic pipeline segmented recordings into speech and pause segments and calculated several durational measures. For each speech or language measure, we built a linear mixed-effects regression model, where the speech measure was included as a dependent variable, and time, group, and the interaction of time and group were included as fixed effects. Individual participants were considered as a random effect, and picture type and education level were included as fixed effects. The CN group was the reference group in all models. Results: The MCI Aβ+ patients produced fewer grammatical particles over time (group x time: $\beta=-0.07$, $p=0.016$), whereas the CN participants produced more particles over time ($\beta=0.06$, $p=0.031$). Also, patients with MCI Aβ+ produced more partial words over time (group x time: $\beta=0.15$, $p<0.001$), whereas partial word count of the CN participants did not change over time ($p=0.52$). Similarly, patients with MCI Aβ+ repeated words more frequently over time (group x time: $\beta=0.23$, $p<0.001$), whereas the repetition frequency of CN participants did not change ($p=0.78$). The groups did not differ on other lexical measures. As for the durational measures, patients with MCI Aβ+ paused longer on average over time (group x time: $\beta=0.02$, $p<0.001$), whereas the mean pause duration of the CN participants decreased ($\beta=0.01$, $p=0.007$). The MCI Aβ+ group exhibited less speaking time out of total duration over time (group x time: $\beta=-0.35$, $p=0.018$), whereas the proportion of speech for the CN group did not change over time ($p=0.488$). Lastly, the MCI Aβ+ patients produced fewer words per minute over time (group x time: $\beta=2.26$, $p<0.001$), whereas the CN group produced more words per minute over time ($p=0.002$). Conclusion: Speech and language features extracted from one-minute picture descriptions produced by patients with MCI Aβ+ showed different longitudinal trajectories compared to those of the CN participants, suggesting that our automated measures may provide objective, non-invasive, and sensitive speech biomarkers for longitudinal monitoring of patients with MCI and for detection of early-stage AD.

Topic Area: Disorders: Acquired

Poster C11 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

The role of research design in the reproducibility of L1 and L2 language networks: A review of bilingual neuroimaging meta-analyses.

Lindy Comstock[1]; [1]UCLA

The functional organization of first (L1) and second (L2) language processing in bilinguals remains a topic of great interest to the neurolinguistics community. Today, papers investigating L1 and L2 language processing in bilinguals number in the hundreds, allowing for no less than six neuroimaging meta-analyses devoted to aspects of bilingual language use (Cargnelutti, Tomasino, & Fabbro, 2019; Indefrey, 2006; Liu & Cao, 2016; Luk, Green, Abutalebi, & Grady, 2012; Sebastian, Laird & Kiran, 2011; Sulpizio, Del Maschio, Fedeli, & Abutalebi, 2019). It is well known that meta-analyses are a reliable method to increase the statistical power and generalizability of fMRI findings, such that differences in L1 and L2 processing that may be too subtle to be detected in individual fMRI studies should become apparent in a meta-analysis. But why then is there still little consensus between the reported findings of even the most recently published (and therefore, most highly-powered) meta-analyses? While weaknesses stemming from limitations in the literature, such as the absence of a common method to define and measure descriptive categories like proficiency level, degree of language exposure, and AoA are often cited, an equally plausible explanation lies in a lack of understanding about the technical differences in how meta-analyses are conducted. These details are often given minimal attention, elided from the method section, or are not stated in a manner that the general public may easily recognize or understand. Moreover, the specific nature of many research questions in neurolinguistics has facilitated experimental paradigms that defy easy categorization or comparison, frequently leading to the combination of data types that are not compatible in effort to increase the size of the overall data set. Ultimately, an aggregation of substantially different data types may weaken the validity of meta-analysis findings. This presentation begins with a review of the key factors by which meta-analyses may differ, including data types, task designs, thresholding, and analysis strategy. Next, how these methodological choices can affect the results of a meta-analysis is explained, and a case is made for greater attention to task categorization. Finally, some results of a task-based meta-analysis are presented (Comstock & Oliver, 2021).

Topic Area: Methods

Poster C12 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

The P600 and explicit memory formation

Friederike Contier[1], Melissa Höger[1], Milena Rabovsky[1]; [1]University of Potsdam, Germany

The P600 event-related component is elicited by a wide range of anomalies during sentence comprehension, such as grammatical and semantic violations, structural ambiguities, and even spelling errors, and remains important for neurocognitive models of language comprehension (e.g., Kuperberg, 2021, Top. Cogn. Sci.). A recent hypothesis proposes that the P600, similar to the earlier domain-general P3, reflects phasic norepinephrine (NE) release from the locus coeruleus (LC) to salient stimuli that need selective attention and behavioral adaptation (e.g., Bornkessel-Schlesewsky & Schlesewsky, 2019, Front. Psychol.). Importantly, phasic release of norepinephrine plays an important role in explicit memory formation since the LC innervates limbic structures that are involved in consolidation of long-term memory (Sara, 2009, Nat. Rev. Neurosci.). If these late positivities indeed reflect phasic norepinephrine release from the LC, an enhanced amplitude should thus lead to stronger explicit memory formation. Indeed, the P3 amplitude to a stimulus is predictive of later recall of that stimulus (e.g., Karis et al., 1984, Cogn. Psychol.). This ERP study investigates whether the P600 amplitude similarly relates to explicit memory formation. In the encoding phase, participants (N = 38) will read 240 sentences word by word including a critical target noun that is either morphosyntactically violated (incorrect article), semantically deviant, or correct and semantically fitting. Within this task, we expect that both morphysyntactic and semantic violations will elicit larger amplitudes than controls between 600-900 ms relative to target word onsets at parietal sites (P600 effect). In a subsequent word recognition task, participants will judge whether a particular word (seen target vs unseen word) appeared in a sentence during the encoding phase or not (Y/N) and how certain they are of their answer (likert scale). Seen targets should be more likely to be recognized than unseen words. Crucially, within seen targets, recognition should be positively predicted by the P600. That is, both recognition accuracy and certainty should be better for words that elicited larger P600 amplitudes during the encoding phase. We will additionally explore whether this is the case for both semantic and morphosyntactic violations. We will use linear/logistic mixed effects models, taking into account that the effect of interest might vary across participants and/or items. Data collection will start in June and we expect to present preliminary results at the 2022 SNL meeting. Since the explicit memory effect is a prediction of a specific

neurobiological theory of the P600, observing this effect would further link the component to the LC/NE system and the P3, possibly suggesting a more domain-general nature of the component. In addition, it would suggest down-stream consequences in that the brain response that deals with salient and anomalous aspects in the linguistic input in the moment will also be involved in keeping this event available for later recall.

Topic Area: Control, Selection, and Executive Processes

Poster C13 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam C session.

Familiarity and iconicity impact lexical access in LSE (Spanish Sign Language)

Brendan Costello[1], Chiara L. Rivolta[1,2], Núria Sánchez[1,2], Francisco Vera[1,3], Marcel Giezen[1]; [1]BCBL (Basque Centre on Cognition, Brain and Language), [2]University of the Basque Country (UPV/EHU), [3]Universidad Rey Juan Carlos

Research into the processing of sign languages is limited by the unavailability of lexical characteristics (or large corpora) for most sign languages. Lexical databases for British Sign Language (BSL) and American Sign Language (ASL) include measures such as familiarity and iconicity ratings or phonological neighbourhood density (Vinson et al., 2008; Sehyr et al., 2021). As part of an ongoing project to expand the Spanish Sign Language LSE-Sign database, a lexical database with 2400 LSE signs (Gutiérrez-Sigut et al., 2016), we collected familiarity and iconicity ratings from 90 deaf signers (half of whom were native signers) for a subset of 300 lexical signs in the database. These signs were chosen to be representative of the full database (in terms of phonological form) and to include a broad range across the frequency and iconicity dimensions; additionally, 200 of the signs had meanings represented by an image in the Multipic database (Duñabeitia et al., 2018). The familiarity ratings show a broadly normal distribution whereas the iconicity ratings tend toward a binomial distribution, with signs being rated as either highly iconic or not iconic. The data reveal a negative correlation between familiarity and iconicity, confirming a pattern found for other sign languages (Sehyr et al., 2021). [We are currently in the process of collecting iconicity ratings for these 300 signs from sign-naïve hearing individuals to examine how experience with a sign language influences the perception of iconicity. Additionally, we are developing a measure of phonological neighbourhood density and hope to be able to report the results of this analysis also.] To examine the impact of these lexical properties on sign processing, we carried out a lexical decision task with 200 of the rated signs plus 200 pseudosigns (created by changing the handshape, location or movement of a real sign so that it no longer had a meaning). Results from forty-two deaf signers (half of whom were native signers) showed a clear lexicality effect: responses to real signs were faster and more accurate compared to pseudosigns. Analysis of the responses to real signs revealed a facilitatory effect of familiarity: signs with higher familiarity ratings had more accurate and faster responses (with no difference between native and non-native signers). Iconicity was also associated with greater accuracy, but the effect on reaction times depended on sign language background: native signers – but not non-native signers – responded faster to iconic signs. [We also collected data on a picture naming task for these 200 signs from the same participants and will be able to report the results of this study. We also intend to incorporate the phonological neighbourhood density index into the analysis of the lexical decision and the picture naming responses.] These results reveal that lexical access in a signed language bears similarities to spoken language access – we see typical lexicality and familiarity effects – but there are also modality-specific effects: iconicity impacts how signs are processed, and native signers appear to be more sensitive to this visual property than non-native signers.

Topic Area: Signed Language and Gesture

Poster C14 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam C session.

Graded Functional Organization in the Left Inferior Frontal Gyrus: Evidence From

Task-Free Functional Connectivity And Task-Based Coactivation

Veronica Diveica[1], Michael Riedel[2], Taylor Salo[3], Angela Laird[2], Rebecca Jackson[4], Richard Binney[1]; [1]School of Human and Behavioural Sciences, Bangor University, [2]Department of Physics, Florida International University, [3]Department of Psychology, Florida International University, [4]MRC Cognition and Brain Sciences Unit, University of Cambridge

The left inferior frontal gyrus (IFG) has been associated with various cognitive functions, including language, executive control, and social cognition. One possibility, therefore, is that IFG subregions will reveal multiple functional specialisations. For instance, within the cognitive domain of language, functional distinctions have been proposed between the anterior IFG, thought to support semantic processes, and the posterior IFG, which has been associated with phonological processing. However, the organisation of this region and the degree to which functional differentiation occurs in a discrete or graded pattern is unclear. The aim of the present study was to explore the functional organisation of the left IFG using a data-driven approach. To this end, we first used diffusion embedding to extract connectivity gradients from 1) the resting-state fMRI timeseries of 150 participants from the Human Connectome Project, and 2) task-constrained whole-brain activation patterns across a range of tasks and cognitive domains obtained from a large database of activation coordinates. In a second step, we characterized the resulting gradients by performing seed-to-brain resting-state functional connectivity and meta-analytic coactivation modelling analyses on hard clusters extracted from the gradient maps. This allowed us to identify the connectivity patterns that drive the functional organization of the left IFG. Both datasets revealed a connectivity profile that shifted in a graded fashion along two principal organizational axes. An anterior-posterior connectivity gradient shifted from being preferentially associated with the default-mode network (anterior IFG) to ventral attention and sensorimotor networks (posterior). A second dorsal-ventral axis was characterized by higher connectivity with the frontoparietal control network on one hand (dorsal IFG), and preferential connectivity with the semantic network, on the other (ventral). These results provide novel insights into a graded organisation of the left IFG and suggest that it functions as an interface between distinct large-scale networks, with different subregions preferentially supporting the controlled access and manipulation of information in different cognitive domains. During linguistic and semantic processing, the connectivity of the anteroventral region might allow the context- and task-appropriate retrieval of conceptual knowledge.

Topic Area: Control, Selection, and Executive Processes

Poster C15 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Face-to-face spatial orientation fine-tunes the brain for neurocognitive processing in conversation

Linda Drijvers[1], Judith Holler[1,2]; [1]Max Planck Institute for Psycholinguistics, [2]Donders Institute for Brain, Cognition & Behaviour

Orienting spatially towards one another for communication is rare in non-human animals but the default mode for communication in our species. We here put forward the radical hypothesis that this socio-spatial orientation in itself induces a special 'social mode' for neurocognitive processing during conversation, even in the absence of visibility. Participants conversed face-to-face, face-to-face but visually occluded, and back-to-back to tease apart effects caused by seeing visual communicative signals and effects caused by spatial orientation alone. Using dual-EEG, we found that 1) listeners' brains engaged more strongly while conversing in a face-to-face than in a back-to-back spatial orientation, irrespective of the visibility of communicative signals, 2) listeners attended to speech more strongly in back-to-back compared to face-to-face spatial orientation without visibility; visual signals further reduced the attention needed; 3) the brains of interlocutors were more in sync in a face-to-face compared to a back-to-back spatial orientation, even when they could not see each other; visual signals further enhanced this pattern. Communicating in face-to-face spatial orientation is thus sufficient to induce a special 'social mode' which fine-tunes the brain for neurocognitive

processing in conversation.

Topic Area: Meaning: Discourse and Pragmatics

Poster C16 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Interactive gestures as response mobilizing cues? Evidence from corpus, behavioral, and EEG data

Alexandra Emmendorfer[1,2], Anna Gorter[3], Judith Holler[1,2]; [1]Donders Institute for Brain, Cognition, and Behaviour, [2]Max Planck Institute for Psycholinguistics, [3]Radboud University

In face-to-face communication, speech is often accompanied by co-speech gestures. There is a growing body of experimental research dedicated to the processing of multimodal language relating to representational gestures, which depict actions and objects or point towards fictive referents (e.g., ter Bekke et al., 2020) or beat gestures, which are visual indicators of emphasis (e.g., Biau et al., 2018). However, non-representational interactive gestures (Bavelas et al., 1992; 1995) remain largely unexplored, especially regarding their potential effect on comprehension. Interactive gestures are thought to aid in the coordination of dialogue, for example by referring to the addressee with an addressee-directed point, or with an open hand, palm facing up (palm-up open hand, PUOH) or by presenting information to the addressee with an open hand, palm to the side (palm lateral, PL). We aim to explore whether interactive gestures may act as response mobilizers by making the addressee “feel addressed”, thus leading to faster responding/response planning, a vital component of language use in conversational turn-taking (Levinson, 2016). We do so by examining data from a multimodal corpus of Dutch conversations, and developed behavioral and EEG experiments to test our hypotheses. Corpus analysis of 1692 questions (requests for information) revealed 8.3% of questions were accompanied by non-representational gestures, with the majority of these gestures falling in the category of palm-up open hand gestures (PUOH 47.1%). Following prior observations that questions with gestures get faster responses (Holler et al., 2018, ter Bekke et al., 2020), we examined whether this was also the case for non-representational gestures using a subset of the interactive gesture forms (pointing, n = 23; PUOH, n = 35; PL, n = 9). While a small difference in median turn gap duration was observed, where questions with these interactive gestures received faster responses (median turn gap: 364ms) compared to questions without gestures (median turn gap: 425 ms), this was not statistically significant. Given that the corpus data contains a multitude of overlapping visual and auditory signals, and the relatively small number of observations for these specific gesture forms, an effect of interactive gestures on response time may be masked by other signals. We therefore designed two experimental studies (online behavioral, EEG) to investigate whether interactive gestures influence response time in a controlled experimental setting. In both experiments participants respond to 240 polar questions (yes/no) by means of button press. Questions are asked by an animated avatar, allowing full control over bodily signals. In 120 questions, the question is accompanied by one of 3 gestures: pointing (40), PUOH (40), and PL (40). The remaining 120 questions were not accompanied by a gesture and served as the control condition. We hypothesize faster responses in questions with interactive gestures compared to the no gesture controls, and explore whether this differs for the different gesture conditions. EEG analyses will focus on the lateralized readiness potential (LRP), providing an indicator of how early these differences in response preparation arise. Data collection will launch in June, and we expect to present preliminary results at the SNL meeting.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster C17 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Using natural language processing to examine word frequency in spoken vs. written English

Ann Marie Finley[1]; [1]Temple University

People convey messages in writing and speaking in fundamentally different ways. Yet, much of our understanding of spoken language rests on written language norms. In part, this is because until recently, the scope and size of spoken language corpora were considerably limited relative to written language corpora. Recent advances in natural language processing and the rise of podcasting have intersected to create a sample of spoken language data readily available for research. We report the steps we took to create a podcast-derived spoken word frequency dataset and contrast spoken vs. written English word frequencies. First, we identified a large spoken language podcast corpus consisting of audio files and transcriptions for 105,360 episodes of English-language podcasts. We developed custom data processing and cleaning pipelines using the R programming language and ran all scripts using a high-performance interactive-use server. We then used the 'quanteda' R package to convert the cleaned texts into a corpus object that we tokenized into single words. We transformed this word vector into a document-feature matrix and calculated word frequency for 110,168 words, drawn from a corpus of 622,115,467 spoken words. We calculated word frequency using the Zipf scale, which implements a scale of 1 (e.g., low frequency) to 7 (e.g., high frequency). To compare spoken vs. written English word frequencies, we applied the same cleaning processes to a comparable corpus of written English. This yielded written word frequency data for 191,495 unique words drawn from a corpus of 641,410,953 total words. We hypothesized that word frequency would differ between spoken and written English. We examined word frequency by modality using the 108,948 words with frequency measures present in both the spoken and the written corpora. We first compared the proportion of high:low frequency words in written vs. spoken English. Using the Jaccard similarity index, we found that spoken and written English contain roughly similar proportions of high:low frequency words (two-sample z test with a Yates continuity correction yielded = .05: X2 = 3.72, df = 1, p = 0.97, 95% CI = [2.6e-03, 1]). Next, we examined whether a greater proportion of spoken vs. written words would overlap across modalities (e.g., occur at least once in each modality). We found that our prediction was supported (two-sample z test with a Yates continuity correction; significant at = .05: X2 = 61,501 with df = 1, p < .001, 95% CI = [0.42, 1]. Finally, we used the Wasserstein distance to compare word frequency by modality. We found that word frequency distribution differed by modality (Wasserstein distance d significant at p < 0.0001* for all contrasts (e.g., full distribution, 40,000 most frequent words; 40,000 least frequent words; overlapping words). Our results indicate that word frequency differs by language modality across many different contexts and genres. Additionally, it seems that the effect of modality on word frequency depends on the relative frequency of the word in question. Future research should include more fine-grained analyses to examine interaction effects of modality within different contexts and genres.

Topic Area: Computational Approaches

Poster C18 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Examining visual word recognition and composition in natural reading with eye movements: A co-registered MEG and eye-tracking study

Graham Flick[1,2], Liina Pylkkänen[1,2]; [1]New York University, [2]NYUAD Research Institute

Eye movements during reading are influenced by the linguistic and cognitive demands of what is being read, indicating that the brain networks controlling eye movements, and those controlling the recognition and integration of individual words, must cooperate. Historically, however, neuroscientific studies of reading have tended to present stimuli in rapid serial visual presentation (RSVP), eliminating eye movements. This makes it unclear if neurocognitive accounts of reading, when informed by RSVP studies, generalize to the natural behavior of interest. Co-registered eye-tracking and electroencephalography (EEG, e.g., Kretzschmar et al., 2015), or functional magnetic resonance imaging (fMRI, e.g., Henderson et al., 2015), studies have begun to address this issue, but each suffers from a weakness in spatial (EEG) or temporal (fMRI) resolution. Magnetoencephalography (MEG), when source estimation is informed by structural MRIs, is a promising alternative, providing high temporal and relatively high spatial resolution to characterize neural activity during reading. In this work, we are using co-registered MEG and eye-tracking to examine visual word recognition in natural reading and directly contrasting it, within the same individuals, with word recognition in RSVP. In primary analyses, we are examining the influence of predictability and lexical frequency on neural responses to words, localized to occipitotemporal areas that support visual word recognition. Participants in this study complete three components while concurrent eye-tracking and MEG data are collected: (1) a localizer to isolate stages of visual word recognition in occipitotemporal cortex (Gwilliams et al., 2018; Flick et al., 2021); (2) a factorial design manipulating frequency and predictability of words within 432 target sentences, read naturally and in RSVP; and (3), a story-reading task consisting of short stories from the Natural Stories Corpus (Futrell et al., 2021), presented one paragraph at a time and read naturally. With synchronized pulses and a photodiode to ensure accurate timing, we are extracting MEG responses following the onset of individual fixations and using distributed minimum-norm estimation to localize these responses to each individual's cortical surface. Each component of the MEG protocol is then designed to test specific hypotheses concerning these responses. First, the initial localizer will be used to examine the consistency of evoked responses and assess how these may differ between sentence reading in RSVP and reading with eye movements. Second, the factorial manipulation of predictability and frequency will be used to examine correlates of top-down and bottom-up influences on visual word processing, with a particular focus on whether activity localized to the left fusiform gyrus, proposed to house a bottleneck on visual word recognition (Woolnough et al., 2021), can explain variability in fixation times. Lastly, the story reading task will provide a large sample of fixation-related response data, localized to the cortical surface, which will be used to compare different operational definitions of predictability (e.g., word number, cloze, linguistic surprisal) and their correlates. In this way, our approach aims to provide a highly informative and comprehensive dataset of brain responses during natural reading, which we hope can be used to test numerous extant hypotheses concerning the brain basis of reading.

Topic Area: Reading

Poster C19 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Depth of pre-activation in predictive processing: comparing monolinguals and bilinguals

Agnes Gao[1,2], Tamara Swaab[1,2], Matthew Traxler[1,2]; [1]University of California Davis, [2]Center for Mind and Brain

Monolinguals engage in context-based predictive processing, which pre-activates the semantic and perceptual features of the upcoming word (Brothers et al., 2016). Getz & Toscano (2019) showed that specific top-down lexical predictions can pre-activate phonological features prior to word onset (e.g., voice onset time), and can override the bottom-up ambiguous input. In particular, the N1's sensitivity to an ambiguous /b-p/ sound disappeared when listeners were expecting to hear /p/ as in "park" following the highly associated prime word "amusement", and moreover, the N1 to an ambiguous /b-p/ sound resembled the N1 to an unambiguous voiceless /p/. In comparison, bilinguals have limited predictive abilities, and past research has shown that pre-activation in bilinguals only occurs at the semantic level. This could be because bilinguals need a global language context to select the contextually appropriate language to pre-activate more specific word features other than meaning (Hoversten & Traxler, 2016). To investigate this hypothesis, we will test bilingual pre-activation of phonological features in single word context versus in sentence-level context. In Experiment 1, I will replicate the cross-modal priming paradigm of Getz et al. (2019) in proficient Spanish-English bilinguals. The prime will be presented visually, and the target will be presented acoustically. All targets will have stop consonants as onsets, and the VOTs will be manipulated to be short, intermediate (ambiguous) or long. There will three conditions: 1) association: the prime will be highly associated with the target (e.g., amusement PARK); 2) neutral: the prime will not be associated with the target (e.g., finger PARK); 3) masked: the prime will be a non-word letter string (e.g., xxxx PARK). I will measure the N1 to index VOT perception and the N400 to index the comprehension of semantics. I expect bilinguals to show sensitivity to VOT changes in the

N1 in all three conditions, since VOT will not be pre-activated at the word level; however, bilinguals will show slightly reduced N400 effect to the ambiguous target word in the association condition, since word meaning will be pre-activated. In Experiment 2, each associated word pair will be embedded in a critical spoken sentence, preceded by a high or low constraint written discourse context. When provided with a high constraint context and a global English context, proficient bilinguals will show native-like patterns. Specifically, they will no longer show the linear N1 sensitivity to VOT changes, as the phonological feature will be pre-activated, which will override the bottom-up ambiguous input. Also, the N400 to the ambiguous target will completely disappear, as bilinguals will have predictively comprehended the word meaning. When provided with a low constraint context, bilinguals will not benefit from semantic context, and therefore, they won't pre-activate VOT, but they will pre-activate meaning. Overall, when only given a single priming word, bilinguals would not be able to pre-activate features other than semantics; however, when given a constraining sentence context and an appropriate global language context, bilinguals will be able to select the relevant language to engage in predictive processing to the same extent as monolinguals do.

Topic Area: Multilingualism

Poster C20 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Investigating neural processing of syllabic and phonemic timescales information in spoken language

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Recent experimental and theoretical advances in neuroscience support the idea that both low and high frequency cortical oscillations play an important role in speech processing. One influential framework states that oscillatory activity in the auditory cortex aligns with the temporal structure of the acoustic speech signal in order to optimize sensory processing (Giraud and Poeppel, 2012). Within the theta range, this alignment supports the extraction of discrete syllabic units from a continuous stream of speech information. Higher frequency oscillations in the gamma range (25−40 Hz) parse temporally fine-grained phonological information (phonemic timescale). To date, however, experimental evidence has better established that theta activity in the auditory cortex tracks the syllabic rhythm during speech perception. The present work aims at testing the hypothesis that speech is sampled in parallel at both syllabic and phonemic timescales. To this end, a new behavioral paradigm was developed, in which spoken materials are selected so as to independent manipulation of the number of syllabic and phonemic units present in single French sentences. Intracranial recordings from ten epileptic patients with electrodes implanted primarily in auditory regions were acquired while patients listened to these sentences. For the set of speech stimuli selected, an analysis of multiple acoustic cues reveals that amplitude envelope modulations and spectral flux are good acoustic proxies for syllabic and phonemic timescales, respectively. Using cerebro-acoustic coherence analyses (Peelle et al., 2012), we show that theta neural activity tracks the speech envelope and allows decoding of syllabic rhythm - while low-gamma activity tracks spectral flux and allows decoding of the rate of phonemic units. These results were most pronounced within the first stages of the auditory cortical hierarchy. Finally, phase−amplitude coupling mechanisms were also scrutinized but did not allow the decoding of linguistic cues. Overall, our results support the hypothesis of parallel sampling of speech at syllabic and phonemic timescales, which occurs at the level of the auditory cortex. These findings open new avenues for the understanding of how the human brain transforms a continuous acoustic speech signal into discrete linguistic representations at a range of time scales.

Topic Area: Perception: Auditory

Poster C21 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Temporal disconnection associated with naming deficits in postoperative temporal lobe epilepsy

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Background: Picture naming relies on a widespread network of anatomical structures, which explains why naming deficits can be detected across distinct types of neurologic disorders. Here, we aimed to comprehensively evaluate the critical temporal lobe neuroanatomy associated with naming in a visual confrontation task by applying a combination of classical voxel-based symptom mapping with a novel approach to infer white matter disconnections across different brain regions. To do this, we studied a cohort of patients with drug-resistant temporal lobe epilepsy (TLE) who underwent surgery. Indeed, surgery can lead to seizure control in many patients but removal (e.g., anterior temporal lobectomy) or destruction (e.g., laser ablation) of temporal brain areas is often associated with post-operative language deficits, particularly in naming. We hypothesized that disconnections of different sub-regions within the temporal lobes would be associated with anomia after TLE surgery. Method: We tested our hypothesis in a cohort of 56 patients with TLE who underwent epilepsy surgery by applying lesion-symptom mapping with pre- vs. post-operative performance changes on the Boston Naming Test. Results: Our findings reveal that the integrity of a temporal lobe network linking the temporal pole, basal temporal structures, and lateral temporal language regions is crucial for preserving visual naming performance in patients with TLE undergoing surgery to treat seizures. Discussion: While prior lesion-symptom mapping studies pointed to a crucial role for different areas within the temporal lobe having a crucial role in naming impairments (anterior temporal pole vs. basal temporal region), our findings offer a unifying explanation by demonstrating that a loss of white fiber tracts connecting these regions are critically associated with anomia in TLE. These findings offer a neurobiological mechanism for an integrative role of ventral stream pathways in visual naming.

Topic Area: Disorders: Acquired

Poster C22 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Emotional Processing of Taboo Words in Naturalistic Stimuli

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Taboo words (i.e., “expletives,” “curse words,” “obscenities,” “swear words,” etc.) are an evocative subset of words and have been shown to present distinctively in neurological disease and injury. Excessive expletive production may occur in pathologies such as traumatic brain injury. Ictal swearing has been observed in cases of epilepsy. Coprolalia in Tourette syndrome is a well-known phenomenon, and many patients with global aphasia are still capable of cursing. These examples provide evidence that this category of words is somehow encoded and/or accessed differently in the brain than other types of words. Despite their relevance to neurological conditions, relatively little is known about the neurobiological substrates that underpin taboo word processing. This study examines the nature of expletives as taboo expressions and how this impacts the functional neuroanatomy of their perception in natural contexts. An existing theory is that expletives are imbued with tabooness due to their emotionality (or that their tabooness evokes emotionality), with emotionality defined on a commonly used two-dimensional scale of affective arousal and valence (i.e., positive/negative association). To explore the relation between emotionality and cursing within real-world contexts, we used the Naturalistic Neuroimaging Database. 56 healthy adult participants watched one of seven films during blood oxygen level dependent (BOLD) MRI acquisition, with each film containing 20+ taboo words. Using a duration-modulated deconvolution, we compared expletives with words matched on frequency, arousal, and valence scores. In a second amplitude-modulated deconvolution, we compared obscenities to words matched solely on frequency, with arousal and valence as modulators, to investigate the contribution of these dimensions to the neurobiological underpinnings of taboo word processing. A linear mixed effects model was used to examine group level effects. Perceiving expletives – compared to perceiving words matched on arousal, valence, and frequency – led to increased activation in superior and middle temporal gyri, occipital lobe, precuneus, and superior frontal gyri. The second analysis, examining the modulatory role of emotionality, showed that arousal and valence varied with BOLD response of expletive perception in the occipital lobe and precuneus. Additionally, arousal modulated activation in orbitofrontal areas and anterior cingulate gyri, while valence modulated activation in superior frontal gyri and the posterior portion of the cingulate gyrus. In comparison, both modulators varied with BOLD response of matched frequency word processing in the superior and middle temporal gyri. These results indicate that taboo words in natural contexts may invoke more brain activity than emotionally matched words in auditory and visual processing regions, as well as regions presumed to integrate sensory information. Expletive perception varied with emotionality in areas associated with visual processing, cognitive integration, and emotional regulation, while perceiving words of similar frequency varied with emotionality in putative language regions. These results, based on context-independent ratings of word emotionality, call for further investigation into the role of dynamic pragmatic use cases (e.g., audiovisual context, narrative-based usage) in brain representations of taboo words. By understanding the biological basis of properties associated with cursing, we gain insight into why this class of words is unique in social communication and neurological disease.

Topic Area: Meaning: Lexical Semantics

Poster C23 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam C session.

Disentangling the effects of a bilingual fetal acoustic environment on neonatal neural sound encoding

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Language experience shapes how auditory system processes sound from the first moments in life. Early childhood is the developmental window when learning has a maximal influence on neural function and learning a second language in early childhood is a driving factor of functional neuroplasticity. Even though the auditory system of newborns is not biased to the native language of their parents, exposure to specific language environment alters infants' speech perception during the first year of life. Yet, several studies have demonstrated that even fetal hearing experiences shape the infants' musical and linguistic preferences. As bilingualism, relative to a monolingual environment, has been demonstrated to enhance evoked responses to speech in children and adults, the present study sought to determine whether a bilingual environment during pregnancy modulates the newborn's ability to processing sounds. To do so, the frequency-following response (FFR), an auditory evoked potential elicited to complex sounds, was recorded in a sample of 90 healthy term neonates during their first days of life. Newborns were divided into two groups according to their prenatal language exposure as reported by their mothers through a questionnaire (45 exposed to a bilingual fetal acoustic environment; 41 monolingual-exposed). The FFR was recorded to an /oa/ stimulus and quantified as the spectral amplitude and signal-to-noise ratio (SNR) at the stimulus F0. Results revealed that neonates exposed to a monolingual environment exhibited larger SNR of the F0 as compared to the bilingual group, whilst no differences where observed on the spectral amplitude of the F0. These results suggest that prenatal

language exposure modulates the neural responses to human speech at birth and, in particular, we observe that a fetal monolingual environment provides a more stable background for newborns to encode and process sounds. On the other hand, newborns exposed to a bilingual fetal environment, despite having a similar neural response as monolinguals to the presented stimulus, are also tracking other frequencies outside the fundamental frequency. Our results contribute to the current hypothesis that bilingual infants commence the process of language acquisition by separating languages from birth by demonstrating that, whilst a monolingual fetal environment provides a more stable background, bilingually exposed newborn's auditory system is tracking a wider range of frequencies.

Topic Area: Development

Poster C24 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

A polysomnographic study of speech-sound memory consolidation in individuals with and without DLD

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Developmental Language Disorder (DLD) is a prevalent, specific learning disability relating to problems with language comprehension and expression beginning in childhood and that cannot be attributed to some other primary condition (Bishop et al., 2017). Prior work has suggested that a period spent in sleep benefits the learning of new speech–sound categories in typical adults (TD) but not in adults with developmental language disorder (DLD) (Earle & Myers, 2015a, 2015b; Earle, Landi & Myers, 2017; 2018). Despite these findings, it remains unclear whether this discrepancy is due to differences in memory consolidation processes that occur during sleep, or if it is epiphenomenal to other factors such as offline time spent in wakeful rest or diurnal effects. To address this, we investigated the effects of a daytime nap on the consolidation of speech-perceptual information in adults with DLD and typical (TD) adults. Twenty-seven native speakers of American English (age 18-25; 10 DLD, 17 TD) were trained to identify the Hindi dental-retroflex contrast. The study consisted of four phases, taking 5-hours in total: pre-nap training, nap, post-nap assessments, and language and reading assessment battery. Participants were fitted with a 32-channel EEG cap pre-positioned in the 10-20 electrode system, two EOG channels, three EMG channels placed on the chin, and two channels placed on each mastoid, as recommended for polysomnography (PSG) by the American Academy of Sleep Medicine (AASM, Berry et al., 2015). Participants were then provided an opportunity to nap for approximately 2.5 hours. PSG was recorded continuously throughout the nap sampling at 500 Hz. later. After removing the cap and electrodes, participants took the post-nap assessment and were administered the language assessment battery used for participant classification (DLD vs. TD). Perceptual performance (discrimination and identification tasks) of the target speech-sound contrast were first converted to d' scores (MacMillan & Creelman, 2005). PSG recordings were staged via consensus scoring by trained undergraduate research students. EEG signals were segmented to epochs of N2 and SWS sleep and then filtered to retain frequencies representative of sleep spindles (8-16Hz). We are in the process of identifying using a continuous (Morelet) wavelet transform with individual thresholds set to detect visually identified spindles with 95% reliability for the first 10 epochs (Tsanas & Clifford, 2015). Preliminary analyses of our behavioral data suggest that while TD adults improve in performance following a daytime nap, $t(16)=3.56$, $p=.003$, adults with DLD do not, $t(9)=1.04$, $p=.323$. These results resonate with prior findings of an overnight consolidation deficit for speech-sound learning in individuals with DLD (Earle, Landi, Myers, 2018). We will present the potential sleep mechanisms underlying this behavior by examining group differences in sleep architecture, spindle count, and spectral power.

Topic Area: Speech Perception

Poster C25 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Observed timing and facilitation effects after theta-burst stimulation of the

reading network.

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Introduction: Theta-burst stimulation (TBS) is a well-established technique for delivery of repetitive transcranial magnetic stimulation. However, there is some debate as to the reliability and reproducibility of behavioral effects of TBS. In this study, we sought to evaluate the inhibitory versus excitatory effects of continuous and intermittent TBS (cTBS, iTBS) after stimulation of key nodes of the reading system and to observe at what time point after stimulation the greatest effects of stimulation were observed. Methods: 21 participants were recruited into this study. Participants completed a baseline forced-choice reaction time phonological discrimination task and received cTBS or iTBS to the supramarginal gyrus (SMG) or middle temporal gyrus (MTG) or no stimulation control condition. Immediately following stimulation, participants performed the same reading tasks at four timepoints, approximately 15 , 30 , 60 , and 70 minutes post stimulation. Percent change from baseline in reaction time of correct trials was calculated for each timepoint. Results: For all sites, there was a significant effect of time after stimulation ($t = -2.9$, $p < 0.003$) but not of stimulation type ($t=-.99$, $p <0.4$, (F, $(2,162) = 4.817$, $p < 0.01$, $r2 = .056$) on percent change in reaction time. In the SMG condition, multiple linear regression of time after stimulation and type of stimulation in the SMG condition indicated a significant effect of time after stimulation ($t = -2.3$, $p <0.03$) but not of stimulation type ($t = -1.2$, $p <0.2$) ($F(81,2) = 3.5$, $p <0.04$, $r2 = 0.08$). This pattern was also evident in the MTG condition. In the MTG condition, there was a significant effect of time after stimulation ($t = -2.7$, $p < 0.05$) but not of stimulation type ($t = .13$, $p > 0.9$) ($F(63,2) = 2.6$, $p <0.08$, $r2 = 0.08$). In the no stimulation condition, regression of percent change from baseline and time after stimulation ($t = -.3$, $p < 0.8$) was not significant ($F(1,13) = 0.07$, $p < 0.8$, $r2 = .006$). Conclusion: In summary, cTBS and iTBS showed a facilitatory effect on change in reaction time compared to control. These data support recent work in the motor system that suggest that both cTBS and iTBS led to facilitation of MEPs (Ozdemir et al., 2021). Percent change in reaction time improved the most at the last two time points (60-70 minutes post stimulation) and this effect was not seen in the no-stimulation condition suggesting the observed effect is beyond that expected of traditional task practice effects. These data suggest that the greatest impact of TBS in the language system is much later in time than those reported in the motor system. While these results need to be replicated in other datasets before we can draw firm conclusions, they indicate that we need to be more critically analyzing the effects of cTBS and iTBS and at what timepoint after stimulation outcome measures are taken.

Topic Area: Disorders: Acquired

Poster C26 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Rate synchronization reveals a corresponding syllable rhythm in brain oscillations and speech productions

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Considerable research has highlighted that oscillatory brain activity contributes to speech processing via tracking quasi-periodic speech rhythms. Because the central syllable rhythm of the acoustic envelope is remarkably similar across languages (~4-5 Hz), we assumed that this intrinsic periodicity would reveal an organizing principle in both auditory and motor systems involved in speech. To assess relations between entrainment in the perceptual and production domains, we measured phase locking values for ongoing EEG signals to speech stimuli and simultaneous speech production synchronization to heard syllable rates between 2.5-8.5 Hz, values approximating to the ecological range of syllable rates across languages. Given that the origin of the intrinsic rhythm remains unclear, we also examined how accurately the rates were produced without concurrent auditory inputs, thereby isolating a more putative motor speech function. Our data from young adults revealed that neural synchronization flexibly adapts to the heard stimuli in a rate-dependent manner but that phase locking is boosted near ~4.5 Hz, the purported value of

intrinsic rhythm. Audio-motor synchronization, which invokes simultaneous sensorimotor interaction, appeared to be optimal between 2.5-4.5 Hz. Linking auditory and motor systems, we found strong correlations between EEG and production synchronization abilities, which imply that individuals with stronger auditory-perceptual entrainment better match speech rhythms motorically. We further observed critical evidence that participants most precisely generated rates at 4.5 and 5.5 Hz in “pure” motor productions. Together, our findings support an intimate link between syllable rhythmic processing around 4-5 Hz in both the auditory and motor systems. The simultaneous speech synchronization demonstrated a low frequency constraint emerging on account of the direct sensorimotor integration. Our data are suggestive of an intrinsic syllable rhythm near 4-5 Hz that probably results from dynamics of the speech motor system coupled with experience-dependent tuning of the auditory perceptual system via the interface of perception-action.

Topic Area: Perception: Auditory

Poster C27 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Greater learning-induced plasticity in children than adults during linguistic SL

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Statistical learning (SL), the ability to extract regularities from inputs, plays a key role in the development of language and literacy skills (Aslin & Newport, 2014; Erickson & Thiessen, 2015). The theoretical frameworks of SL have emphasized the contribution of both modality-specific and domain-general cognitive processes in SL (Conway, 2020), which raises important questions regarding how SL skills development across age. Previous behavioral study has not been able to differentiate between the age-invariant account and the less-is-more account. Even though linguistic SL has shown much less age effect measured by offline recognition accuracy, compared to nonlinguistic SL (Shufaniya & Arnon, 2018; Authors, 2022), children learned more quickly than adults only in the linguistic domain (Authors, 2022). In the current fMRI study, we aim to compare the engagement of linguistic-specific and domain-general attention networks in SL between children and adults. The less-is-more account predicts greater learning-induced changes in the developing language network in children, who have fewer years of language experiences and less mature attention network than adults. In contrast, the age-invariant account predicts similar learning-induced changes between children and adults. 18 children (Mean Age=7.76, SD=3.58, 11 Males) and 27 adults (9 Males) completed two auditory SL tasks in the scanner. In the linguistic Syllable SL task, participants listened to syllable sequences containing triplet patterns, intermixed with random tone sequences. In the nonlinguistic Tone SL task, participants listened to tone sequences containing triplet patterns, intermixed with random syllable sequences. Participants alternated between responding to a target syllable and responding to a target tone during learning. Participants’ BOLD responses were analyzed within the language network (LN; Fedorenko et al., 2010) and the dorsal attention network (DAN), which was isolated using a map generated by Neurosynth via an automated meta-analysis of 99 studies. In the LN, there was a greater learning-induced changes in the linguistic than the non-linguistic domain across both adults and children ($b=-1.35$, $t=-8.63$, $p<0.000$). The changes were greater in children than adults in the linguistic SL but not in the nonlinguistic SL task (Syllable: $t(31.5)=-1.838$, $p <0.05$). In both the LN and DAN, adults showed an overall greater activation than children across tasks and sequences (LN: $b=-1.35$, $t=-8.63$, $p<0.001$. DAN: $b=-0.47$, $t=-9.33$, $p<0.001$). Finally, stronger activation in the DAN was associated with better responses to the structured sequences in the LN across adults and children for both tasks ($b=0.32$, $t=4.45$, $p<0.001$). Together, these results provide the initial neural evidence supporting the less-is-more account of language acquisition. While adults showed greater overall engagements in both networks than children across both tasks, children’s LN showed a greater degree of learning-induced plasticity only for the linguistic domain. Moreover, greater attention engagement during the task is associated with greater learning-induced functional malleability in LN for both age groups, supporting a tight interplay between domain-general and domain-specific learning mechanisms underlying SL.

Topic Area: Development

Poster C28 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Do Spanish-English bilinguals pre-activate word form information when predicting in L2?

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There is abundant evidence to suggest that predictive processing facilitates language comprehension in monolinguals by pre-activating linguistic representations for upcoming language input (e.g., Kuperberg & Yeager, 2016). Despite the global ubiquity of bilingualism, studies that examine the type of and extent to which features of words are being pre-activated when bilinguals process their second language (L2) are more limited. Previous work suggests that Spanish-English bilinguals show greater facilitation of information at the word form level than monolinguals do (Hoshino & Kroll, 2008). But these studies did not address whether these facilitatory effects can be attributed to pre-activation of word form information in the L2 of Spanish-English bilinguals prior to the presentation of the target word. The proposed study aims to address this question by examining prediction during word processing in Spanish-English bilinguals. 50 Spanish-English bilinguals and 50 English monolinguals will be recruited to participate in a two word priming study with a prediction task. Materials from Gao et al. (2022) will be normed within a different sample of 60 Spanish-English bilinguals to establish that the forward association between primes and targets is the same in this population. Before the norming study and the experiment, all bilingual participants will complete a language history questionnaire (LHQ3) and a validated test of English proficiency (LexTALE) to establish their language proficiency of L2 (Li et al, 2020; Lemhöfer & Broersma, 2012). In the priming study, participants will be presented with 480 prime-target word pairs. Target words are semantically related (circus-clown) or unrelated to the primes (trim-clown). Their task is to predict the target words and to produce (name) the predicted word prior to the presentation of the target (within 1800ms). They then make a lexical decision to the target words. The pre-target naming response will be compared to the presented visual target word to assess whether it is identical (accurate prediction), semantically related or unrelated, and lexical decision latencies will be analyzed accordingly. We will replicate this study using ERPs. Previously, we have found that monolingual participants showed facilitated processing of accurately predicted target words relative to semantically related target words, which indicates processing benefits of lexical pre-activation (Gao et al, 2022). If bilinguals pre-activate lexical form in their L2, they should show this same pattern of results. Preliminary norming results from 18 proficient Spanish-English bilinguals replicated the 50% forward association strength that was found in a monolingual norming study with 60 participants. LMER analyses will be performed and we predict main effects of prediction accuracy and relatedness on RT latency and the N400 event-related potential (ERP) component. An interaction of prediction accuracy by relatedness would be consistent with pre-activation of word forms in L2. This finding would indicate that bilingual language users selectively activate words in the context language when they are engaged in an active prediction task.

Topic Area: Multilingualism

Poster C29 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam C session.

Investigation of the Gradual Increase of Lesion Size in the Chronic Stage of Stroke

Lisa Johnson[1], Roger Newman-Norlund[1], Chris Rorden[1], Natalie Busby[1], Alex Teghipco[1], Argye Hillis[2], Leonardo Bonilha[3], Julius Fridriksson[1]; [1]University of South Carolina, [2]Johns Hopkins University, [3]Emory University

Introduction: Stroke is a leading cause of death and disability worldwide and affects nearly 800,000 people in the United States each year. With great advances in treatment of acute stroke in the hospital setting, the rate of stroke-related deaths has declined leaving stroke survivors with long-withstanding chronic deficits. The pathophysiology and neuronal recovery patterns during the acute stage have been well defined, leaving such efforts in chronic stage unexplored. Some investigation in subacute and early chronic stroke recovery have shown evidence of necrotic tissue and edema remaining in perilesional regions. This inflammation likely dysfunction may explain the high rates of stroke-related dementia in the years following a stroke event and could explain the inherent unreliability in treatment response to post-stroke therapy. For these reasons, better understanding of chronic stroke pathophysiology is very much needed and could shed light on long-term recovery patterns in these patients. Methods: This was a retrospective study in which 102 stroke survivors with at least 2 structural MRI scans (k=259 observations) more than 6-months between scans were included. Lesion masks were created using automated lesion segmentation software LINDA and lesion volumes at each timepoint were subsequently calculated. A paired sample t-test was conducted between initial and final follow-up lesion sizes. To investigate factors that predict lesion size changes over time, a linear mixed effects model (LME) was conducted with lesion volume at each time point as the dependent variable and the following independent variables: months post-stroke at scan, sex, years of education, age at stroke, and NIH stroke scale (NIHSS). Results: A paired t-test between initial and final follow-up scan indicated lesion size at final follow-up scan (M=106.4, SD=70.1) was significantly larger compared to the initial time point (M=96.5, SD=65.1) after controlling for time between scans (t=-7.13; df=101; p<.0001). The results from the mixed effects model suggest that months post stroke onset (p<.0001), sex (p=.04), age at stroke (p=.003), and initial rating on the NIHSS (p<.0001) are significant predictors of lesion growth in the chronic stage. The model suggests that with every month post-stroke, the lesion expands by approximately .2cm3 voxels. Men appear to have a greater rate of lesion growth, increasing by ab out 24.9cm3 voxels compared to females. With every year increase of stroke age, lesion size tends to decrease by 1.6cm3 voxels. Finally, initial NIHSS (taken in the chronic stage of recovery), significantly predicted growth of lesion size by 8.9cm3 voxels with every increased point on the NIHSS (higher score indicates greater severity). Summary: Results from the present study provide evidence that the lesion size the chronic stage of stroke recovery (>6 months post-stroke) can change over time. Demographic and behavioral variables such as age at stroke, months post-stroke, sex, and NIHSS are significant predictors of lesion size changes. We suggest that further investigation of the pathophysiology of the stroke lesion in the chronic stages of stroke is merited, particularly in identifying any association between lesion growth and persistent stroke-related deficits.

Topic Area: Disorders: Acquired

Poster C30 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

An investigation of the cognitive and neural correlates of semantic memory search related to creative ability

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Creative ideas likely result from searching and combining semantic memory knowledge, yet the mechanisms acting on memory to yield creative ideas remain unclear. Here, we identified the neurocognitive correlates of semantic search components related to creative abilities. We designed an associative fluency task based on polysemous words and distinguished two search components related to clustering and switching between the different meanings. Clustering correlated with divergent thinking, while switching correlated with the ability to combine remote associates. Furthermore, switching correlated with semantic memory structure and executive abilities, and was predicted by connectivity between the default, control, and salience networks. In contrast, clustering relied on interactions between control, salience, and attentional networks. Our results suggest that switching captures interactions between memory structure and control processes guiding the search whereas clustering may capture attentional controlled processes for persistent search, and that alternations between exploratory search and focused attention support creativity.

Topic Area: Meaning: Lexical Semantics

Poster C31 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam C session.

Moving away from lexicalism in psycho- and neuro-linguistics: A non-lexicalist model of language production

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In standard models of language production, the units which are retrieved and combined into a syntactic structure are 'lemmas' or 'lexical items'. Such models often implicitly assume 'lexicalism', the idea that syntactic structure does not extend below the word level. However, across the last several decades, linguistic research examining a wider array of languages has provided strong evidence against this assumption. This has significant implications for models of language processing as well as understanding of aphasia and other language disorders. Here we provide an overview of the arguments against lexicalism, discuss how lexicalist assumptions have influenced models of language production, and propose a non-lexicalist model of language production as an alternative. Lexicalist approaches are characterized by some or all of the following assumptions: firstly, that sub-word and supra-word processes are different in kind, such that the rules that apply in the syntax cannot apply within lexical items; secondly, that wordhood is the domain of listedness; and thirdly, that lexical items necessarily include triads of sound, meaning, and syntax. In standard models of language production, lemmas - and other varieties of 'lexical' representations - act as triads of meaning, syntax, and form, also serving to codify the correspondence between wordhood and listedness, as well as a distinction between morphology and syntax. These models also exhibit a division between syntactic and 'lexical' processes, or treat morphology as a separate operation from syntax. For early models of language production, which were based largely on Dutch and English, these seem like intuitive conclusions; however, these assumptions become problematic when applied to other languages. For example, in polysynthetic languages, where sentences are regularly formed by a single word composed of multiple highly productive morphemes, lemmas would need to include either massive inflectional paradigms, or there would need to be thousands of redundant lemmas that could be created spontaneously. In addition, several languages exhibit verb suppletion based on the syntactic properties of the object. This indicates that form must be determined based on syntactic context, and that lemma selection cannot be done in isolation from syntactic structure building. In order to move away from lexicalism in models of language, it is not enough to simply update the syntactic representations; the algorithms also need to be reconsidered. Here we propose a non-lexicalist model of language production which does not rely on a lemma representation, but instead represents that knowledge as mappings between (a) meaning and syntax, and (b) syntax and form. We do not assume any architectural restriction on the size of the units that participate in stored mappings; as in the case of so-called 'idioms', syntactic complexes can have stored mappings to meaning or to form. The model has a single integrated stage for morpheme retrieval and syntactic structure building. Our model also emphasizes the role of cognitive control mechanisms in linearizing speech. By moving away from lexicalist assumptions, this model provides better cross-linguistic coverage, and also aligns better with contemporary syntactic theory.

Topic Area: Language Production

Poster C32 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Systems Supporting Clinically Salient Language Deficits

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Introduction Language is a complex higher-order cognitive function supported by two large systems: a ventral (temporal-parietal) network primarily responsible for semantic computations, and a dorsal (parietal-frontal) network involved with sequential processing and phonological mapping.1,2 Critically, everyday language functions like speech comprehension, naming, speech repetition, and spontaneous speech rely on shared components of the ventral and dorsal streams.2,3 Prior research in aphasia has historically examined neural correlates of each functional domain in isolation, ignoring their reliance on shared structural networks and the high correlation across functional abilities in these domains.4 In an effort to remediate this issue, we employed a singular value decomposition approach and partial least squares to test the simultaneous involvement of behavioral deficits onto damaged ventral and dorsal structures as a core mechanism to explain variance in impairment. Method A total of 93 participants with chronic (>12-months post-stroke) aphasia after one or more left hemisphere (LH) strokes were recruited for the current study. Participants underwent a detailed case history, language assessment (Western Aphasia Battery, WAB; Kertesz, 2007), and neuroimaging. Multiple facets of brain damage were defined by neuroimaging, namely: 1) lesion characteristics derived from T1-/T2-weighted imaging, 2) connectomics (functional and structural) derived from high-resolution diffusion tensor imaging tractography and resting-state fMRI, 3) gray and white matter tissue integrity, 4) task-based fMRI, 5) tissue microstructure derived from diffusion MRI, and 6) tissue perfusion measured with arterial spin labeling. A partial least squares approach was employed for model construction to evaluate the shared and unique aspects of both the dependent factors (WAB subscores: Speech Comprehension, Naming, Repetition, and Spontaneous Speech) and their predictors (neuroimaging data). A leave-one-participant-out machine learning algorithm was applied to assess model accuracy, while also determining the association between the latent decompositions of dependent factors and their predictors. Model accuracy was evaluated based on Pearson's correlation between observed vs. predicted language scores. Results Spontaneous Speech performance emerged as the dominant component in all models irrespective of neuroimaging modality (loading range: -36 to 27). The most accurate prediction of Speech Comprehension was achieved by a model based on the structural connectome ($r=.45$, $p<.01$), followed by task-based fMRI ($r=.35$, $p<.01$). Performance on the Naming subtest was most accurately predicted based on white matter voxel-based morphometry (VBM; $r=.39$, $p<.01$), followed by the structural connectome ($r=.37$, $p<.01$). Manually demarcated lesion data composed the most accurate prediction of Speech Repetition scores ($r=.38$, $p<.01$), followed by a model based on tissue microstructure (fractional anisotropy, FA; $r=.33$, $p<.01$). Finally, the structural connectome model achieved the highest accuracy by far for the prediction of Spontaneous Speech scores ($r=.42$, $p<.01$). Models based on white matter VBM and FA values both achieved an accuracy of $r=.01$ ($p<.01$). Discussion Our findings indicate that speech production is a significant component in clinically salient speech impairments, and that variance in impairments is explained by lesion affecting both the ventral and dorsal language streams. These results highlight the importance of considering multiple neuroimaging modalities simultaneously to explore the intricate nature of language deficits for future research and clinical purposes.

Topic Area: Disorders: Acquired

Poster C33 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Basic Combinatorial Operations during Language Processing in English Monolinguals and Mandarin-English Bilinguals: Insights from Event-Related Potentials and Neural Oscillations

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Recent psycholinguistic studies have garnered support for the notion that multi-word sequences are more widespread and pervasive in sentence processing than previously assumed. Specifically, second language (L2) learners tend to produce fewer and less natural multi-word sequences compared to native speakers of the same language. Thus, this dissertation aims to examine event-related potential (ERP) correlates and neural oscillations of collocational processing using a verb-noun paradigm (e.g., play games). Multi-word sequences are believed to be stored and computed holistically, similar to the way single words are stored in and retrieved from semantic memory. However, the anticipatory and integration effects of collocations remain unknown. Thus, collocations provide a test ground for the fundamental mechanisms of the basic combinatorial processes by which words are constructed into phrases. While a handful of behavioral studies have examined L2 collocational acquisition, electrophysiological results would provide further insight into the combinatorial mechanisms that underlie cross-linguistic variations in phrase construction. This study aims to pinpoint the time windows and frequency bands at which the encoding of English verb-noun collocations differs between monolinguals and bilinguals. At the anticipatory stage, we expect to observe an enhanced anterior negativity in the high-constraint context compared to the neutral context as well as a beta power decrease, which may indicate a higher processing load induced by strong prediction. At the integration stage, we expect to observe a reduced N400 and theta activity for the collocations in the high-constraint condition but decreases in the beta and theta power for the non-collocations, which would suggest benefits of confirmed predictions and potential costs of disconfirmed predictions (Li et al., 2017). The differences between the anticipatory and integration stages of collocational processing will be compared between both English monolinguals and Mandarin-English bilinguals. Here, we propose an experiment wherein we will present a series of collocations and matched distractors (i.e., non-collocations) that were retrieved from the Corpus of Contemporary American English to 25 English monolinguals and 25 Mandarin Chinese learners of English during EEG collection as paid volunteers. A norming procedure of the carrier sentences was performed on 278 English native speakers to ensure the constraint of the sentences. Finally, 62 collocations and 248 carrier sentences in the four conditions of high-constraint collocation, high-constraint non-collocation, low-constraint collocation, and low-constraint non-collocation were produced. A 2 (Sentential Constraint: high or low) × 2 (Collocation Type: collocation or non-collocation) × 2 (Language Group: monolinguals or bilinguals) factorial design will be used. A series of behavioral and cognitive tasks (i.e., English proficiency test, AX-Continuous Performance Task, and demographic survey) will be performed prior to the EEG study. In addition, participants' EEG data will be recorded while they perform the AX-CPT. Following the above tasks, each participant will read 124 sentences within one of the four counterbalanced lists plus 120 filler sentences. Understanding the basic combinatorial operations during language processing will provide a critical bridge to rehabilitation and essential interventions for less proficient L2 readers.

Topic Area: Meaning: Combinatorial Semantics

Poster C34 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
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Prosodic Entrainment Influences Subsequent Sentence Comprehension

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Neural oscillations facilitate speech processing by synchronizing to rhythmic acoustic cues in speech. In particular, delta-band oscillations (< 4 Hertz) synchronize with speech prosody. In a series of behavioral studies, we have observed that rhythmic prosodic contours can trigger downstream effects that persist beyond stimulation, affecting the comprehension of upcoming sentences devoid of prosody. This is in line with the finding that via entrainment, oscillations can inherit a stimulation frequency to persist after stimulus offset. To support the interpretation that our behavioural effects reflect electrophysiological entrainment, we conducted an MEG experiment. We combined an initial prosodic rhythm with a subsequent visual target sentence. Target sentences were either long or short (e.g., “Max sees Tom and Karl laughs” vs. “Max sees Tom and Karl”). In a 2 × 2 design, these were combined with prosodic contours that were either long or short (corresponding to the durations of “Max sees Tom and Karl” and “Max sees

Tom", respectively). In the entrainment part of each experimental trial, a contour was repeated 3 times to induce rhythmic entrainment. In the target part, a visual target sentence was presented word by word; presentation was duration-matched to the rate of the previous stimulus. We first hypothesized that delta-band oscillations would entrain to the rate of the contours. Second, we hypothesized that this frequency would still be detectable in the MEG for the visual target sentence. In the entrainment part, we observed coherence with the prosodic contour at the stimulation rate over all MEG sensors ($p < 0.001$, corrected). Coherence indeed persisted into the target part ($p < 0.001$, corrected), with an anterior shift of the topography. Critically, when long contours were followed by short sentences, a P300 ERF was observed at the offset of the short sentence—likely indicating an omission response under the expectation of a long sentence. Together with our behavioral results, we conclude that sustained prosodic entrainment affects subsequent sentence comprehension, with the stimulation frequency being conserved by brain areas associated with higher-level linguistic processing. To substantiate the apparent shift from bottom-up (= auditory) to top-down (= predictive) brain regions, we are now conducting source reconstruction.

Topic Area: Speech Perception

Poster C35 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Neural dynamics of anticipatory coarticulation

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Models of speech motor control propose different encoding processes allowing the transformation of an abstract linguistic message into speech motor codes that will be later articulated. During motor planning, the first post-linguistic speech motor process, motor plans (or speech sound maps in the DIVA model, Gunther, 2016) are suggested either to be retrieved from memory or to be assembled on-line according to the frequency at which a speech target is produced. Upon the retrieval and/or assembling of the motor goals, movements for each sound composing the speech item are sequentially organized and coordinated. In parallel, motor plans are adapted to the phonetic context in which they will be produced, creating the potential for coarticulation of those sounds within a unit. In the present study we are interested in this last aspect. Specifically, we explore the brain dynamics of anticipatory coarticulation, in which the phonetic realization of a given phoneme is influenced by subsequent speech sounds. Assuming that the phenomenon of coarticulation takes place during motor speech encoding processes preceding articulation and considering that the delayed production task permits to target those non-linguistic processing stages, participants were asked to produce a series of disyllabic (CCV1-CV2) non-words in a delayed fashion while their brain activity was recorded with electroencephalography (EEG). Half of the non-words involved some degree of vowel-to-vowel (VtV) coarticulation (i.e. /traki/), while the other half did not (i.e. /traka/). As expected, preliminary acoustic analyses on six participants revealed systematic shifts of formant values in the coarticulation condition (/traki/) as compared to the neutral condition (/traka/). Specifically, the compact V1 /a/ exhibited significantly more diffuse spectrum—as measure by the F1-F2 difference—under the influence of the high frontal V2 /i/ ($W = 125$, $p = .000$). Contrarily, no difference between conditions was found in terms of accuracy (94% for both coarticulated and non-coarticulated non-words) and reaction times (618ms and 619ms for non-words requiring or not coarticulation, respectively). Event-related potential (ERP) results will be analysed when completing the group of participants (n=20) in order to determine whether anticipatory VtV coarticulation involve the recruitment of different brain networks between items that exhibit some degree of coarticulation and those which do not.

Topic Area: Speech Motor Control

Poster C36 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Mapping the timescales of language representations in the cerebellum using

interpretable multi-timescale models

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Natural speech contains information at multiple timescales, ranging from spectrotemporal information on a sub-second scale to semantics and discourse over longer time periods. The human cerebral cortex hierarchically processes diverse temporal information, starting from the auditory cortex with a bias for short timescales to high-level regions like prefrontal cortex and precuneus which support increasingly long timescale representations. Previous work has shown that the cerebellum robustly responds during language processing and represents semantic information. While the cerebellum has been shown to play a central role in representing precise temporal relationships essential for motor control and perception, its temporal organization for language is not well understood. In this work, we built computational models to characterize processing timescales within the cerebellum during natural language processing. We collected fMRI data while participants (2 male, 3 female) listened to over five hours of naturally spoken, narrative English language stimuli. We then used voxel-wise encoding models of the cerebellum to predict the fMRI response of each voxel from features of the stimuli. These features were extracted from a multi-timescale recurrent neural network (MT-RNN). In this neural network, each unit integrates linguistic information at a fixed, distinct timescale. The range of timescales used in this model were derived from distributions of natural language. The MT-RNN encoding models significantly predicted cerebellar responses on a held-out dataset. We then used the regression weights on different MT-RNN units to estimate every voxel's processing timescale. Similar to what is observed in the cortex, we found that the cerebellum represents information at several different temporal scales. Surprisingly, we also found a gradient of timescales across cerebellar depth such that superficial areas of the cerebellar folia represent longer timescale information and deeper regions of the folia represent shorter timescale information. We ruled out possible artifactual accounts of this temporal gradient across folia depth. First, we estimated the hemodynamic response function (HRF) of each cerebellar voxel by using a finite impulse response model and found no difference in the estimated HRF across depth in the cerebellum. Second, we collected resting state data using the same sequencing parameters and found no difference in the power spectrum across depth in the cerebellum. This suggests that the timescale variance across depth in the cerebellum is not simply due to frequency differences in the BOLD signal. We then examined the semantic selectivity of voxels across depth and found that they capture similar semantic concepts despite processing information at varying timescales. Overall, these results provide evidence of cerebellar involvement in temporal processing in a novel task domain, language, with an unexpected organization of semantic information over multiple timescales.

Topic Area: Speech Perception

Poster C37 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

How listening to nonnative-accented speech in a noisy environment impacts online lexical-semantic access and offline sentence comprehension: A combined ERP and behavioral study

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In today's globalized world, people increasingly encounter speakers with a foreign accent. Moreover, natural speech communication rarely takes place in ideal listening conditions, as we often listen to others when surrounded by background noise. Processing and comprehending foreign-accented speech in noisy backgrounds has thus become a common characteristic of everyday communication in our multicultural and multilingual society. However, few if any neurolinguistic studies have examined how listeners process foreign-accented sentences in background noise. In this project, we examined the neural and cognitive mechanisms underlying the semantic processing of native-accented and foreign-accented sentences embedded in background noise, and we focus on the N400 effect as an index for

semantic access, because of its high sensitivity to preceding semantic context. Using a semantic violation paradigm, 35 American English monolingual young adults (27 female; MAge = 19.38, SD = 0.95) without any substantial exposure to foreign-accented speech listened to a total of 288 unique sentences, while EEG were recorded. These sentences were counterbalanced across conditions of Accent (native accent: American, foreign accent: Chinese) and of Background (quiet, multi-talker babble noise) and Sentence semantic types (well-formed: e.g., "Kevin reached into his pocket to get the keys", anomalous: e.g., "Kevin reached into his funeral to get the keys"). After hearing each sentence, participants verbally repeated the sentence, which was coded and scored as offline comprehension accuracy measure. Analysis of the verbal repetition accuracy data showed that background noise negatively impacted repetition accuracy of foreign-accented sentences more than native-accented sentences. This finding aligns with previous behavioral literature (e.g., Bent, 2018). ERP analyses of the N400 component showed that the semantic N400 effect (larger N400 for semantic anomalies than for control words) was larger for native-accented than for foreign-accented sentences, and for sentence presented in quiet than for in noise, indicating an impaired lexical-semantic access when listening to foreign-accented sentence or sentences embedded in background noise. In fact, when facing both a foreign accent and background noise, the semantic N400 effect was completely absent (mean amplitude: -0.05 mV across regions of interests). Taken together, this indicates that our brains fail to generate predictions based on semantic context when being confronted with an unfamiliar foreign accent in background noise.

Topic Area: Meaning: Lexical Semantics

Poster C38 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
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Development of Cerebellar Lobule VI, and Its Association With Stuttering Severity in Children Who Stutter

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The cerebellum plays a crucial role in a wide variety of complex behaviors. Altered brain activity and connectivity in the cerebellum have been reported in stuttering, especially in the right cerebellar hemisphere, which primarily inter-connects with left cortical regions supporting orofacial movements, language and speech motor control. In this study, we focused on the right cerebellar lobule VI, a region heavily involved in the cerebellar-cortical loops in speech-motor control models such as the Directions into Velocities of Articulators (DIVA) model (Guenther et al., 2006). Specifically, we investigated how the gray matter volume (GMV) in cerebellar lobule VI changes with age during early and middle childhood, how cerebellar development may be associated with speech development (articulation), and stuttering severity in children who stutter (CWS). 95 CWS (aged 3 to 10 years) and 93 age- and gender-matched controls participated the study. All participants were monolingual English speakers exhibiting normal speech, language and cognitive development. Stuttering severity was assessed by collecting samples of spontaneous speech, elicited through storytelling and conversational tasks with a certified speech-language pathologist. For each participant, high resolution T1-weighted MRI images were acquired on a GE 3 T Signa HDx MR scanner. Among them, 44 CWS and 47 age- and gender-matched controls completed two structural scans about two years apart (age gap: 18 -31 months). Structural MRI data were segmented to tissue types, normalized and generated voxel-wise volumetric maps using SPM12. Whole-brain voxel-wise analyses were conducted to test age effects on GMV across and between groups (CWS vs. controls) controlling for sex and social economic status (SES), and to test how GMV was associated with speech development (Goldman-Fristoe Test of Articulation [GFTA]) and speech disfluency (SSI-4) across and between groups controlling for sex, SES and age at the initial scan. For the longitudinal samples, age gap between the two timepoints were also controlled for. Threshold for statistical significance was set at $p<0.05$ corrected for family-wise errors. Additionally, voxel-wise analyses specific to the right cerebellar lobule VI, defined using the AAL atlas, were conducted with small-volume adjustment. We found that GMV at right cerebellar lobule VI, along with other posterior cerebellar regions, increased with age linearly across groups in both the cross-sectional and longitudinal samples. GMV at right cerebellar lobule VI showed quadratic association with age in the cross-sectional sample, suggesting that younger age is associated with more GMV increase in this region. Meanwhile, longitudinal sample analyses revealed that CWS showed more GMV increase at right cerebellar lobule VI than controls during the 2-year period. While there was no association between GFTA and cerebellar GMV in either group, decreased stuttering severity was associated with increased GMV at right cerebellar lobule VI in CWS. The altered development of right cerebellar lobule VI and association with speech disfluency in CWS, suggests a possible critical role of this cerebellar lobule in the neural bases of stuttering.

Topic Area: Speech Motor Control

Poster C39 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Univariate and multivariate mapping of the brain regions involved in word retrieval across stroke and neurodegeneration

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The ability to retrieve a word one wants to say is a fundamental human skill that frequently breaks down after brain injury. Behaviorally, it is typically measured by having patients name the objects depicted in a sequence of pictures. Prior lesion studies of word retrieval have implicated a wide variety of discrete brain regions, often in an around the left temporal lobe. One important factor that arguably contributed to this variability in the mapping between lesion and deficit is the spatial bias, and ensuing localization errors, that follow from the non-random distribution of brain damage: e.g., stroke-induced brain lesions are constrained by the anatomy of the vascular tree, while neurodegenerative diseases affect (preferentially) vulnerable large-scale neural networks. Critically, lesion-deficit relationships observed across different etiologies with largely uncorrelated spatial biases would be much less likely to be contaminated by localization errors. Here, we embrace this logic to localize brain regions that are persistently necessary for successful word retrieval in two large samples of patients suffering from brain damage caused by stroke (n = 587) or neurodegeneration (n = 205). To further enhance the robustness of our results, we combined both mass-univariate and multivariate voxel-based lesion-deficit mapping approaches, as implemented by the SVR-LSM toolbox (https://github.com/atdemarco/svrlsmgui) using default settings, including cluster-level family-wise error correction via permutation testing. Moreover, to ensure the identification of brain regions involved in word retrieval specifically, we considered a set of nuisance covariates to control for components of object naming related to, for example, visual perception, semantic processing, phonological encoding and articulation; in addition to accounting for the influence of time since onset and lesion volume, as is routinely done in lesion-deficit analysis. We identified a region in the left mid-to-anterior superior temporal sulcus/middle temporal gyrus, extending into neighboring white matter, which was consistently associated with word retrieval ability across both analysis types (univariate and multivariate) and neurological conditions (stroke and neurodegeneration). We also show, in an entirely independent sample of stroke patients (n = 236), that damage in this region predicts (i.e., out-of-sample) around a third of the variance in object naming scores, underscoring its scientific and clinical importance. Taken together, our findings strongly imply that we have accurately localized a left temporal region that is a critical node in the object naming network, and where damage is likely to impair word retrieval ability.

Topic Area: Disorders: Acquired

Poster C40 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam C session.

Bilateral temporal involvement in predictive morphological segmentation and processing during spoken word comprehension: MEG evidence from Arabic

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A major challenge in speech processing is how the brain segments a continuous input stream. This has typically been studied on the phoneme or word level. But does the brain segment spoken words to their smallest meaningful units (i.e., morphemes)? If so, what's the nature of this process? We contrast three hierarchically-nested models: (i) A simple morphologically-naïve model that has acoustic, lexical and phonetic predictors, but is insensitive to morphological information/boundaries; (ii) A morphologically-passive model, sensitive also to morpheme boundary/onset, and (iii) A morphologically-predictive model, sensitive also to predictive segmentation and morphological surprisal and uncertainty (calculated based on transition probabilities between morphemes). 27 participants listened to single words in Arabic while we recorded brain activity using magnetoencephalography (MEG). Words had two morphemes: a verb stem, and one of four direct object pronouns (e.g., 'qayyama-ni'='(He) evaluated-me'; hyphens represent morpheme boundaries). Verb stems were either long (all following the Arabic template '_a__a_a') or short (a shorter template with the same onset: '_a__a'). In Arabic, sets of root consonants are substituted into the underscored slots of these templates, producing different verbs (e.g., root {j,r,b} produces 'jarraba'='(he) tested' in the long template; {j,r} produces 'jarra'='(he) dragged' in the short template). We had two conditions. Morphologically unambiguous stems were all long (e.g., 'qayyama'), with no derivable shorter stems (i.e., 'qayya' is not an Arabic verb/stem). Morphologically ambiguous stems were either short or long: all long stems had corresponding shorter stems with the same onset (e.g., 'jarra' vs. 'jarraba'), producing temporary ambiguity during comprehension. All stems across conditions had identical uniqueness points (offset of the string _a__a). Comprehension tasks targeting either stems or pronouns followed 25% of trials. Using source-localization, we estimated cortical activation in bilateral inferior frontal, and superior/middle temporal cortex. We used a temporal response function (TRF) framework to estimate typical responses to each model's predictors, measuring each model's power to explain cortical activity. Compared to a null model, all three models significantly explained activity in all ROIs ($p<0.0001$;p-values corrected for multiple comparisons), which validates our models' predictive power. When comparing nested model pairs, the passive model with morpheme onset information explained significantly more activity than the naïve model in bilateral temporal and inferior frontal ROIs ($p=0.0001$). In turn, the predictive model explained more activity than the passive model in bilateral superior temporal cortex ($p<0.0001$). This supports models of speech processing that contain bottom-up and top-down morphological information. We also compared evoked responses across conditions by averaging long-stem stimuli time-locked to uniqueness points ($t=0$). We found an early effect, 200–50ms before uniqueness point, in the bilateral superior temporal cortex, showing more negativity for ambiguous vs. unambiguous stems ($p=0.002$). This could index 'eager' predictive processing of a potential morpheme boundary in ambiguous stems. A later effect, 50–125ms after uniqueness point (left temporal:$p=0.006$; right temporal:$p=0.02$), shows the opposite pattern, possibly reflecting boundary revision in ambiguous stems. Our results provide evidence for morphological segmentation during speech processing, and support models where the brain predictively segments words into morphemes, rather than passively waiting for uniqueness points or boundaries.

Topic Area: Morphology

Poster C41 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Intra- and inter-brain synchrony during (un)successful face-to-face communication

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Inter-brain neural synchrony has been observed during several cognitive tasks, such as joint attention, speech interactions and cooperative tasks, suggesting that neural alignment between individuals is an important feature of

social interactions. Nonetheless, it is still unknown whether intra- and inter-brain synchrony are necessary and/or beneficial for successful face-to-face communication. Here, we use dual-EEG to study the relation between neural synchrony, within and between conversational partners, and episodes of successful and unsuccessful communication during multimodal interactions. Moreover, we investigate whether the presence of co-speech gestures affects the strength of inter-brain neural synchrony. Dyads will perform a tangram-based referential communication task, while both their EEG and audiovisual behavior is recorded. We will compare brain-to-speech entrainment and inter-brain synchrony during episodes of miscommunication and episodes of mutual understanding. Additionally, we investigate whether co-speech gestures modulate these neural patterns. We expect that when communication is successful, inter-brain synchrony and brain-to-speech entrainment will be stronger than when communication is unsuccessful, and we expect that these patterns will be most pronounced when co-speech gestures are present. Preliminary results will be discussed.

Topic Area: Meaning: Discourse and Pragmatics

Poster C42 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

DTI-based structural connectivity of picture naming scores in chronic post-stroke aphasia

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Impairment in various features of speech production is a complicated phenomenon yet a widely occurring symptom among individuals with post-stroke aphasia. To date, aphasia researchers have primarily used either a single-case or small group designs to investigate associations between brain damage and language deficits. In this paper, we explore the relationship between structural connectivity (SC) in the brain and picture naming scores in a relatively large sample of persons with left hemisphere post-stroke. Ninety-three participants with chronic stroke (36 Broca's, 20 Anomia, 17 Conduction, 5 Global, 4 Wernicke's, 2 Transcortical Motor, and 9 no aphasia) were recruited and assessed using the Western Aphasia Battery, Revised (WAB-R) and neuroimaging data. We analyzed structural connectome measures of a left hemisphere neural network to detect brain networks supporting language outcomes from the Philadelphia Naming Task (PNT). An updated version of NiiStat (https://github.com/neurolabusc/NiiStat) was applied to explore the brain-language relationship using General Linear Model (GLM). Our analyses revealed that several regions primarily included in the dual-stream model of language processing are correlated with the task assessing picture naming abilities. Specifically, we found that increased white matter connectivity within the dorsal stream and between areas in the ventral and dorsal streams was associated with higher correct responses on the picture naming task (GLM z-scores between 3.93 to 4.81). In particular, connections between inferior frontal gyrus and superior temporal gyrus, inferior frontal gyrus and precentral gyrus, superior frontal gyrus and middle temporal gyrus, inferior frontal gyrus and supramarginal gyrus showed significantly positive correlation with number of correct responses on the PNT test. This means that the stronger the structural connection between these brain regions is, the better participants of this study performed on the PNT test. It is clear that different features of speech production are processed by a network of regions distributed across the brain, and disruption in any of these regions could result in impaired language performance. The current research shows that higher score on the picture naming task is correlated with higher synchrony in the dual-stream network of language. Discussion will focus on the role of structural brain connections in supporting object naming, and the extent that structural connections/disconnection can be useful in predicting language outcomes in aphasia.

Topic Area: Language Production

Poster C43 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

What's in the Sound? fNIRS neuroimaging reveals cross-linguistic differences in neural organization for phonological awareness in Spanish-English bilingual learners.

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How does the developing bilingual brain build foundational literacy skills for each of the child's languages? Phonological awareness helps children map language sounds onto letters, thereby providing a foundational stepping stone to literacy development across languages. Theories of bilingualism pose that phonological awareness is a linguistically-shared skill that offers a common foundation for dual-language literacy development. We tested the neuro-cognitive bases of this theoretical assumption by asking Spanish-English bilingual heritage language learners raised in the US to complete phonological awareness tasks in each of their languages during functional Near Infrared Neuroimaging (fNIRS), along with behavioral literacy measures (n = 48, Mage= 8.2(1.4)). In our methodological description, we detail an efficient fNIRS neuroimaging approach, a portable/accessible/low-cost neuroimaging method - and as it applies to studying populations underrepresented in neuroimaging research. In Spanish and in English, the neuroimaging task engaged the phonological neural network, including left frontal and temporal regions - supporting the idea of language-common neural organization for phonological processing across bilinguals' two languages. Nevertheless, brain-behavior correlation revealed a positive association between left temporal/STG activation phonological proficiency during the Spanish task and a negative association between left STG and phonological proficiency during the English task. We follow-up on these findings with person-specific functional connectivity approach for each of the children's languages using the Group Iterative Multiple Model Estimation (GIMME) to reveal cross-linguistic differences in functional organization for phonological processing in bilinguals' two languages and its association with dual-language proficiency. Taken together, the results suggest that bilingual children's neural architecture for spoken language skills that are foundational to literacy reflect cross-linguistic differences between the children's two languages and their experiences with those languages. The findings thus inform theories of bilingualism and those of dual language literacy development.

Topic Area: Multilingualism

Poster C45 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Using multivariate pattern analyses of EEG to examine linguistic transfer in second language learning

Victoria Ogunniyi[1], David Abugaber[2], Irene Finestrat[3], Alicia Luque[4], Kara Morgan-Short[5,6]; [1]Honors College, University of Illinois Chicago, [2]Department of Linguistics, University of Michigan, [3]Department of Spanish and Portuguese, Northwestern University, [4]Department of Language and Culture (ISK), UiT The Arctic University of Norway, [5]Department of Hispanic and Italian Studies, University of Illinois Chicago, [6]Department of Psychology, University of Illinois Chicago

Grammar learning is an important aspect of learning a second language (L2). However, theories disagree about the role of grammatical transfer between a learner's L2 and their native language (L1) (e.g., Tsimpli & Dimitrakopoulou, 2007; Schwartz & Sprouse, 1996). Event-related potential (ERP) research on this topic has produced conflicting results, with some studies finding native-like ERPs to L2-specific grammar features (e.g., Alemán Bañón et al., 2014), whereas other studies show only trends toward sensitivity (e.g., Gabriele et al., 2021). This disparity may be attributed to variability during language processing resulting in qualitatively different ERP responses among individuals, in which negative and positive ERP components associated with linguistic processing (i.e., N400 and P600) may cancel each

other out, leading to null results in group-averaged analyses even when individual participants show neural evidence of native-like grammar processing (Tanner, Goldshtein, & Weissman, 2018). Our study addresses this limitation in previous ERP examinations of linguistic transfer for different domains of L2 grammar via multivariate pattern analysis (MVPA), a machine learning method that accounts for individual differences in neural activity by calculating, for each participant, patterns in correlations between electrodes that best distinguish trial conditions (Fahrenfort et al., 2018). In our experiment, 52 native English speakers were recruited from second-year university Spanish courses who evidenced low-intermediate Spanish proficiency. Participants read Spanish sentences while performing a grammaticality judgment task during simultaneous electrophysiological recording (EEG). Sentences consisted of three conditions that tested either grammatical features shared between L1 English and L2 Spanish (30 grammatical/30 ungrammatical trials for subject-verb number agreement; 31 grammatical/31 ungrammatical trials for determiner-noun number agreement) or a feature unique to L2 Spanish (31 grammatical/31 ungrammatical trials for determiner-noun gender agreement). For each of these three conditions, MVPA was performed to distinguish grammatical vs. ungrammatical trials on -200 ms to 1200 ms relative to the critical word in each sentence. Analyses were performed via the ADAM toolbox (Fahrenfort et al., 2018) using a backward decoding model based on a linear discriminant analysis classifier with cross-class balancing of sample sizes and five-fold cross-validation and included correction for multiple comparisons using cluster-based permutation testing. Behavioral results showed above-chance accuracy in grammaticality judgments for each of the three conditions (subject-verb agreement $d'=1.14$, determiner-noun number agreement $d'=0.95$, determiner-noun gender agreement $d'=0.93$). For our EEG results, our MVPA decoding yielded above-chance trial classification accuracy to features shared between their L1 and the L2 (subject-verb number agreement, determiner-noun number agreement), but only in learners with higher proficiency. Above-chance trial classification accuracy was not found for features unique to the L2 (determiner-noun gender agreement). Our finding of significant MVPA decoding only for L2 grammatical features that are shared with the L1 is most consistent with transfer theories that posit differences for L2-unique grammatical features, although future studies should examine high proficiency L2 learners to fully test the predictions. More generally, this study represents (to our knowledge) the first use of MVPA to analyze L2 grammar processing, demonstrating how this technique can complement the ERP method to inform theoretical questions about learning L2s.

Topic Area: Multilingualism

Poster C46 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Closely connected: linking functional connectivity and word-finding difficulties in older adults

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Ageing leads to word-finding difficulties, reflected by age-related decreases in verbal fluency. Functional brain networks, which reflect the neurophysiological organisation, change with age and have been linked to age-related decreases in cognitive performance. This study aimed to investigate the relationship between age-related decreases in verbal fluency and functional brain networks, specifically segregation and integration, which represent communication between neighbouring and distant brain regions, respectively. We hypothesised that decreased network segregation is related to word-finding performance in older adults, but not in younger adults. Secondary data analysis was performed on data from 106 right-handed younger and older adults (N=53 per group) from the Leipzig Study for Mind-Body-Emotion Interactions (Babayan et al., 2019). The subset of participants used had no history of alcohol nor substance abuse, and no depression. Participants had completed a category and letter fluency task. We estimated functional networks from eyes-closed resting-state electroencephalography (EEG) recordings (61 channels). Debiased weighted Phase Lag Index was computed to index the strength of connectivity between each pair of electrodes to obtain a fully-weighted brain network. The network was then filtered with a data-driven Orthogonal

Minimum Spanning Tree algorithm. Segregation and integration were measured through the clustering coefficient (CC), modularity, and average path length (PL). Multiple linear regression analyses were conducted to investigate the effect of age, segregation, and integration on verbal fluency performance. The study was preregistered on the Open Science Framework (https://osf.io/u6p42). Our results indicated that, in older adults, both CC (β = -250.0, p = .023) and modularity (β = -24.1, p = .041) were inversely related to category fluency in the beta band. In the delta band, CC was positively related to letter fluency (β = 169.3, p = .016) and modularity was positively related to category fluency (β = 34.4, p = .02), irrespective of age. Regarding brain integration, we found the average PL was positively related to letter fluency in the delta band, irrespective of age (β = 6.2, p= .040) and an age effect on letter fluency in the theta band (β = 4.0, p = .047). These results indicate that brain segregation and integration are related to word-finding in older adults in a way that is specific to EEG frequency band. Hence, this study demonstrates that neural mechanisms at rest can be linked to age-related declines in word-finding ability. More specifically, decreased brain segregation does not always lead to declines in cognitive performance in older age. If segregation and integration states are too high during rest, the brain might be less flexible to change to the correct network configuration during cognitive tasks, leading to lower task performance. Babayan, A., Erbey, M., Kumral, D., Reinelt, J. D., Reiter, A. M. F., Röbbig, J., Schaare, H. L., Uhlig, M., Anwander, A., Bazin, P.-L., Horstmann, A., Lampe, L., Nikulin, V. V., Okon-Singer, H., Preusser, S., Pampel, A., Rohr, C. S., Sacher, J., Thöne-Otto, A., … Villringer, A. (2019). A mind-brain-body dataset of MRI, EEG, cognition, emotion, and peripheral physiology in young and old adults. Scientific Data, 6(1), 180308

Topic Area: Language Production

Poster C47 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam C session.

Tracking lexical access during sentence production

Adam Morgan[1], Werner Doyle[1], Orrin Devinsky[1], Adeen Flinker[1]; [1]NYU School of Medicine

During word production, stages of lexical representation come online in a feed-forward sequence beginning with the conceptual, then grammatical, phonological, and finally articulatory (Levelt, 1989; Indefrey, 2011). However, this model is based primarily on picture naming data, and recent work indicates that the temporal dynamics of lexical access may be fundamentally different during sentence production (Momma & Ferreira, 2019). Here, we employ direct neural recordings (ECoG) in humans and leverage a machine learning (decoding) approach to track the activation of two stages of lexical representation during sentence production, elucidating (1) the patterns of neural activity that code for discrete stages of lexical representation (conceptual/articulatory), and (2) the temporal dynamics of these stages during various production tasks. Eight patients undergoing neurosurgery for refractory epilepsy repeatedly produced 6 nouns (dog, ninja, etc.) in response to cartoon images while electrical potentials were measured directly from cortex. In picture naming blocks, patients saw an image of a cartoon character and responded overtly (“dog”). In scene description blocks, patients saw cartoon images of the same characters embedded in static scenes and produced corresponding sentences (e.g. “The dog tickled the ninja”). We were able to predict above chance ($p<0.05$ permutation test, accuracy level ~30%) which of the 6 nouns a subject was about to produce during sentence production using multi-class classifiers trained on data from the picture naming block. To track words’ articulatory representations during sentence production, we leveraged neural activity patterns during picture naming which encode articulatory information in the time window just prior to articulation to train an “articulatory classifier.” We then used this classifier to predict word identity during sentence production trials. This analysis accurately predicted word identity ~200ms prior to each word’s articulation onset in sentences. Next, we aimed to track the conceptual stage of lexical representation during sentence production. Conceptual processing is the first stage of lexical access, so we assume that the first word-specific differences in neural activity patterns after stimulus onset during picture naming (excluding vision-related electrodes) reflect conceptual information. In preliminary analyses, we identified this time period for each patient by decoding word identity in just the picture

naming data at each time point from stimulus onset using 10-fold validated multi-class classifiers. Once the time point was identified, we used all of the picture naming trials from that time point to train a "conceptual classifier," which we successfully used to predict word identity during sentence production. For the first noun in a sentence (the subject), conceptual representations were detected at comparable times (relative to articulation onset) to nouns produced during picture naming. However, the second noun in a sentence (the object) was detected later, suggesting that for words in the middle of a speech stream, the sequence of lexical stages may be temporally condensed. Our results constitute an important step toward understanding how the brain accesses words during fluent speech, and toward linking neural spatiotemporal codes to theoretical models of sentence production.

Topic Area: Language Production

Poster C48 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Effects of multilingual experience on oscillatory dynamics in working memory

Sergio Miguel Pereira Soares[1,2], Yanina Prystauka[3], Vincent DeLuca[3], Jason Rothman[3,4]; [1]University of Konstanz, [2]Max Planck Institute for Psycholinguistics, [3]UiT The Arctic University of Norway, [4]Nebrija University

At least under specific conditions of individual-level experience/engagement with multilingual language exposure and use, bi-/multilingualism can lead to structural and functional brain adaptations (Bialystok & Craik, 2022). However, the effects of bi-/multilingualism on the neural underpinnings of working memory (WM) remain understudied. Research using time-frequency representations (TFRs) has shown that WM tasks (e.g., N-back task) modulate power within theta- and alpha frequency bands. These power modulations have been linked to a greater engagement of the WM control system (Riddle et al., 2020). Herein, we use EEG with a WM task (N-back task: 0-, 1-, and 2-back), to investigate if/how group and individual language experience differences modulate neurocognitive oscillatory dynamics. The N-back is an especially appropriate task given recent proposals that situate potential mechanisms for bilingual effects to neurocognition squarely within the broader attentional control system (Bialystok & Craik, 2022): beyond its obvious WM component, the N-Back task builds in complexity incrementally and thus progressively taxes the attentional system. EEG and behavioral data were collected from 28 early bilinguals and 32 late-acquired L2 learners. Participants also completed the Language and Social Background Questionnaire (LSBQ). TFRs were computed for the 0-back-, 1-back and 2-back trials. Two WM (cognitive) loads were calculated: low WM load (difference between 1-back and 0-back conditions) and high WM load (difference between 2-back and 1-back conditions). These measures were used as (i) comparison between early- and later acquired bilinguals (via cluster-based permutations analysis), (ii) a function of individual differences in language experience using continuous measures of bilingualism derived from the LSBQ (group level), and (iii) behavioral performance predictors. We predicted greater brain engagement in early- compared to late bilinguals, specifically increased (frontal) theta activation followed by (frontoparietal) alpha suppression, especially in the high WM load situation. Furthermore, we hypothesized the degree of active bilingualism to predict changes in alpha and beta bands in both early and late bilinguals. Finally, we predicted a correlation between reaction times (RTs) and power within the alpha- and theta bands. We observed significant differences (mostly in theta and alpha frequency bands) between groups for both the low and high WM load conditions. Furthermore, individual differences analyses revealed significant correlations between age, age of acquisition, and usage of the non-societal language in Social environments with theta, alpha and beta band activity for both high WM loads and low WM loads. Finally, when correlating alpha power with RTs, early bilinguals showed a negative correlation while later bilinguals show a positive correlation (for the high WM load situation only). These findings indicate adaptations towards differential brain recruitment to deal with the memory (cognitive) demands associated with variation in language experience which crucially have implications for domain-general control processes. References Bialystok, E., & Craik, F. I. (2022). How does bilingualism modify cognitive function? Attention to the mechanism. Psychonomic Bulletin & Review, 1-24. Riddle, J., Scimeca, J. M., Cellier, D., Dhanani, S., & D'Esposito, M. (2020). Causal evidence for a role of theta and alpha oscillations in the control of working memory. Current Biology, 30(9), 1748-1754.

Topic Area: Multilingualism

Poster C49 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Norms for Image Naming in Older Adults

Sara Pillay[1], Cassidy Bertagnoli[2], Jena Burton[2], Sabine Heuer[2]; [1]Medical College of Wisconsin, [2]University of Wisconsin-Milwaukee

Introduction: Image naming paradigms have been broadly utilized to better understand the linguistic processes underpinning theories of lexical retrieval and to explore linguistic deficits in people with neurologic communication disorders such as aphasia and dementia. These disorders become more common with increasing age (Chen, Lin, & Chen, 2009; Engelter et al., 2006; Kelly-Hayes, 2010). However, lexical retrieval is affected in both, healthy aging adults (Au et al., 1995; Connor, Spiro, Obler & Albert, 2004; Feyereisen, 1997; Mortensen, Meyer, & Humphrey, 2006; Spieler & Balota, 2000) and people with neurologic disorders (Adlam et al., 2006; Bayles, Tomoeda, & Trosset, 1990, Goodglass & Wingfield, 1997, Raymer, 2005). Therefore, norms for image naming in older adults are important for defining what constitutes normal performances at different age cohorts, but also to refine markers for impaired word finding. To date, norms for image naming in older adults are lacking (Souza, Garrido, & Carmo, 2020). The purpose of this study is to provide norms for older adults free of neurologic impairments on a freely available, large set of photographs of everyday objects, normed for a large number of normative variables on younger adults, the Bank of Standardized Stimuli (BOSS, Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010; Brodeur, Guérard, & Bouras, 2014). Methods: Twenty-three participants were recruited. All are native speakers of English, at least 50 years old, and are self-reportedly free of neurologic deficits. Each participant was presented with 600 photographs of common objects derived from the BOSS on a computer screen and was asked to name each image as quickly and accurately as possible. Accuracy and response times were recorded and analyzed. The normative variables modal name, name agreement and name accuracy were computed. Results: Preliminary results revealed mean naming accuracy across participants at 84.49%. The analysis for modal name agreement indicated an overall 80 % agreement across the 600 stimuli. Our long-term goal is to recruit a total of 80 participants between the ages of 40-80. In addition to establishing norms for older adults on the BOSS, we aim to establish an index of image naming difficulty based on the normative variables (i.e. reaction time, % modal name agreement). This index will be valuable for stimulus selection in studies utilizing image-naming paradigms with older individuals with and without neurologic deficits. Lastly, we plan to analyze data for across age groups to characterize changes in naming abilities with increase in age. Conclusions: Image naming performance is commonly studied in people with and without neurological deficits. Norms across the age range for image naming are a critical prerequisite for behavioral research that tackles theoretical as well as clinical questions.

Topic Area: Language Therapy

Poster C50 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Using MEG/EEG and multivariate analyses to investigate neural computations of word meaning from spoken language

Victoria Poulton[1], Máté Aller[1], Lucy MacGregor[1], Matt Davis[1]; [1]University of Cambridge

How do listeners settle on the appropriate meaning of ambiguous words? Previous behavioural research shows that multiple alternative meanings of ambiguous words (e.g., “bank”) are transiently activated before the contextually-appropriate meaning is selected (Onifer & Swinney, Mem. Cognit., 1981; Swinney et al., Mem. Cognit., 1979). Ambiguous words therefore allow us to study how and when listeners incorporate contextual information during word recognition and meaning selection. Here, we contrast two neural computations proposed to drive meaning selection: (1) “sharpening” computations, in which representations of predictable contextually-appropriate meanings are enhanced or sharpened; and (2) “prediction error” computations, in which predictions are subtracted from the meaning of heard words.The goal of the present study is to determine the neural time course and source localisation of the computation of meaning during spoken sentence comprehension. Often, univariate analyses are employed to investigate the impact of different factors (e.g., lexical information, prediction, semantic constraint) on the amplitude of ERP/ERF components like the N400. The change in N400 response magnitude has been interpreted to reflect the magnitude of prediction error (Rabovsky et al., Nat. Hum. Behav., 2018). However, changes in response magnitude are consistent with multiple computations, including sharpening or prediction error (Aitchison & Lengyel, Curr. Opin. Neurobiol., 2017). Therefore, we will instead use a multivariate approach with representational similarity analysis (RSA) in order to assess neural responses to sentence-final ambiguous words and matched single-meaning controls. Multivariate analyses of selected and suppressed meanings allow us to distinguish sharpening and prediction error computations during the comprehension of ambiguous words, as these neurocomputational proposals make opposing predictions for the similarity of neural responses within critical pairs of trials. To date, simultaneous MEG/EEG data have been collected from three participants; and we intend to pre-register an analysis with N>30 datasets. Participants listened to sets of sentences, with examples like “While sailing down the river, she noticed the trees along the…”, which are biased towards one meaning of a target ambiguous word (here, “bank”). A sentence in the set can end in either the ambiguous word, a contextually-consistent synonym (e.g., “shore”), or an unpredictable word related to the non-selected, alternative meaning (e.g., “account”). For each critical comparison (i.e., ambiguous “bank” vs. synonym “shore” and ambiguous “bank” vs. alternative “account”), we will calculate the multivariate dissimilarity between the neural response patterns across samples (i.e., spatial dissimilarity over time) and across space (i.e., temporal dissimilarity across sensors/sources). Sharpening proposals predict low dissimilarity (i.e., high similarity) between neural responses to ambiguous words (“bank”) and contextually-consistent synonyms (“shore”) as the predictable meaning (<riverbank>) is shared. In contrast, prediction error proposals predict low dissimilarity for the other comparison – ambiguous words (“bank”) and alternative meaning words (“account”) – as both of these words will elicit a qualitatively similar prediction error for the unexpected meaning of the ambiguous word (<financial institution>). With the high temporal and spatial resolution of combined MEG/EEG, the results of this study will allow us to determine the time course and spatial dynamics of ongoing neural computations underlying meaning comprehension from spoken sentences.

Topic Area: Meaning: Lexical Semantics

Poster C51 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Auditory discrimination in quiet and noisy backgrounds: cognitive control differences between stuttering and non-stuttering adults

M. Blake Rafferty[1], Ashley Harkrider[1], Eddie Brown[1], Tim Saltuklaroglu[1]; [1]University of Tennessee Health Science Center

In addition to disrupting speech fluency, stuttering is associated with cognitive control deficits. However, few neuroimaging studies have addressed these deficits. We recorded electroencephalography (EEG) as 20 adult persons who stutter (PWS) and a matched control group (CG) discriminated auditory stimuli in quiet and noisy backgrounds 160 times per condition. Trials with correct responses were subject to additional analysis. Source reconstructed time-frequency data from bilateral premotor/motor and posterior auditory regions were similar in PWS and CG groups in the quiet condition. In the noisy condition, prior to stimulus onset (early attention), CG displayed stronger high alpha (10-13 Hz) enhancement in premotor/motor regions compared to PWS. In contrast, PWS showed stronger beta (15-25 Hz) suppression especially in the right hemisphere. Immediately following stimulus presentation (working memory encoding), PWS showed stronger low alpha (7-10 Hz) suppression compared to CG, especially in left auditory regions. Beginning about 1000ms after stimulus offset (working memory retention), CG showed stronger high alpha

enhancement in left premotor/motor and right auditory regions. Audio-motor coherence was stronger in the right hemisphere for both groups. In the noisy condition, beta coherence was weaker in PWS in the right hemisphere. Data indicate that 1) PWS have selective attention deficits that reduce their ability to filter noise and result in increased reliance on prediction of forthcoming stimuli; 2) PWS are compromised in their ability to retain information in noise and rely more heavily on encoding as stimuli enter working memory. Inhibitory deficits may be attributed to basal ganglia dysfunction underlying stuttering.

Topic Area: Disorders: Developmental

Poster C52 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Auditory feedback perturbation as a window into functional links between production and perception in Spanish/English bilinguals

Madeleine Rees[1], Abbie Bradshaw[2], Brechtje Post[1], Matt Davis[2]; [1]University of Cambridge, [2]MRC Cognition and Brain Sciences Unit, Cambridge

Introduction. The relationship between speech production and speech perception is highly debated. In auditory feedback perturbation experiments, the speaker learns to adjust their own feedforward speech motor commands to offset the perceived error (in reality the altered feedback). This process, termed adaptation, suggests that production and perception representations of speech sounds inform and constrain each other. Novel feedback perturbation studies of bilingual participants show that speakers with greater experience in a second language show stronger adaptation responses in that language (Shiller et al., 2021). This result suggests that the interaction between production and perception representations, previously seen in response to feedback perturbation, takes time to develop in a second language. However, it is not known with certainty how adaptation functions in bilinguals nor cross-linguistically, especially in similar (but not identical) vowels, and across dense and sparse vowel spaces. To address this gap, this experiment examines how an individual's magnitudes of adaptation in their dominant language relate to those in their non-dominant (but phonologically similar) language. Methods. Two participant groups of English-dominant (n=12) and Spanish dominant (n=11) English/Spanish bilinguals (approximately C1-level proficiency in non-dominant language) underwent altered auditory feedback tasks in both languages. In the baseline phase, speakers produced 30 unperturbed tokens of the words "head" (English) and "dedo" (Spanish). During the English Hold phase, speakers produced 30 trials of "head", while in the Spanish Hold phase, speakers produced 30 trials of "dedo". In the Hold phase, vowel productions were downshifted by 130 mels in F1 and upshifted by 130 mels in F2 in real time, using Audapter (Cai et al., 2008). Adaptation magnitudes were calculated by projecting F1 and F2 change in each trial onto the vector of perfect opposition (+130 mel in F1 and -130 mel in F2). Preliminary Findings. In the English task, English-dominant bilinguals showed significantly more adaptation to altered feedback than the Spanish-dominant bilinguals (p=0.0127). In the Spanish task, both groups followed the perturbation similarly. Unexpectedly, the Spanish-dominant group showed a significant increase in adaptation in their non-dominant language (p=0.0410). Conclusions and projections. Language dominance is associated positively with adaptation only in English. Vowel space density in the task language appears to negatively influence adaptation, as the perturbation in the sparser Spanish vowel space is less likely to encroach upon a vowel category boundary. Future work will assess production after-effects from feedback perturbation, to ascertain if bilingual speakers share phonological representations in similar vowels cross-linguistically, and can transfer effects of motor learning across languages. Further statistical analysis will investigate potential differences between compensation and adaptation processes by dividing hold phase tokens into early and late time windows. References: Cai, S., Boucek., M, Ghosh, S.S., Guenther, F.H., & Perkell, J.S. (2008). A system for online dynamic perturbation of formant frequencies and results from perturbation of the Mandarin triphthong /iau/. In Proceedings of the 8th Intl. Seminar on Speech Production, Strasbourg, France, Dec. 8-12, 2008. Shiller, D.M., Bobbit, S. & Lametti, D. R. (2021). Sensorimotor adaptation in bilingual speech. SNL 2021 Virtual Edition, 5-8 October 2021.

Topic Area: Speech Perception

Poster C53 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Does Bilingualism Reduce False Hearing in Older Adults?

Chad Rogers[1], Isabela Albuja[1]; [1]Union College

Being bilingual is not only about speaking more than one language, it is a quality that could be a protective factor against cognitive decline. Previous research has demonstrated that bilinguals frequently outperform monolinguals in tasks that are associated with age-related cognitive decline to executive function, working memory, and inhibitory control. Green (1998) proposed the Inhibitory Control Model (ICM) which states that when speaking a given language, bilinguals need to inhibit the other language they know but are not currently using. This model holds that constant inhibition of the non-target language reinforces bilinguals' inhibitory control abilities, which confer benefits on more general executive control tasks. The aim of the current study is to examine whether an age-related bilingual advantage would generalize to the generalize to the false hearing task (e.g., Rogers, 2017), a language task related to cognitive control (Failes, Sommers, & Jacoby, 2020). In one version of the false hearing task, participants hear a clearly presented cue word followed by a target word masked by noise. The cue word can either be related to the target (e.g., "BARN-HAY"), related to a word that sounds like the target ("BARN-PAY"), or totally unrelated to the target (e.g., "BARN-FUN"). Participants identify the word in noise, rate their confidence, and are instructed to respond only on the basis of what they heard, not the associative context primed by the cue word. An online version of the false hearing task was administered to young and older adults who self-reported as being either monolingual or bilingual. Results will be evaluated in terms of bilinguals' presumed capacity of inhibiting irrelevant stimuli as predicted by the ICM and implications towards aging will be discussed.

Topic Area: Multilingualism

Poster C54 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Exploring functional and structural language differences in autism spectrum disorder

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While autism spectrum disorder (ASD) is characterized by difficulties in everyday communicative language use (Vulchanova et al, 2015), evidence from a limited number of neuroimaging studies suggests that language processing itself may also be altered, in at least a subset of this population (Mody and Belliveau, 2013). Functionally, autistic individuals have been documented to show relatively greater recruitment of right hemisphere homologues of the language network than neurotypical (NT) individuals, amounting to atypical functional lateralization in ASD (Jouravlev et al., 2020). Structurally, there have been reports of anatomical alterations in the ASD language network, though the alterations have not been directly associated with language processing (Ecker et al., 2013). The current study aims to expand upon prior suggestions of atypical language processing in ASD by integrating functional lateralization and anatomical asymmetry in ASD, with structural magnetic resonance imaging (MRI) data from a sample of 41 adults with ASD and 35 controls (matched in verbal IQ). First, we attempted to replicate prior observations of reduced lateralization in ASD, using a language localizer task designed to reliably activate the language network (sentences > non-word sequences; adapted from Fedorenko et al., 2010). Second, an analysis of gray matter asymmetry will be performed to test for a possible association between functional and structural language differences. Preliminary behavioral results indicate that both groups covered the attention and memory demands of the task equally well, as

shown by the high accuracy of the task. As expected, processing word sequences activated brain regions commonly associated with the language network in all participants. More precisely, activation was observed in the inferior frontal gyrus and temporal regions of the left hemisphere, as well as temporal regions in the right hemisphere, with no differences between groups. These findings will need to be confirmed with Bayesian inference. Furthermore, our early results are not supportive of atypical functional lateralization across the ASD group. There were no significant differences in the degree of lateralization between groups (measure based on lateralization index, Jouravlev et al., 2020) (MASD = 0.491; MNT = 0.605; p = 0.319). The results of a multiple regression analysis with verbal IQ and autism quotient scores (AQ, Baron-Cohen et al., 2001) further suggest that the lack of differences cannot be ascribed to variation in language ability or autistic traits of participants. An ongoing analysis focuses on exploring gray matter asymmetry in ASD. More specifically, voxel-based morphometry (VBM) analyses will be conducted to investigate group differences in gray matter volume across hemispheres. Autism spectrum disorder is a complex disorder with marked differences in language production and comprehension, driven by alterations in the brain. Integrating functional and structural levels of analysis may provide a new angle on these differences.

Topic Area: Disorders: Developmental

Poster C55 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Investigating the role of spectral cues in eliciting the Speech-to-Song Illusion

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The Speech-to-Song (S2S) illusion is an auditory phenomenon where a spoken phrase repeated in sequence will begin to sound like it is being sung (Deutsch et al., 2011). Prior research has looked at the acoustic properties that may give rise to a song-like percept and found that variations in pitch and rhythm, both of which are fundamental to music perception, are important drivers of the S2S illusion (e.g., Groenveld et al., 2020; Falk et al., 2014). Here, we further examine the role of pitch in the S2S illusion. Specifically, we converted 12 lists, each comprising three English words, into whispered and sinewave (SW) speech. Whispered speech preserves the formant transitions and the envelope of speech, but the fundamental frequency is lost. SW speech lacks the fundamental frequency and degrades the formant transitions but keeps the original speech envelope intact. While it is difficult to understand SW speech, listeners are better able to identify the words if they are made aware that they are listening to speech (Vanden Bosch der Nederlanden et al., 2015). To look at this top-down effect on the S2S illusion, some participants were told that the SW block was based on speech (Known-SW speech) and others were not (Unknown-SW speech). We predicted that because whispered and SW speech lack pitch cues, both will elicit a stronger S2S illusion compared to regular speech by allowing rhythmic qualities to stand out, and this effect may be stronger when listeners do not know SW is based on speech. We recruited both musicians and non-musicians to examine if musical expertise influences the strength of S2S illusion. Thus far, twenty participants (12 musicians and 8 non-musicians) participated. Participants completed three blocks (SW, Whispered, Regular speech) with 12 trials per block. Each trial played one iteration of a three-word list and then asked participants to rate on a Likert scale of 1 to 9 whether the list sounded most like speech ('1') or most like song ('9'). After this initial rating (R1), listeners heard the list repeated 9 times and were asked to once again rate on a scale of 1 to 9 (R9). First, no significant differences between R1 and R9 were observed for any of the three speech conditions, indicating that stimulus repetition did not elicit robust S2S illusory perception in the present study. Similarly, no significant effects were found between the musician and non-musician groups or between the Known-SW and Unknown-SW groups, which could be due to the currently small samples sizes. However, overall, participants reported significantly higher (i.e., more song-like) ratings for the SW speech condition compared to both the Whispered and Regular speech conditions, for both the initial (R1) and the final (R9) rating. Moreover, there were no significant differences in R1 or R9 ratings between the Whispered and Regular speech conditions. These preliminary results indicate that the degradation of formant transitions (as in SW speech) gives rise to more song-like perception initially, but this manipulation does not strengthen the S2S illusion.

Topic Area: Perception: Auditory

Poster C56 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Modulating language processes by synchronizing brain oscillatory activity

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Recent advances underscore the role of functional network-level impairments in post-stroke aphasia. Stroke induces disruptions in the lesion zone and in functionally connected brain regions far from the lesion. A fundamental mechanism proposed for interregional communication (connectivity) is coordinated or synchronized oscillatory activity between distant brain regions. Disruptions in this synchronized activity can impede relevant information transfer across the language network and contribute to language impairments in aphasia. Our current work focuses on examining whether synchronized oscillatory activity can be manipulated in the language network using high-definition transcranial alternating current stimulation (tACS), and whether it is possible to restore normal synchronization to induce language recovery in post-stroke aphasia. One mode of oscillatory communication is via synchronization of phases (systematic phase differences between two or more anatomically distinct regions), which is hypothesized as a mechanism by which distant task-relevant brain regions integrate information across a network. For example, theta phase synchronization between prefrontal and temporal areas has been shown to support resource monitoring and storage in visual working memory. tACS was shown to directly interact with ongoing, task-relevant oscillatory activity and to influence the phase synchronized activity between stimulated regions. The behavioral effects depend on tACS phase and frequency, but these have not been systematically evaluated in the context of higher-level language processes. We evaluated the ability of tACS to modulate picture naming performance in 4 older healthy individuals (age range 61 to 69; 2 women) and 2 stroke survivors with aphasia (men; age 56 and 44 years). We tested our tACS setup with sham, in-phase (0-degree phase difference) and anti-phase (180-degree difference) modes using theta (4-7Hz) and alpha (8-12Hz) frequencies, targeting inferior frontal and parietal regions. During and immediately after tACS, participants engaged in a picture naming task including control trials with scrambled pictures, with concurrent collection of EEG. TACS was applied at 1mA peak-to-peak amplitude using two 3x1 center-surround montage configurations placed over left frontal and parietal regions. To assess the phase and frequency-specific effects of tACS, we computed imaginary coherence, a measure of phase synchronization, between stimulated regions on the post-tACS EEG data. We hypothesized improvement in naming accuracy and/or reaction times and increased synchronization with in-phase tACS, and diminished performance and reduced synchronization with anti-phase tACS, compared to sham-tACS. No major side effects were reported with tACS. Participants could not distinguish sham-tACS. In-phase alpha-tACS increased alpha synchronization, and anti-phase theta-tACS decreased theta synchronization between the targeted frontoparietal regions compared to sham-tACS. Naming accuracy in response to real pictures increased in 2 healthy controls and the stroke patient receiving anti-phase theta-tACS. Two healthy controls and the stroke patient who received in-phase alpha-tACS showed increased accuracy. Increase in accuracy after anti-phase theta-tACS was unexpected. Suppression of frontoparietal theta synchronization with anti-phase tACS may have enhanced synchronization with another, more pertinent region(s) in the network. Our preliminary results indicate the feasibility of tACS to manipulate synchronized oscillatory activity underlying language processes. The relationship between tACS phase and frequency may be non-linear, depending on the ongoing activity in the language network.

Topic Area: Disorders: Acquired

Poster C57 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Automated markers of bulbar motor disease in ALS: Vowel articulation of natural speech

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Introduction: Bulbar motor impairment affects over 92% of people with amyotrophic lateral sclerosis (ALS), leading to a loss of speech and swallowing, with detrimental effects on survival and quality-of-life. Digital speech analytics show promise as automated, quantitative markers of bulbar disease. However, existing platforms analyze structured “pseudo-speech” tasks which lack face validity and therefore give limited insight into clinical outcomes such as intelligibility and swallowing difficulties, and may be confounded by cognitive impairment. This study tests a novel, automated analysis tool of natural speech that focuses on vowel acoustics which have direct lingual (tongue) articulatory underpinnings. We hypothesized that measures related to tongue articulation will be sensitive and specific to bulbar motor impairment in ALS, compared with neurodegenerative controls with behavioral variant frontotemporal dementia (bvFTD) and healthy controls (HC). Methods: We analyzed picture descriptions provided by 83 ALS (10 with ALS-FTD), 34 bvFTD, and 80 healthy controls (HC). Fifty-three ALS speakers had bulbar disease (ALS+bulbar, vs. n=28 ALS-bulbar), based on bulbar scales of ALS Functional Rating Scale-revised and Penn UMN score. Seventeen ALS had longitudinal data (n=9 ALS+bulbar at baseline). The automatic vowel analysis involved tagging vowels using a pronunciation dictionary, extracting their temporal (durational) and spectral acoustic properties (i.e., first and second formants, or F1 and F2, reflective of tongue position in high-low and front-back directions in the mouth), and calculating articulatory-acoustic measures: (1) vowel space area using the F1/F2 coordinates of corner vowels, (2) high-low vowel-pair distance (proxy of tongue elevation magnitude), (3) ΔF2/time during consonant-to-vowel transitions (i.e., F2 slope, measure of articulatory speed), and (4) average vowel duration. We compared ALS, bvFTD, vs. HC; and ALS+bulbar, ALS-bulbar vs. HC, covarying for demographic differences using ANCOVAs, and assessed discriminatory ability using logistic regression and receiver operating characteristic curve analysis. Linear regressions tested the associations of vowel features with bulbar motor and cognitive scores (Edinburgh Cognitive Assessment Scale). Linear mixed modelling assessed within-individual change over time and interactions with bulbar motor group at baseline, covarying for cognitive scores. We explored relations to MRI grey matter volume (GMv) and white matter diffusivity of speech network regions. Results: F2 slope was reduced, and vowel duration was longer in ALS vs. bvFTD ($p = .003$, $p = .046$) and HC ($p = .013$, $p < .001$), and correlated with bulbar motor scores (F2 slope: $R = .46$, $p =.002$; duration: $R = -.37$, $p =.008$). ALS+bulbar were impaired across all 4 measures compared to ALS-bulbar and HC (each $p < .032$). Vowel measures together classified ALS+bulbar vs. ALS-bulbar with area under the curve=.86. Longitudinally, ALS+bulbar significantly decreased F2 slope and increased vowel durations (both $p<.001$), but not ALS-bulbar. None of the measures differed between bvFTD and HC, nor were associated with cognitive impairment or demographics. Shallower F2 slope was related to reduced ventral precentral gyrus GMv ($R=.36$, $p= .05$) and corticospinal tract anisotropy ($R=.30$, $p=.04$). Summary: Automated vowel acoustic features of natural speech are sensitive, independent markers of bulbar motor disease in ALS spectrum disorders.

Topic Area: Speech Motor Control

Poster C58 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Simulating individual differences in response to alexia therapies

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Acquired reading disorders are common after stroke, and while there are effective reading therapies, patient outcomes are highly variable. Reasons for this variability include the severity and location of stroke-related brain damage, as well as the specific therapy utilized by clinicians. This is compounded by the lack of a formal understanding of which therapy is ideal for a given patient's specific impairment. Computational models of reading offer a potential solution to this problem. A full range of possible reading impairments can be simulated, and therapies can be tested against each other to determine which promotes the greatest recovery. We compared the performance of two treatments in their capacity to promote recovery using a computational model of reading damaged to reflect a variety of acquired impairments. The first treatment was a partial, model-adapted implementation of phonomotor therapy (PMT), a multimodal therapy focused on improving phonology. The second treatment was whole-word training. We hypothesized that PMT, with its focus on phonology, would promote recovery following orthography-phonology damage. Since PMT provides no semantic information, we hypothesized that whole-word training would promote greater recovery following semantic damage. We lesioned a feedforward neural network model in four locations: the connections into and out of the hidden layers mediating between orthography and phonology (OP), between orthography and semantics (OS), between semantics and phonology (SP), and the connections into and out of semantics (Sem). Five healthy models were independently damaged three times at each of 25%, 50%, and 75% of connections (80%, 90%, 95% for SP lesions) removed. The lesioned models were retrained using either model adapted PMT or by retraining the model with whole words. Model adapted PMT consisted of 100 epochs of training on anchor vowel and consonant grapheme-phoneme correspondences, 100 epochs of training on anchor/intermediate vowels and consonants, 100 epochs of all vowel and consonants, and finally 60 epochs of words. Normal recovery consisted of 100 epochs of training on words. The number of training items was matched for the treatments (PMT: 303,280, whole word: 299,800). The models were assessed using sets of high and low frequency/consistency words. We find main effects of lesion location, $F(2,702 = 1431.26, p < 0.001)$, severity $F(2,702 = 424.31, p < 0.001)$, and therapy $F(1,702 = 524.86, p < 0.001)$, as well as a three-way interaction $F(4,702 = 59.89, p < 0.001)$. Word reading is best promoted by whole-word retraining across all lesion severities following any semantic lesion, and after 25% and 50% OP lesions. However, following 75% OP lesions, PMT caused better reading recovery. Our results provide a proof-of-concept for tackling individual differences in alexia recovery using computational models. Consistent with our hypotheses, semantic lesions are better served by whole-word training, while severe OP lesions were best remediated with PMT. We suggest that careful use of behavioral testing to identify an individual patient's impairments can inform the location and severity of damage to models of reading. Therapies can then be tested on the individualized model to identify which will promote the greatest recovery for a given patient.

Topic Area: Computational Approaches

Poster C59 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Assessing Concreteness Rating Data in Older Adults

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Concreteness is a psycholinguistic measure which captures how easily a word evokes the senses. Words may either be concrete (e.g., ROSE) or abstract (e.g., LOVE), and the concreteness effect is the observation that concrete words are processed more easily than abstract words. Paivio (1971) developed a concreteness rating scale to measure this property of words, which has since been applied to large-scale survey research. Brysbaert et al. (2013) used this scale to develop a database of concreteness ratings for nearly 40,000 words. This work has been an important resource for researchers examining the concreteness effect; however, closer review of this work reveals that a large percentage of raters were younger adults and only one percent of raters were over the age of 65. This raises questions about the possibility of overlooking older adult perceptions of concreteness. In response, the present study was developed to examine judgments of word concreteness in older adults, operationalized using the Brysbaert et al. (2013) procedures. Word ratings were obtained through online surveys, which contained a subset of the items sampled by Brysbaert et al. (2013). Some control measures for stimuli were the exclusion of proper nouns, pronouns, and items of extreme word lengths, and a limitation for using only one word containing a given root (e.g., ENJOY or ENJOYING, but not both). A total of ten surveys were created in Qualtrics, and each survey was distributed to 25 respondents aged 50 years or older via Prolific. At the beginning of each survey, each participant was introduced to the concreteness rating scale and then proceeded to rate 300 words—10 initial practice words, 284 words for sampling, and 6 control words to screen for instruction compliance. All individual ratings for words were averaged together to create a database of concreteness ratings for this older adult sample. The average ratings from the current sample could then be compared to the ratings obtained in the Brysbaert et al. (2013) study. An analysis of the 2840 rated words revealed a significant difference in concreteness ratings across the two subject pools, where the older adult raters in the present study provided lower average concreteness ratings than the generally younger respondents sampled by Brysbaert et al. (2013). This evidence suggests that older adults judge words as being more abstract than younger adults. This insight can inform the way concreteness effects are studied in older adult populations, which can help improve semantic theories and theories of aging. This insight can also inform the way word retrieval therapies for persons with aphasia (PWA) are developed. Common etiologies of aphasia (e.g., stroke) are most prevalent in older adults. Therefore, the existence of older adult concreteness rating data can afford speech therapists a resource to design more age-appropriate activities which prompt abstract and concrete word retrieval in PWA. Brysbaert, M., Warriner, A. B., & Kuperman, V. (2014). [Citations: Concreteness ratings for 40 thousand generally known English word lemmas. Behavior research methods, 46(3), 904-911. Paivio, A. (1971). Imagery and language. In Imagery (pp. 7-32). Academic Press.]

Topic Area: Meaning: Lexical Semantics

Poster C60 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Shifts in the right pars triangularis network controllability and phonological errors in post-stroke aphasia

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Aphasia after a stroke impacts an individual's ability to work and quality of life. Due to a stroke, the brain can recruit new regions to assist with language processing demands and preserve cognitive functions. One region that displays post-stroke changes in persons with aphasia (PWA) is the right pars triangularis (rPTr). This region has higher functional activity in persons with aphasia (PWA) relative to healthy controls, but the increased connectivity is associated with worse language performance. The goal of the current study was to further clarify the role of rPTr in PWA by investigating if the neuro-plastic changes after stroke are associated with language deficits. To that end, we measured the boundary controllability (BC) of rPTr; BC quantifies the capacity of a region to integrate and segregate the activities of different networks. We hypothesized that BC would be higher in rPTr for PWA than age-matched controls, representing a relatively higher role of this region in the context of stroke. Prior research has found rPTr activity is associated with phonological errors. Furthermore, research has also found that higher BC in healthy individuals is associated with worse performance on tasks with higher semantic demands. In light of these results, we sought to understand whether different types of naming errors corresponded to BC at rPTr. We hypothesized that BC would relate to a specific error type in PWA, and based on prior neuromodulation work, we predicted that it would relate to phonological errors. We tested our hypothesis in 60 chronic post-stroke aphasia patients and 62 matched controls. All PWA completed the Western Aphasia Battery (WAB) and the Philadelphia Naming Test (PNT). With PNT data, we calculated the overall accuracy and proportion of error type (phonological, semantic, and mixed). Consistent with our first hypothesis, we found PWA had higher BC than age-matched controls at rPTr ($t(120) = -2.52$, $p < .01$). A regression model yielded a statistically significant negative relationship between BC and phonological errors that could not be accounted for by lesion volume ($R2 = .11$, $F(1,48) = 6.21$, $p < .05$). Our results provide new insight into the

network-level changes after a stroke causing aphasia. Specifically, the results demonstrate that changes to rPTr after stroke extend beyond functional activity. The shift in the fundamental anatomical role of rPTr suggests the region becomes more critical for integrating and segregating communication across networks of the brain. Moreover, the stronger an anatomical integrator the rPTr is, the better it can help process language information efficiently. This could be because the rPTr has an increased role in mediating communication among language regions of the brain more generally. Compared to findings in the left PTr in healthy subjects, our data suggest that homotopic recruitment may involve shifts in this anatomical property. Changes in BC may also predict functional neuroplasticity observed in prior research. Research has yet to investigate how BC relates to functional activity, and future work is needed to understand this relationship. Moreover, future work should also consider BC in PWA moderates neuromodulation treatment efficacy.

Topic Area: Phonology and Phonological Working Memory

Poster C61 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Neural resources shared by tool-use and language

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Humans own strikingly developed communications abilities characterized by their language but also advanced motor skills as revealed by their skillful use of a large set of tools. According to longstanding evolutionary theories, language could have built on pre-existing motor functions leaving observable parallels between linguistic and motor domains in neural activity. In particular, left hemisphere regions such as the inferior frontal gyrus (IFG), supramarginal gyrus (SMG) and the occipito-temporal (OTC) cortex, as well as the basal ganglia (BG) have been suggested to support both tool use and language processes. In two fMRI experiments on healthy right-handed French native speakers (20-40 y-o), we studied the shared neural resources involved for both tool use and linguistic abilities, such as phonology, semantics and syntax. In the first experiment, 20 participants moved a peg with a 30-cm pliers and with the bare hand as control; the same participants also underwent a semantic and phonological task. The semantic task consisted in a lexical decision task with two semantic categories: tool and animal nouns. The phonological task consisted in an identification task of syllables (/ba/ and /da/ along a continuum). In the second experiment, across seven distinct runs, 40 naïve participants were assessed on their comprehension of complex relative clauses (subject and object relatives) and an adapted version of the motor task allowing to reliably measure the action execution time. In the first experiment, planning an action with a tool activated left hemisphere regions such as the IFG, SMG, OTC and the BG bilaterally. Using representational similarity analysis (RSA), we found that the neural activity elicited by tool and animal nouns was significantly decoded within the IFG and OTC recruited by tool use. No such effect was found when attempting to decode the neural activities elicited by the syllables. In the second experiment, we identified regions of interest jointly involved by the two relative clauses. The results showed within the left BG, a greater averaged signal for the object relatives in comparison to subject relatives, as well as for grasping a peg with a tool, while it was much lower for the bare hand. A similar trend was observed in the right BG. In the left BG, we considered the time course of the activations across the seven runs; and we found that the averaged correlation scores between object relatives and tool grasping was significant, suggesting a comparable decrease of the signal for each condition. No such relation was observed for the correlation scores between object relatives and hand grasping or between subject relatives and tool grasping. Overall, these results highlight the brain areas that are activated by both tool use and language. In particular, in the OTC, IFG and BG a co-localization was observed. The shared network might subserve similar functions for tool use and linguistic functions: semantics may support tool use and vice versa, while hierarchical processing may be crucial for both syntax and tool use. The characterization of these neural overlap may open new avenues for developing new cross-domain learning and rehabilitation strategies.

Topic Area: Syntax

Poster C62 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Brain dynamics of speech act and common ground processing in communication

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What makes human communication exceptional is the ability to grasp speakers' intentions beyond what is said verbally during social interaction. This is because there is a many-to-many relationship between linguistic utterance forms and the various possible functions each of them may carry in specific communicative contexts. For instance, the expression "Here's a pen" can teach someone the meaning of a word, draw attention to a particular object, or offer that object on request. Linguistic-pragmatic theories define these functions as speech acts, and various pragmatic traits characterise them at the levels of propositional content, action sequence structure, related commitments, common ground and social aspects. A still controversial issue in current experimental pragmatic research addresses the latency of brain indexes signifying linguistic-pragmatic understanding of communicative functions and their relationship to other linguistic (phonological, semantic) and cognitive processes. Here we show that identical linguistic utterances conveying different communicative functions (request, naming, statement and question functions) in written, prosodic and gestural modalities triggered distinct ultra-rapid neural responses within 150ms after any perceptual differences and in parallel with early semantic processes. The patterns of activation reflected speech act function. For example, directive speech acts (e.g., requesting an object) specifically activated the cortical motor system, possibly reflecting the expectation of the partner’s action typically following it (e.g., grasping an object and handing it over). Although these results shed light on brain dynamics of speech act processing, they were driven by external differences in communicative contexts, gesture types or prosodic cues that defined the speaker's intention. In communication, understanding a speech act often goes beyond contextual, visual and linguistic input, where speaker's knowledge and assumptions shared with a partner (i.e. common ground) determine the communicative function. To close this gap, we designed different conditions with no differences in the external setup or the immediately preceding context, using, for example, the same critical utterances, speech act types and communicative visual environments. Specifically, the same question, "Which sea borders Croatia?" was posed either by a “student” as a means to obtain information from the partner (genuine question) or by a “tutor” to test the listener's knowledge (exam question). Crucially, these language games did not differ in linguistic form nor in the preceding context or expected verbal response, but clearly in the speaker's knowledge (about whether the speaker knows the answer or not) and thus in its communicative goal (to obtain information or evaluate knowledge). Distinct neural processes were elicited by the same question sentences if they were understood as genuine or exam questions, with the earliest differences appearing after the sentences’ second-words, 100, 180 and 400 ms after their occurrence. As differences occurred when the first content word appeared, this indicates that speakers process common ground and lexical-semantic information simultaneously, in line with some previous evidence. Overall, we show that speech acts are processed immediately in brain and mind, regardless of whether social, contextual, visual or common ground pragmatic traits determine speaker´s action, and that this enables the interlocutor to quickly recognize and understand communicative functions.

Topic Area: Meaning: Discourse and Pragmatics

Poster C63 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Identifying Potential Associations Between Motivation and Speech-Language

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Verbal communication is likely highly influenced by what motivates individuals to approach socially-rewarding stimuli and withdraw from socially-punishing stimuli.1 Individual differences in the motivation to approach and/or withdraw from a speaking situation are likely to impact one's communicative competence and have been theorized to play a casual role in disorders of impaired speech fluency, such as developmental stuttering.2 However, the potential association between motivation and quantitative measures of speech-language production has not been largely studied. The Behavioral Activation System (BAS) and the Behavioral Inhibition System (BIS) are motivational systems governing approach and withdrawal motivations, respectively.3,4 BAS/BIS constructs predict resting prefrontal asymmetry in electroencephalography (EEG), with asymmetry in left and right hemispheres respectively associated with greater BAS and BIS scores.5 The overall hypothesis of this project is that neural correlates of approach and avoidance motivation, as well as BAS/BIS scores, will be elicited in anticipation of speaking tasks of expository discourse. Our experimental paradigm involves expository discourse under three conditions (i.e., reward, neutral, punishment). We expect that the neural and behavioral correlates of approach motivation will be recorded in the reward condition, while correlates for withdrawal motivation will be recorded in the punishment condition. Lastly, we expect neural and behavioral correlates of approach motivation to be positively related to greater measures of speech-language productivity. A contrary relationship is expected between withdrawal motivation and reduced speech-language productivity. Participants include neurotypical adult speakers of English who provide informed consent before participating in this study (N=30, 15 males / 15 females). Participants have no history of neurological injury or psychiatric disorders. All participants are right-handed and will be given five minutes to read about a particular topic and prepare to spontaneously produce a three-minute expository discourse about the topic they have read. The three discourses differ by condition (i.e., reward, neutral, punishment). In the reward condition, participants are told that their speech performance will be rewarded cumulatively (i.e., points rewarded) based on the information provided by the speaker. In the neutral condition, no rewards or punishments are provided. In the punishment condition, only = points are reduced when a lack of information is provided by the speaker. Between reading about the topic and each discourse will be a five-minute rest interval during which time EEG will be recorded with a 32-channel active electrode system (BrainVision LiveAmp). Participants keep their eyes shut while alpha (8–15Hz) and beta (15-25Hz) power is recorded from frontal and central electrodes. Metrics of speech-language productivity to be analyzed include speech rate, Total Number of Narrative Words (TNW) and Total Number of well-formed Sentences (TNS). Syntactic complexity is also measured using Mean Length of Utterance (MLUw). Data collection and analysis is currently ongoing. We expect that our findings will have significant clinical implications for individuals with speech-language disorders. We hope to provide empirical evidence of the link between motivation and speech-language production that can spur future neuromodulation to stimulate approach motivation and decrease withdrawal motivation during speech in clinical populations.

Topic Area: Disorders: Developmental

Poster C64 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Language Network Structure and Vocabulary Size of Toddlers Born Preterm

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Preterm birth has been associated with risk for long-term language impairment, which may be explained by an interruption of typical in-utero language network development. Research with infants demonstrates that the brain's language networks, including the bilateral inferior frontal gyrus (IFG) and superior temporal gyrus (STG), are altered in infants born preterm compared to full-term. The current set of analyses focused on toddlerhood, a key period of early language development, to investigate the relationship between gray matter volume in the language network, prematurity, and vocabulary size. These results are part of a larger study focused on toddler brain and cognitive development following preterm birth. The first analysis focused on parent-reported vocabulary size from toddlers born very or extremely preterm (n =16; adjusted age M =20.40 months; SD = 5.19 months; gestational weeks at birth: M = 26.13; SD = 2.42), including English monolinguals (n = 8), Spanish monolinguals (n = 2), and Spanish-English bilinguals (n =6). Parents completed the MacArthur-Bates Communicative Development Inventory Short Form in English and/or Spanish and composite scores were calculated for bilingual children. Results indicated that, on average, the preterm toddlers understood 59.50 words (SD = 26.20) and produced 20.44 words (SD = 5.80). Based on their term-corrected ages and genders, these vocabulary sizes reflect scores in the bottom 25th percentile, with large variability (SD = 29 percentile points). Next, we compared gray matter volume in the language network from a subset of the preterm toddlers with MRI data (n = 9) to an age-matched sample of toddlers born full-term (n = 8). We processed their T1- and T2-weighted images using the Infant Brain Extraction and Analysis Toolbox (iBEAT V2.0 Cloud), resulting in segmented gray and white matter. We then applied an age-appropriate atlas and extracted gray matter volume from the bilateral IFG (pars opercularis and pars triangularis) and the bilateral STG. Results indicated that, when controlling for total gray matter volume, preterm toddlers had smaller bilateral IFGs only in the pars triangularis region (left: $t = 3.13$, $p = 0.007$, Cohen's $d = 1.75$; right: $t = 4.61$, $p < 0.001$, Cohen's $d = 2.59$). Similar results were observed in the left STG ($t = 3.00$, $p = 0.01$, Cohen's $d = 3.00$). Finally, we examined the relationship between vocabulary size and gray matter volume in the bilateral IFG and STG within the preterm sample. Results indicated that receptive vocabulary size was related to gray matter volume only in the left STG, while controlling for total gray matter volume and gestational age at birth (b -1.14, partial r = -0.96, p =0 0.02). These results reveal language delays and reduced gray matter volume in the left STG and bilateral pars triangularis for preterm toddlers, and highlight the left STG as a region that may explain some of their language delays. Future research is needed to understand how these relationships unfold across the first few years of life and whether high-quality language environments support early brain development for children born preterm.

Topic Area: Development

Poster C65 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

The role of sentence context in idiom disambiguation: and ERP study

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Language in everyday conversations is full of multiword expressions such as idioms (i.e. “spill the beans”; “bite the dust”; “break the ice”). Idioms' meaning is conventional and unrelated to the specific meaning of the individual words. Idiom comprehension challenge the principle of compositionality: the meaning of a complex expression not always results from the meaning of its parts. In contrast, it calls for a retrieval mechanism where idiom recognition as a familiar expression occurs along with its meaning retrieval from memory (Cacciari, 2014; Titone & Connine, 1994). Of interest for neurocognitive researchers, the cognitive operations underlying the composition and retrieval comprehension strategies have different electrophysiological ERP signatures. The N400 is a marker of semantic compositionality, as it reflects semantic integration between word meaning, world knowledge and mental representations of the ongoing sentence processing. The (late) P300 is related to categorical template matching between stored information and input processing. Final target words within idioms (i.e. “beans” in “spill the beans”) compared to the same words in literal contexts, elicit smaller N400s and larger P300s (Rommers et al, 2013; Canal et al, 2017), a pattern of results in line with non-compositional status of figurative interpretation. However, while this might be true for opaque idioms such as “bite the dust”, ambiguous idioms such as “break the ice” are excellent exemplars to test the intricacies of literal and idiomatic processing of the very same sequences of words. Besides, they allow testing for semantic and pragmatic integration processes during sentence comprehension, as the disambiguation of the idiom (either literal or figurative) depends on the correct processing of the preceding context.

The main aim of our study was to address the cognitive mechanisms of idiom disambiguation. We used the N400 paradigm (semantically congruent vs incongruent target words preceded by high constraining context; Federmeier & Kutas, 1997) to characterize the successful integration of contextual information when idiomatic expressions are to be understood. 57 participants were presented with ambiguous Spanish idioms (i.e. “romper el hielo”; “break the ice”, in English) embedded in sentences that strongly biased readers towards the literal or the idiomatic meaning. In half of the sentences, the idiom’s last word (i.e. “ice” in “break the ice”) was replaced by a semantically incongruent word. Hence, we combined the factors Idiomatic meaning (figurative, literal) and semantic congruity (congruent, incongruent) to test for N400 and P300 effects. Our preliminary results revealed: i) N400 (300-500ms) congruity effects only slightly larger for the literal compared to the figurative condition: ii) P300 (500-700 ms) idiomatic effects with larger positive amplitudes for the target word in the idiomatic condition compared to the literal condition. Hence, in ambiguous idioms the difference between basic composition (literal interpretation) and enriched integration (figurative interpretation) was mainly observed in the 500-700ms (frontal positivity), in the same line as Canal et al, 2017. Our results suggest that compositionality strategies of semantic interpretation are not cancelled out in the processing of ambiguous idiomatic expressions at least not before 500ms post-stimuli.

Topic Area: Meaning: Combinatorial Semantics

Poster C66 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Effect of semantic distance on informational masking in listeners with aphasia and controls

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Previous work has shown that persons with aphasia due to stroke (PWA) exhibit more difficulty than age- and hearing-matched controls (AHMC) in understanding target speech when background speech is present (Villard & Kidd, 2019). Additionally, other work has shown that, among other cognitive-linguistic deficits, PWA sometimes confuse semantically related words (e.g., “apple” and “peach”) during receptive language tasks (Butterworth et al, 1984). The primary aim of this study was to examine the effect of semantic distance between target and masker words on the ability of PWA and AHMC to understand target speech under speech-on-speech masking conditions. A secondary aim was to compare the results obtained by in-lab vs. remote testing, in order to learn more about the validity of remote testing paradigms. Thus far, 7 (of 8 anticipated) PWA and 8 AHMC have completed the in-lab version of the experiment. In this experiment, participants listened to simple 3-word target sentences starting with the carrier phrase “Betsy sees…” (e.g., “Betsy sees apples”), while ignoring two simultaneous maskers. Six item categories were included: fruits, clothing, birds, furniture, vegetables, and modes of transportation. The experiment included three conditions: “Same” (masker items were drawn from the same category as the target, e.g., “Karen gives peaches”), “Different” (masker items were drawn from a different category than the target, e.g., “Lucy loves T-shirts”), and “Noise” (maskers consisted of speech-shaped, speech envelope-modulated noise), as well as 4 target-to-masker ratios (TMRs): -10 , -5, 0, and 5 dB. After listening, participants clicked on a picture to report the target item. All participants demonstrated excellent comprehension of target sentences in quiet. A 2 x 3 mixed-model ANOVA examining the effect of group and masking condition on accuracy (at the most challenging TMR, -10 dB, only), revealed that accuracy was significantly higher for AMC than PWA, $F(2,13) = 24.29$, $p < 0.001$. There was also a significant main effect of masking condition, $F(2,26) = 59.18$, $p < 0.001$; post-hoc analyses confirmed significant differences ($p < 0.05$) in accuracy between each of the masking conditions (noise maskers > same-category maskers > different-category maskers). Finally, there was a significant interaction effect, $F(2,26) = 5.29$, $p < 0.05$. Results showed that PWA performance was worse than that of AHMC in the speech-on-speech masking conditions. Additionally, intelligible speech maskers resulted in lower accuracy than noise makers for both groups, with the majority of errors matching one of the presented masker words, indicating frequent target-masker confusions. Surprisingly, results suggested that an intelligible speech masker from the same semantic category as the target resulted in higher accuracy than a masker from a different semantic category. Additionally, the same experiment was repeated via a remote testing setup, and it was observed that results obtained through remote testing were broadly comparable to results obtained in a laboratory setting, providing support for the validity of remote testing paradigms. Work supported by a New Investigators Research Grant from the American Speech-Language Hearing Foundation (PI: Villard), NIH R01DC004545 (PI: Kidd), and a Boston University Undergraduate Research Opportunities Program (awarded to Yap).

Topic Area: Disorders: Acquired

Poster C67 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

The effectiveness of intensive mapping therapy in treating Chinese fluent and nonfluent aphasia

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Introduction Mapping therapy (MT) has been shown to be effective in treating people with post-stroke aphasia for mapping thematic roles to sentence structures in comprehension (Schwartz et al., 1994) and production (Rochon et al., 2005). However, little studies have investigated treatment of Chinese aphasia using MT. The current study adopted the Chinese MT for rehabilitation of post-stroke nonfluent and fluent aphasia. Methods Eleven Mandarin-speaking individuals with post-stroke aphasia (5 Broca's, 3 Wernicke's, 2 anomia, 1 conduction; 9 males/2 females; mean ages=58.27 years, ranging from 30 to 92 ages; mean education =13.36 years; mean symptom duration=3.38 months; mean AQ=53.73; mean CQ=58.71) participated in this study. During the treatment, the therapist trained the patient to identify the participants in the event/action in the simple sentence structures, and then followed with more complex sentence structures. Pictures of high-frequency objects in daily life were used as stimuli to construct simple sentences and more complex sentences. The therapist presented a couple of object pictures (e.g., turtle and carrot) and told the patient to "touch" one picture with another, or to "put" one picture on one side of another. Complexity of sentence structures incremented with more pictures (i.e., arguments in the sentence) and syntactic movement (i.e., Chinese passive bei sentences and disposal ba sentences). The patients were instructed to repeat the sentence they heard for several times while doing the "touching" or "putting" action. The mean treatment duration was 4.70 weeks (ranging from 2 to 12.86 weeks) with a 20-minnute session per weekday. The Chinese Western Aphasia Battery (C-WAB) was administered at the beginning and end of the treatment for assessment. Results Comparisons of the two tests from the C-WAB showed that all participants were significantly rehabilitated as suggested by the WAB AQ ($p=0.003$), CQ ($p=0.012$), degree of severity ($p<0.001$), and fluency ($p=0.005$). Their production ability was also significantly improved as shown by spontaneous speech ($p=0.001$), sentence completion ($p=0.033$), and reaction naming ($p=0.016$), but not for repetition ($p=0.258$). Additionally, their overall naming ($p=0.058$) and word fluency ($p=0.060$) were marginally improved. Further, their performance in sequential commands for the comprehension task was significantly improved ($p=0.046$), although not for overall auditory comprehension ($p=0.072$). Strikingly, our 92-year-old conduction patient, an academician with 22 years of education, was significantly recovered in speech after 4.14 weeks of intensive MT treatment. Conclusions These data add to the growing body of knowledge concerning the rehabilitation of the language deficits across different subtypes of aphasia and across different life span. Our study provides evidence suggesting that intensive treatment using Chinese MT can improve speech for Chinese-speaking people with post-stroke fluent and nonfluent aphasia.

Topic Area: Language Therapy

Poster C68 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Phonological and semantic specialization in 9- to 10-year-old children during auditory word processing

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One of the core features of brain maturation is functional specialization. Previous research has found that 7- to 8-year-old children start to specialize in both the temporal and frontal lobes. However, as children continue to develop their phonological and semantic skills rapidly until approximately 10 years old, whether any changes in specialization later in childhood would be detected is unclear. Thus, the goal of the current study was to examine phonological and semantic specialization in 9- to 10-year-old children during auditory word processing. Sixty-one children were included in the analysis. They were asked to perform a sound judgment task and a meaning judgment task, each with both hard and easy conditions to examine parametric effects. Consistent with previous results from 7- to 8-year-old children, direct task comparisons revealed language specialization in both the temporal and frontal lobes in 9- to 10-year-old children. Specifically, the left dorsal inferior frontal gyrus showed greater activation for the sound than the meaning task whereas the left middle temporal gyrus showed greater activation for the meaning than the sound task. Interestingly, in contrast to the previously reported finding that 7- to 8-year-old children primarily engage a general control region during the harder condition for both tasks, we showed that 9- to 10-year-old children recruited language-specific regions to process the more difficult task conditions. Specifically, the left superior temporal gyrus showed greater activation for the phonological parametric manipulation whereas the left ventral inferior frontal gyrus showed greater activation for the semantic parametric manipulation.

Topic Area: Phonology and Phonological Working Memory

Poster C69 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Localizing early visual word processing for Arabic script

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The fusiform gyrus is the seat of several functional regions specializing in pattern recognition for various visual phenomena, from faces to words. The Visual Word Form Area (VWFA) in literate individuals has been demonstrated to discriminate an array of linguistic properties of the written word, including morphological complexity (Dehaene, et al. 2005, among others). Arabic exhibits an unusual root-and-pattern system that places it at the forefront of many lexical access studies investigating morphology. Because of this, the current study focuses on in-progress efforts to develop and validate a functional localizer in VWFA for reading Arabic text. Arabic is written using an abjad, an orthographic script that optionally indicates vowels with additional diacritics, and is written right-to-left. Arabic also exhibits an extreme heterogeneity of letter shapes; each character exhibits four different word-position-dependent forms. Additionally, the writing system typically connects letters in a form of cursive, though some letter combinations do not connect. Previous work probing Arabic readers’ sensitivity to this last property has implicated the VWFA (Taha et al. 2013). N=12 right-handed native Arabic speakers (aged 19-31, M=23.7) participated in a passive looking task, with concurrent MEG recording using a 1000 Hz sample rate on a 208-channel axial gradiometer system. Duration of the task was approximately 10 minutes. Eye blinks, heartbeat, and other motor artefacts were identified and removed using independent component analysis (ICA). Each trial displayed an image with the following properties for 200ms: (a) string type (non-linguistic symbol vs. letter/word); (b) length (singleton vs. length of 3); (c) noise mask (Gaussian level 1 vs. Gaussian level 24). Words were monomorphemic and did not include diacritics given they have been shown to inhibit reading speed (Asadi 2017) and recruit insula and inferior frontal regions (Bourisly et al. 2013). Materials were based on a design for English from Gwilliams et al. (2016), in turn from a localizer for Finnish text (Tarkiainen et al. 1999). Both English and Finnish writing systems enjoy a wealth of widely-used monospace fonts in which letters are uniform in their space allocation, easing the control of stimulus properties with respect to both size of letters compared to each other and compared to symbol strings; Arabic does not. Deviating from the English and Finnish designs, symbols were placed in close proximity, with random two symbol pairs touching to mirror the effect of cursive writing. A spatiotemporal permutation cluster analysis was performed on source estimates of the MEG data (Maris and Oostenveld, 2007) in bilateral occipitotemporal regions searching over a 120–200ms time window, based on previous M/EEG research identifying components related to the written word such as the M130, N170, and M170. A regression for each stimulus property above was fit at each time and source point. A cluster for “Type Two” (i.e. linguistically sensitive, Tarkiainen et al. 1999) response for level of Gaussian mask was identified (p=0.056). These preliminary results cement the role of VWFA in discriminating linguistic properties in early visual word recognition further, this time for a typologically distinct orthographic system.

Topic Area: Reading

Poster C70 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Longitudinal lesion-symptom mapping based on the linear-mixed model: a study of neural correlates of verbal fluency of stroke patients

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Both voxel-based and multivariate lesion-symptom mapping approaches aim at establishing a statistical relationship between lesions of individuals and their impaired behavioral performances on a task. However, their applications in modeling longitudinal data are very limited due to methodological issues, such as incorporating repeated measures, missing data handling, and variance-covariance structure specification. Although recent research has used voxel-based repeated-measures analysis of variance to model the lesion-symptom relationship over time, its usefulness is still constrained by prerequisites like balanced research designs, no data clustering, and no missing data, etc. As many clinical longitudinal datasets call for more flexible models tailored to their specific data features, we proposed a novel voxel-based lesion-symptom mapping approach based on the linear-mixed model. In our study, we used this approach to investigate how white matter tract disconnections impact the semantic and phonemic fluency of stroke patients over time. The verbal fluency scores and anatomical T1 and T2 lesion data of 121 individuals at 3- (early chronic) and 12-months (chronic) post-stroke were obtained from the Cognition And Neocortical Volume After Stroke project with the lesion locus distributed on both hemispheres. The lesion prevalence across the subjects was on the right hemisphere. Each voxel-wise linear-mixed model included phonemic or semantic fluency scores as behavioral dependent variables. No significant differences were found between 3 and 12 months for each score ($p > .05$). The independent variables included the within-subject mean of lesions and the voxel lesion probability of each individual as predictors of interest. Only voxels damaged in at least 5% of the sample were included. The confounding effects of age and lesion volume were accounted for by running behavioral and lesion nuisance models before model fitting. As the simplest random intercept model excelled in model performance through hierarchical model selection, we obtained its corresponding volumetric statistical maps containing t and corrected p values of lesion predictors with the voxels significantly related to phonemic or semantic behavioral scores. The information on white matter disconnections was derived by overlapping the number of streamlines in each tract of the HCP842 tract atlas with the statistical maps at a threshold of 80%. Our results showed that white matter tract disconnections on the right hemisphere have different effects on phonemic and semantic fluency. The stroke patients with higher semantic fluency scores had lower risks of damage to the right arcuate fasciculus (AF) and right frontal aslant tract (FAT), providing the evidence that the right AF and FAT disconnections are related to the disrupted degree of semantic fluency. In contrast, stroke patients with enhanced phonemic fluency performance over time showed lower risks of damage to the right AF, suggesting its potential role in the neural recovery of phonemic fluency. To conclude, our study showed that lesion-symptom mapping based on the linear-mixed model could be employed as a more flexible approach to reveal both the cross-sectional and longitudinal effects of brain lesions on behavioral performance.

Topic Area: Language Production

Poster C71 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

The neural basis of agent-patient relations in working memory

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Language enables us to express and comprehend different types of abstract relations between/among entities, including agent-patient relations. Agent-patient relations are the abstract relations between the initiator (the agent) and the receiver (the patient) of transitive events, which are ubiquitous in real life. For example, in both “the lion hit the elephant” and “the lion kicked the elephant”, the two animals are involved in an abstract agent-patient relation, although the action itself differs. We are able to represent agent-patient relations in working memory, yet it is unclear what brain region(s) are responsible. Previous studies on events and event roles (i.e. agent/patient) have suggested two candidate regions that may host agent-patient relations in working memory. One is the superior temporal cortex (Frankland & Greene, 2015, 2020), which may host the specific transitive actions themselves (e.g., hitting, kicking) (Wurm & Caramazza, 2019). The other is the posterior parietal cortex (Wang et al., 2016; Matchin et al., 2019). Based on the critical role of the posterior parietal cortex in representing relations between visual objects (Xu & Chun, 2007; Ayzenberg & Behrmann, 2022) and working memory (Robitaille et al., 2010; Xu, 2017), we hypothesize that the posterior parietal cortex also hosts abstract agent-patient relations between conceptual entities conveyed through language, and is able to carry such relations forward through time. On the other hand, although superior temporal cortex encode specific actions, these regions may not encode abstract agent-patient relations. Most relevant studies have used fMRI, whose relatively poor temporal resolution makes it hard to separate the encoding and maintenance phases. In order to identify the brain regions representing agent-patient relations in working memory, we design an MEG experiment given its higher temporal resolution. In this study, we employ a sentence-picture delayed matching paradigm, in order to examine the retention phase in between. In each trial, subjects first view a sentence (1000 ms). After a retention period (1000 ms), subjects view a picture and are asked to respond to whether the picture matches with the sentence before. In half of the trials, the sentence is about two entities under an agent-patient relation (e.g., “John kicked Mary”). In the other half of the trials, the sentence is about two entities coordinated together (e.g., “John and Mary jumped”), which does not contain agent-patient relations yet involves the same number of entities. We hypothesize that the posterior parietal cortex will show differential activity for the agent-patient relation condition compared to the coordination condition during the retention period, as the former condition contains agent-patient relations that are absent in the latter condition. Data collection for this experiment is still ongoing.

Topic Area: Meaning: Combinatorial Semantics

Poster C72 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Exploring the dynamics underlying taxonomic and thematic semantic organization in picture naming

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Semantic knowledge about concepts has been argued to be organized in different ways: based on shared features (taxonomic) or based on co-occurrence in common scenes and scenarios (thematic). The goal of the current study is to examine how flexibly different semantic systems can be engaged, with a focus on picture naming. Contemporary theories of semantic cognition, such as the dual-hub hypothesis (Mirmam et al., 2017) and the controlled semantic cognition (CSC) framework (Lambon Ralph et al., 2017) assume that task-context influences which semantic systems are engaged, though competing theories differ in details about how this flexibility operates, for example, whether both taxonomic and thematic systems are equally engaged or disengaged (dual-hub) or whether the taxonomic organization is the core structure of semantic knowledge, with thematic organization flexibly engaged only in appropriate task settings (CSC). Examining the effect of task demands and semantic contexts on which semantic systems are engaged can adjudicate competing theoretical accounts of semantic knowledge and resolve discrepancies in the past literature on the dissociations of taxonomic and thematic relations. To address this question, we examined the representational structure underlying the semantic space in different task contexts by applying representational similarity analysis (RSA) to EEG datasets. In a series of experiments, EEG signals were collected while participants named pictures under different task demands: 1) task demands directing attention to taxonomic categories of objects; 2) no task to draw attention to the taxonomic or thematic structure of objects; 3) task demands drawing attention to either taxonomic or thematic categories of the same set of objects. The RSA approach allows us to examine the pairwise similarity in scalp recorded amplitude patterns at each time point following the onset of the picture and relate it to theoretical taxonomic and thematic measures derived from computational models of semantics. Across all task contexts, the similarity structure of scalp recorded neural activity correlated better with taxonomic than thematic measures, in the time window of semantic processing previously identified by meta-analysis (Indefrey, 2011). Most strikingly, we found that the scalp-recorded patterns of neural activity between taxonomically-related items were more similar to each than the scalp-recorded patterns of neural activity for thematically-related or unrelated items, even in tasks that focused attention on thematic relationships. These results suggest that the principle semantic organization of these concepts during picture naming is taxonomic, and that, at least in the context of picture naming, the engagement of different semantic systems is not as flexible as has been argued by leading theories of semantic cognition. Indefrey, P. (2011). The spatial and temporal signatures of word production components: a critical update. Frontiers in psychology, 2, 255. Lambon Ralph, M. A., Jefferies, E., Patterson, K., & Rogers, T. T. (2017). The neural and computational bases of semantic cognition. Nature Reviews Neuroscience, 18, 42–55. Mirman, D., Landrigan, J. F., & Britt, A. E. (2017). Taxonomic and thematic semantic systems. Psychological Bulletin, 143(5), 499.

Topic Area: Meaning: Lexical Semantics

Poster C73 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam C session.

Intelligibility of Audiovisual Speech Drives Multivoxel Response Patterns in Human Superior Temporal Cortex for Words and Sentences

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Regions of the human posterior superior temporal gyrus and sulcus (pSTG/S) respond to the visual mouth movements that constitute visual speech and the auditory vocalizations that constitute auditory speech. Neural responses in pSTG/S may underlie the perceptual benefit of visual speech for the comprehension of noisy auditory speech. We examined this possibility through the lens of multivoxel pattern responses in pSTG/S. BOLD fMRI data was collected with from 37 participants. Stimuli consisted of sentences or single words presented in five formats: clear auditory speech paired with a video of a talking face (AcV); noisy auditory speech with a face video (AnV); clear auditory-only (Ac); noisy auditory-only (An); and visual-only (V). Following the presentation of each item, participants rated intelligibility with a button press. Noisy speech was often rated as intelligible, but only if it was paired with a face video (mean of 76% with face video, 45% without). For these conditions, the fMRI data was post hoc sorted into intelligible and unintelligible trials. In each hemisphere, a region of interest in pSTG/S was localized. Then, the mean percent signal change of each voxel in the ROI to each condition was calculated. The mean percentage signal change across conditions was calculated for each voxel and subtracted from the response to each individual condition to increase the dynamic range of the fMRI pattern correlation. Within each hemisphere, the fMRI pattern similarity between each pair of conditions was calculated by correlating the mean-centered percent signal change across all voxels in the ROI. The pairwise correlations were averaged across hemispheres. The patterns evoked in pSTG/S by physically-similar noisy audiovisual speech differed, depending on intelligibility. The response pattern to intelligible AnV speech was more similar to that evoked AcV speech (mean r = 0.38) while the response pattern to unintelligible AnV speech was less similar to that of AcV speech (mean r = -0.09). The cross-correlations were Fisher z-transformed and entered into a linear mixed-effects model. There were main effects of intelligibility (p = 10-15) and stimulus type, with a stronger intelligibility effect for words than sentences (p = 10-6), without a significant interaction. To visualize the pairwise correlations, multidimensional scaling (MDS) was applied to the average correlation matrix for sentences and words. The MDS for sentences and words were qualitatively similar. Plotting the pairwise correlations for correlation ranks across words and sentences against each other showed a significant positive correlation of correlation ranks, r = 0.68; p = .0008. Seeing the face of the talker significantly improves the perception of noisy speech. Across two independent experiments using single word or sentences, we found that noisy but intelligible audiovisual speech evoked brain activation patterns in pSTG/S similar to those of clear audiovisual speech. The successful integration of visual and auditory speech produces a characteristic neural signature in pSTG/S, highlighting the importance of this region in generating the perceptual benefit of visual speech.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster C74 *Friday, October 7, 10:15 am - 12:00 pm EDT, Millennium Hall*

Behavioral and neural dynamics of negation

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Negation (e.g., ‘no’, ‘not’) is a communication device that is essential and unique to human language. Broadly speaking, negation reverses or modifies the meaning of a word, phrase, or sentence. The function of negation in natural language has been a matter of debate among philosophers, psychologists, and linguists. Conversely, relatively little cognitive neuroscience research has investigated how the brain represents negated concepts. In particular, two fundamental questions remain to be addressed: (1) How does negation operate at the neural level? Psycholinguistic studies suggest that negation reduces the availability of information within its scope; this hypothesis is supported by neuroimaging data showing that negation operates through general-purpose inhibitory mechanisms. These data, however, are mostly limited to the effect of negation on action representation. (2) When does negation operate? Previous psycholinguistic and neuroimaging studies offer contrasting evidence supporting either the hypothesis that negation operates in two steps, whereby the affirmative information is first represented and then suppressed/revised, or the hypothesis that negation operates in a single step, whereby negation incrementally fuses with the representation within its scope. To investigate how and when negation operates on the representation of its scope, we conducted an online behavioral experiment (continuous mouse tracking, 78 participants) and a magnetoencephalography experiment (MEG, 26 participants), in which participants read antonymous adjectives (e.g., 'good'/'bad', 'loud'/'quiet' etc.) within affirmative (e.g., ‘really really good’) or negated phrases (e.g., ‘not really bad’). Each affirmative and negated adjective phrase was rated for its overall meaning on a continuous scale (e.g., from ‘really really bad’ to ‘really really good’). Behavioral results show that participants were slower in deriving the composed meaning of negated than affirmative phrases, suggesting that negation increases processing difficulty. Importantly, mouse-tracking trajectories show that participants initially interpreted negated phrases as affirmative phrases (e.g., ‘not good’ was interpreted as ‘good’) and then modified their interpretation towards the opposite meaning (e.g., 'bad'), however never reaching the opposite side of the scale (e.g., ‘not good’ < ‘bad’). These behavioral results are further illuminated by our MEG decoding results: First, we found that the representation of the adjective (e.g., ‘good’) is similarly encoded in affirmative (e.g., ‘really really good’) and negated (e.g., ‘not really good’) phrases, within the time window associated with lexical-semantic processing (i.e., between 140 and 560 ms from the onset of the adjective); however, the decoding accuracy of the antonyms is reduced in negated compared to affirmative

phrases; finally, we observed higher beta power in left-lateralized sensorimotor brain regions for negated than affirmative phrases. Together, our behavioral and MEG results show that adjectives are similarly represented in affirmative and negated phrases. This demonstrates that negation does not readily invert the representation of a scalar adjective to that of its antonym. Moreover, our results show that negation decreases the strength of the representational difference between antonyms and elicits greater beta power, supporting the hypothesis that negation reduces the availability of information within its scope, possibly through general-purpose inhibitory systems.

Topic Area: Meaning: Lexical Semantics

Poster D1 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Assessing the role of implicit vs. explicit processes in L2 grammar task performance via reaction time-to-ERP correlations

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Adult second language learning is a complex task involving both explicit and implicit processes (i.e., processes that do/do not involve conscious awareness). Studies on this topic using reaction time (RT) methods can measure overall performance but cannot ascertain whether RTs capture the same vs. different underlying processes between implicit and explicit learning (e.g., Leung & Williams, 2012). In turn, prior EEG research suggests separate event-related potentials (ERPs) associated with implicit and explicit processes (e.g., Batterink et al., 2014), but have not determined whether neural markers of explicit processing are directly tied to production of external responses or simply an epiphenomenon of conscious noticing that is only indirectly tied to task performance. Our study addresses this latter question by extending an established artificial language paradigm (Batterink et al., 2014) with an analysis of the relationship between RTs and ERP timing. English native speakers (N=48) performed a semi-artificial language task that covertly tests for learning of a hidden grammatical regularity by comparing responses to rule-adhering vs. rule-violating trials. Afterwards, participants' awareness of the hidden regularity was assessed via a debriefing interview; 24 participants were coded as rule-aware and 24 as rule-unaware. Slower RTs and lower accuracies for rule-violating trials suggested grammar learning in both rule-aware and rule-unaware participants with no differences between the two, replicating prior findings using this paradigm (Batterink et al., 2014). We found a positive ERP in a late (800-1100ms) time window for rule-unaware learners but no significant ERPs for rule-aware learners (possibly due to trial-to-trial variability in conscious processes). We assessed the relationship between the ERP in rule-unaware learners and their RTs via four parallel analyses as in Sassenhagen et al. (2014). First, inspection of ERP images visualizing per-trial ERP latencies and RTs (Jung et al., 2001) suggested a relationship between the two. Secondly, per-participant RT quartile rank was significantly related to mean ERP latency per quartile (Marathe et al., 2013), $F(3,48) = 21.81$, $p < .001$, $\eta 2G = .53$. Thirdly, we found a non-significantly positive mean per-participant correlation between individual trial RTs and ERP latencies as estimated via Woody filtering (Kutas et al. 1977), mean $r = 0.10$ ($SD = 0.26$, 95% CI = [-.03, 0.23]). Fourthly, we found non-significantly greater inter-trial phase coherence (Delorme et al., 2007) in response time-aligned (vs. stimulus-aligned) data, $t(23) = 1.83$, $p = .080$. In sum, our first and second analyses showed evidence for time-locking between RTs and ERPs. Our third and fourth analyses trended in the same direction but were not significant, which we attribute to the weakness of the observed ERPs in this artificial learning paradigm. Because we did not find a significant ERP for rule-aware learners, we were unable to investigate the relationship between conscious processes and task performance. We consider these results in light of previous findings that have tied late positive ERP components to explicit processing or knowledge (e.g., Batterink et al., 2014; Morgan-Short et al., 2022) and consider whether implicit processing is reflected in these late components.

Topic Area: Multilingualism

Poster D2 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Lexical Mediation of Reduplication Effects in Arabic Speakers: Implications for Associationist Accounts of Word Formation

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In Semitic languages like Arabic or Hebrew, words (e.g., janna 'garden') are created by a combination of a three-consonant root (e.g., jnn) and a wordform pattern (e.g., C1VC2C3V). These languages may also have a root that reduplicates, or repeats, the second consonant, (jnn) but not the first (jjn). Berent (2002), using a lexical decision task, showed that Hebrew speakers were faster at rejecting nonwords with unattested repetition patterns (e.g. [jjn]) than they were at rejecting nonwords with attested repetition patterns (e.g. [jnn]). These results were used as evidence for the symbolic account that attributes linguistic generalizations to the use of abstract rules. However, it is also possible that Hebrew speakers were only trying to recognize words in the task, and since no words exist that have a root [jj_], they recognize the item as not a word immediately when they hear the second consonant of the root. Such an interpretation could support associationist accounts that attribute linguistic generalizations to statistical properties like similarity to existing words in the lexicon. In this work, we asked what mechanism is responsible for assisting a speaker in knowing that [jnn] could be an acceptable root for a word, but [jjn] could not, even when the speaker is hearing items they have never heard before? We collected simultaneous magnetoencephalography (MEG) and electroencephalography (EEG) data from native speakers of Standard Arabic while they completed an Arabic lexical decision task. In each block, subjects heard a series of trisyllabic CVCVC nonsense words with a common syllable reduplication pattern (e.g., AAB as in jijin, ABB as jinin, and ABC as jinik), and they were tasked to press one of two buttons to signify if they thought the item was an Arabic word or nonword. There were 1160 trials divided into ten blocks. Reaction time and accuracy data were both collected during the experiment. We compared the neural responses in the three-syllable reduplication conditions (AAB, ABB, and ABC) using effective connectivity analyses of brain activity to view how different root representations are utilized. Behavioral results showed participants performed the lexical decision task with high accuracy and were faster at rejecting AAB nonwords than they were at rejecting ABB nonwords replicating Berent's results. Neural results showed both attested and unattested repetition patterns produced stronger influences of brain regions implicated in wordform representation and phonetic/motor functions on acoustic-phonetic regions. These results suggest that speakers are making a comparison between an unattested root pattern and an existing root pattern in the lexicon, and judgments are shaped by how close the given root pattern is to an existing root. While these preliminary results do not resolve questions about the mechanisms responsible for assisting a speaker in knowing whether unattested root patterns could be an acceptable root or not, future progress will benefit from developing independent, empirically derived characterizations of the representations upon which any mechanism must depend.

Topic Area: Phonology and Phonological Working Memory

Poster D3 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neurophysiological correlates of auditory attention in monolinguals and bilinguals

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Introduction: Evidence suggests that bilinguals allocate attention to spoken language to a larger extent than monolinguals (Garcia et al., 2018). Here, we propose a study that investigates the neurophysiological correlates of attention allocation during auditory processing, by co-registering EEG, eye-tracking, and heart rate in monolingual and bilingual adults. Specifically, we ask the following three questions: (1) what is the difference between the two language groups in their neurophysiological measurements (i.e., neural oscillations, involuntary eye movements, and heart rate); (2) what are the effects of different stimulus type (linguistic vs. non-linguistic) and cognitive load level (high vs. low) of the task across language groups; (3) is there any correlation between neurophysiological responses and general language/cognitive abilities measured by behavioral tests. Methods: Seventy young adults will be recruited, including 35 monolingual and 35 simultaneous bilingual English speakers from comparable socioeconomic backgrounds. Sample size is calculated based on previous research similar to our study. Prior to the experiment, participants will fill out the Language Experience and Proficiency Questionnaire (LEAP-Q) to evaluate their language background and proficiency and to determine the grouping. During the experiment, participants will complete an auditory recognition task, which consists of two sessions (linguistic and non-linguistic) and each has 18 trials. In each trial, participants listen to a short passage (spoken in English or an unfamiliar language Hebrew, i.e., linguistic session) or a series of instrument sounds (occurred in different combinations and varied by interstimulus intervals, i.e., non-linguistic session) while presented with isoluminant videos on the screen. Then they will be asked to recognize a target stimulus (i.e., a word or sound) by pressing a button. The task complexity varies by the cognitive load required (e.g., higher level for listening to a Hebrew passage, or identifying an instrument sound occurred less frequently). In addition to their behavioral responses, participants' EEG (e.g., gamma-band oscillations, associated with attentional selection), eye movement (e.g., microsaccades and pupil dilation, indices of attentional effort), and heart rate (an indicator of arousal) data will be collected. After the experiment, participants will complete the Clinical Evaluation of Language Fundamentals (CELF-5) and Test of Nonverbal Intelligence (TONI-4) to assess general language and cognitive abilities, respectively. Data Analysis: Regression analyses will be conducted to investigate the effects of manipulated variables and to quantify the link between behavioral and neurophysiological measures. The outcome variables include response accuracy, brain oscillations, eye movements (microsaccades, pupil size) and heart rate (mean heart rate, interbeat interval). The predictor variables include language group, stimulus type and cognitive load level. The confounding variables are scores obtained from CELF-5 and TONI-4. Anticipated Results and Significance: We predict that monolinguals and bilinguals will have different neurophysiological responses, which will likely be affected by stimulus type and task complexity and confounded with participants' language/cognitive abilities. This novel neurophysiological explanation of cognitive differences between monolinguals and bilinguals will contribute to advancing theoretical models on bilingual development. Pilot data will be presented.

Topic Area: Multilingualism

Poster D4 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Rapid Automatized Naming (RAN) and word reading fluency in early school-aged children: An eye-tracking study

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Introduction. Rapid automatized naming (RAN) is the ability to accurately name familiar items as quickly as possible and is considered a significant predictor of reading fluency. RAN tasks require similar cognitive and linguistic processing when compared to word reading; specifically, RAN and word reading both require visual object recognition and speech production processes. Eye tracking is a sophisticated technology that allows for a fine-grained and natural record of word reading behavior in children and adults. Eye-tracking variables such as total time (defined as the sum of all fixations on a target word) and rereading duration (defined as the sum of all fixations except for those fixations made during the first time the target word is read) are thought to reflect different aspects of the reading process. Despite several studies on eye tracking and reading, few have explored the relationship between RAN performance and word reading as measured by eye tracking within early school-aged children. We investigate the relationship between the eye-tracking variables total time and rereading duration and RAN performance within 1st and 2nd graders who are at a critical point in reading development. Methods. Thirty-three monolingual 1st and 2nd graders (Meanage = 6.74 years, SDage = 0.65) participated in the Comprehensive Test of Phonological Processing (CTOPP-2) to obtain rapid letter naming (RLN) and rapid digit naming (RDN) raw scores. Eye movements were recorded using an EyeLink Portable Duo with a sampling rate of 500 Hz. Participants read twenty sentences with embedded target words aloud and then answered a yes-no comprehension question presented auditorily. Results. RLN performance predicted the total reading time of the target words for the entire group ($p = .01$); however, RDN was trending but not a significant predictor of total time ($p = .06$). Rereading duration and RAN variables were analyzed with zero-inflated gamma models as rereading duration includes zeroes (i.e., trials where the word was not refixated after reading the target word for the first time). Both RLN and RDN significantly predicted both the non-zero ($p = .008$ and $p = .03$ respectively) and zero values ($p = .002$ and $p = .02$ respectively) of rereading duration. This suggests that slower RLN and RDN times are associated with increased instances of rereading the target word. Conclusion. RLN predicted total reading time; however, RDN did not. RLN may be a more sensitive indicator of real word reading. Slower RAN performance for both RLN and RDN was associated with higher attempts of rereading duration. This indicates that children who were less automatic on RAN tasks were more likely to reread a target word embedded at the sentence level. Clinical implications of the association between rereading duration and RAN performance will be discussed.

Topic Area: Reading

Poster D5 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Language rehabilitation in bilingual aphasia: A tDCS study

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Background: Numerous behavioral therapies have been suggested to reduce naming difficulties in persons with chronic aphasia; however, their effectiveness is somewhat limited. To improve the outcomes, researchers have been applying neuromodulation techniques (e.g., transcranial direct current stimulation, tDCS) as an adjunct to the conventional language therapy. While previous research has been conducted exclusively in monolinguals, the current study focused on bilingual speakers with aphasia. The effects of naming therapy combined with tDCS were assessed on naming the trained items as well as on generalization to untrained items and to connected speech in the treated language. We also tested for cross-language transfer of therapy benefits to naming and connected speech in the untreated language. Method: Eight participants (four women) were enrolled in the study thus far. They were aged 68 years on average (range: 46 to 80 years) and have had chronic aphasia for 9 to 36 months resulting from a single vascular stroke in the left hemisphere. Participants were Russian native speakers who learned Hebrew as a second language later in life (age range: 23 to 45 years) and used it in everyday life prior to the stroke. Ten 1-hour therapy sessions were divided equally between two blocks, each lasted two weeks. Therapy targeted word retrieval in Hebrew. In one of the blocks, active stimulation was delivered (20 min, 2 mA), and the other served as a control condition (sham stimulation). The anode electrode was placed over the left dorsolateral prefrontal cortex and the cathode electrode – over the right supraorbital area. Before and after each block, naming of trained and untrained items as well as connected speech (elicited by a picture sequence) in Hebrew, the treated language, and Russian, the untreated language, were assessed. Results: Change scores were calculated as the difference between the scores after and before therapy. Difference between the change scores of the two blocks was tested using one-tailed paired-samples t-test. Naming the trained and untrained items in Hebrew improved comparably following the active and the sham block (trained: 44% vs 38%, respectively; untrained: 8% vs 2%, respectively). In contrast, naming translation equivalents in Russian of the trained and untrained words in Hebrew improved significantly more following active stimulation compared to sham stimulation (trained: 12% vs 0.5%, respectively; untrained: 7% vs -3%). Finally, there was a greater increase in productivity of connected speech (i.e., words per minute, different words per minute) in the active than sham block in both Hebrew and Russian (the differences were marginally significant, $p < .10$). The blocks did not differ in other indices of connected speech (i.e., word retrieval difficulties, dysfluency, and informativeness) in either language. Conclusions: Anodal tDCS combined with naming therapy may have numerous benefits in bilingual speakers with aphasia: It promotes generalization to connected speech in the treated language and to naming and connected speech in the untreated language. These preliminary results highlight the clinical applicability of tDCS in bilingual speakers with aphasia and pave the way to developing diagnostic and therapy protocols specifically designed for this population.

Topic Area: Disorders: Acquired

Poster D6 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

The neural implementation of semantic and syntactic composition: ERP evidence from adjective and verb processing

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Linguistic theory posits distinct combinatorial operations for predication (verb-noun) and modification (adjective-noun) structures. Previous work by Olstad et al. (2020) suggests that the two theoretical operations trigger different ERP responses. Moreover, lexico-semantic properties of words are also known to impact composition: Intersective (grey), subsective (small) and privative (fake) adjectives, when combined with a noun like elephant, differentially affect the meaning of the resulting phrase. The present study employed a novel paradigm to test whether syntactic and semantic properties of words impact the neural implementation of composition differently. The Cut-Compose paradigm compares full sentences (Compose) with sentences where composition is prevented by a naturalistic sentence boundary (Cut). This allows the comparison of the same element (a noun in our case) preceded by matched lexical material in combinatorial and non-combinatorial contexts. We conducted an EEG experiment asking whether the brain employs different mechanisms for combining nouns in predication vs. modification contexts, as well as for combining nouns with different classes of adjectives. We compared well-formed Norwegian sentences involving the composition of intersective (1.a.), subsective (2.a.) and privative (3.a.) adjectives with a noun (modification), as well as composition between verbs and nouns (4.a.) (predication) to corresponding baseline Cut conditions where the two words were part of different sentences and separated by punctuation. Cloze probabilities were matched across conditions. These examples are approximate translations of the original Norwegian the word 'elephants' was the point where composition was measured: MODIFICATION: 1.a. Intersective-adj Compose: Some birds must sit on grey elephants to clean them. 1.b. Intersective-adj Cut: Some birds have wings that are grey. Elephants are sometimes white. 2.a. Subsective-adj Compose: Both brown monkeys and small elephants life in Afrika. 2.b. Subsective-adj Cut: Monkeys are usually small. Elephants can step on them. 3.a. Privative-adj Compose: Animal-stories in childrens books depict fictional elephants that fly. 3.b. Privative-adj Cut: Animal-stories for children are fictional. Elephants are real. PREDICATION: 4.a. Verb Compose: In some countries people ride donkeys and feed elephants every day. 4.b. Verb Cut: At night people the horses feed. Elephants find food by themselves. We find different ERP responses involving modification and predication. All Compose–Cut contrasts modulate early components (N1-P2) but responses diverge later on. Verb Compose vs. Cut results in a higher N400 amplitude at the noun, while modification Compose–Cut do not significantly differ in the N400 time-window for any adjective class. The semantic environment also impacts processing of the noun differently. Composition with privative adjectives reliably modulates the N400 component compared to composition with intersective and subsective adjectives as shown by the Privative Compose vs. Intersective Compose and Privative Compose vs. Subsective Compose contrasts. Our results are novel in linking well established ERP components to theoretically posed constructs. More specifically, we show that the composition of words as neurally implemented is impacted differently by different syntactic and semantic environments, with processing costs incurred by obligatory argument saturation as well as by composition with privative adjectives that substantially alter the original denotation of the noun.

Topic Area: Meaning: Combinatorial Semantics

Poster D7 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Localising and Investigating Morphological Decomposition in Tagalog: an MEG study

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Previous studies from various languages have shown that morphologically complex words are subject to early, form-based decomposition mechanisms, taking place within the first 200ms of word recognition (M170) and localized in the left fusiform gyrus, (the Visual Word Form Area – VWFA). Gwilliams and Marantz (2016) developed a functional localizer for this response for English, building on original work in Finnish, which contrasts words and symbol strings embedded in varying levels of Gaussian noise. The current study has two objectives: (1) validate a functional localizer specific to Tagalog, in order to allow (2) investigations of VWFA-based morphological decomposition as modulated by phonological alternations and morphophonological variability. METHODS: 18 right-handed native Tagalog speakers (aged 19-52, $\bar{X} = 35.46$) have so far participated in two tasks, with concurrent MEG recording using a 1000 Hz sample rate on a 208-channel axial gradiometer system: the localizer, lasting 10 min, a passive looking task with 4 stimulus types (i.e., a 4-letter Tagalog word, a single letter, a symbol, or a string of symbols, either unmasked, or masked by Gaussian noise level 24), and a lexical decision task, lasting 20 min, with three conditions, all involving the prefixes paN- or maN-: (a) No-Change; words that do not exhibit phonological alternations (e.g., paN + halo 'mixer' = paNGhalo); (b) Nasal-Assimilated: the nasal N is pronounced as /m/ , /n/ or /ŋ/ to match the place of articulation of the stem initial obstruent (e.g., paN + pook 'district' = pampook); (c) Nasal-Substituted: the prefix-final nasal and the stem-initial obstruent are substituted by a single phoneme that is homorganic to the original obstruent (e.g., maN + palo 'slap' = mamalo). Nasal substitution makes the boundary between the prefix and stem opaque, and whether a stem triggers Assimilation or Substitution is not entirely predictable, but Substitution is more likely to occur for voiceless-initial than voiced-initial stems. We predict that the effects of morpheme-boundary opacity and the predictability of the prefix allomorph should be detected as variance in the M170. LOCALIZER RESULTS: we conducted a two-stage regression analysis in which regressions were fit at each time point and source point per-subject for factors of String Type (symbols, letters) and Stimulus Type (1-character string, 4-character string). Spatio-temporal cluster-based permutation tests were conducted in the bilateral occipitotemporal region over a 130–180ms time window. We found a type II response for letter/word vs. symbol in the medial surface of the lingual gyrus that is approaching significance ($p = 0.059$), with higher activation for letter/word than symbol, thereby replicating the canonical activation direction previously found in English, Greek, and Finnish. However, this response is in the right hemisphere, contrary to expectation. Given that the right-hemisphere VWFA analogue has been implicated in morphological processing (Zweig and Pylkkanen 2009), the region identified in the current study will serve as an fROI for the M170 analysis of the lexical decision task, aiming to shed light into how phonological rules influence early, form-based, morphological decomposition.

Topic Area: Morphology

Poster D8 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neural correlates of phonotactic context effect in speech categorization

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Listeners perceive speech sounds in a categorical manner, mapping varying acoustic information into discrete linguistic representations (Goldstone & Hendrickson, 2010). Earlier studies have provided evidence of neurophysiological mechanisms underlying this non-linear transformation in bottom-up processing, demonstrating that acoustic information is faithfully encoded at the sub-cortical level but is warped into categories at the cortical level (Bidelman et al., 2013; Ou & Yu, 2021). However, listeners normally perceive sounds in context, not in isolation. Despite previous reports of the neural manifestation of phonetic (Zhang & Peng, 2021) and lexical context effects (Bidelman et al., 2021), the top-down influence of phonotactic restrictions on the neural encoding of categorical perception remains unclear. To fill this gap, we conducted a pilot behavioral study (N=10) and are running an ERP experiment to examine the effects of phonotactic restrictions on vowel categorization in Mandarin. A five-step /i/-/u/ vowel continuum was resynthesized from natural tokens by parameterizing F2 values in five equal steps between 680

and 2580 Hz while keeping F0, F1 and F3 values constant. In Mandarin, /s/ and /ɕ/ provide phonotactically constrained contexts in that they form illegal sequences with /i/ (*/si/) and /u/ (*/ɕu/), respectively, whereas aspirated /p/ and /t/ provide neutral contexts. Each of these four onsets (phonotactic: /ɕ/, /s/, neutral: aspirated /p/, /t/) was combined with the vowels from the five-step continuum to construct twenty CV syllables. In the behavioral experiment, participants heard each of the CV syllables and were asked to categorize the vowel (/i/ or /u/) they perceived as quickly as possible. Preliminary results showed that Mandarin listeners' vowel categorizations were biased towards phonotactically legal sequences (/ɕi/ and /su/), particularly when the response times decreased (RT < 1000 ms). This reaction time effect was most prominent with the ambiguous tokens (Step 3). These findings reflect a strong but transient phonotactic effect, motivating our on-going ERP experiment. The P2 component, which is usually associated with category information at the phonetic or phonological level, will be the neural index of the study. We predict: (1) larger P2 amplitudes for the non-ambiguous (Steps 1 and 5) than the ambiguous vowels (Step 3) in the neutral contexts (aspirated /p/, /t/), in which listeners must resort to bottom-up acoustic information for perceptual categorization, replicating Bidelman et al., 2020; and (2) larger P2 amplitudes for the ambiguous vowels (Step 3) in the phonotactic contexts (/ɕ/, /s/) relative to neutral ones (aspirated /p/, /t/), since categorical vowel percepts could be modulated by phonological biases through top-down processing. We will further run a correlation analysis to investigate how the bottom-up and top-down processes described above interact during speech categorization at the individual level. Finally, topographic distribution of ERPs will be examined to determine if different contexts engage different cognitive processes. Our findings are expected to shed light on the role of top-down processing in speech categorization and on the individual differences in general cognitive processing.

Topic Area: Speech Perception

Poster D9 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Online paradigms to measure sequential learning

Gabriel Cler[1], Jiwon Kim[1], Samantha Bartolo[1]; [1]University of Washington

Online data collection has gained popularity due largely to the COVID-19 pandemic, but also to recruit larger and more representative samples. In this project, we discuss online adaptations of two sequential learning tasks. Sequence learning is of interest to language researchers as it recruits language-relevant subcortical structures including the striatum and underlies rule-based aspects of language including phonology and morphosyntax. We recruited adults ages 18–45 with no history of communication concerns. Tasks were scripted in PsychoPy/PsychoJS and run on Pavlovia.org. Online platforms cannot produce reaction times that are interpretable in raw form, as keyboard, operating system, and browser configurations contribute to differences in latency between activating a key and recording the keypress. However, high precision allows for reaction time differences (within participant) to be compared between participants using different computer configurations (Pavlovia <3.5 ms; Bridges et al., 2020). One common sequential learning paradigm is the serial reaction time (SRT) task, in which participants are cued to perform keypresses that are either pseduorandomly ordered or comprise a repeating sequence. Learning is indexed as either the mean reaction time of the final sequence block, or (relevant for online testing) the difference in reaction time between random and sequence blocks. Here participants completed an implicit version of the task using a 10-item sequence following a standard design (Lammertink et al., 2020). However, 9/9 participants reported that keypresses were repeating patterns. To reduce this explicit awareness of the sequence, we added 10-15 pseudorandom keypresses following each two repetitions of the sequence. Fewer participants (5/23; 21%) explicitly noted a sequence. Performance on the task also declined, so no further adjustments were made; initial participants had a motor learning index of 46 ms, while those with interspersed random keypresses had an index of 14 ms. Another paradigm involving implicit sequential learning is a (visual) statistical learning task. In this paradigm, participants watch a stream of shapes that contain repeated triplets. Participants are asked to identify triplets that were or were not in the stream in a two-alternative forced choice (2AFC) test. To promote attention to the stream due to online testing, we implemented a cover task in which participants indicated when they saw repeated items (Turk-Browne et al., 2005). The original version of this task (no cover task, shapes moving around the screen) reported 95% accuracy on the 2AFC test (Fiser & Aslin, 2002). Turk-Browne interspersed two streams of 312 shapes each and reported 59% accuracy on the attended stream (Turk-Browne et al., 2005). Our piloting of the Turk-Browne version showed a mean accuracy of 49% in 5 participants. Simplifying to one stream of 312 shapes and adjusting the presentation time of each stimulus still produced performance around chance. Finally, we doubled the number of stimuli to 624 shapes, for which 25 participants had a mean accuracy of 55%. Online testing will likely continue to be relevant, and further research is needed to explore validity of these and related paradigms for understanding the interrelation between sequence learning and language.

Topic Area: Methods

Poster D10 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Personalized neuroimaging sheds insight into the role of motivation in language processing

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Most neuroscience research relies on standard paradigms which may obscure important individual differences in the brain. This is especially relevant for the study of language, in which comprehension abilities and even interpretations of the same materials can differ across individuals. Prior studies have demonstrated that manipulating the personal-relevance or salience of stimuli (e.g., changing speaker, altering social context, presenting familiar faces) can alter brain activation. Personal-relevance, interest, and motivation may be particularly relevant for the study of language. Prior studies have shown that interesting materials can increase reading comprehension, and own-name and significant-other-name recognition results in greater activation than processing stranger names. Although individuals vary greatly in what they find intrinsically motivating or interesting, there has been a near absence of research about how individual differences in motivation modulate language processing in the brain. The goal of the current study was to assess how individual differences in motivation or interest affected language processing in the brain using personalized neuroimaging experiments for every child. To do this, we measured language network activation using functional magnetic resonance imaging (fMRI) in n=19 neurotypical children (mean age=9.32±1.42) while they listened to personalized stories about a passion or hobby of particular interest ("special interest"). For each child, we assessed the intensity, duration, and scope of their specific interest. We wrote and recorded unique stories related to the special interest for every child. We collected fMRI data while children listened to (1) personalized special interest stories, (2) neutral, non-personalized stories, and (3) backward speech as a low-level auditory control. We identified brain regions that showed a higher response for special interests versus neutral stories (special interest>neutral stories). We found that special interest-related stories engaged the language network to a much greater degree than neutral stories and that these patterns were robust at the level of an individual child (t>3.1). Importantly, special interests (often called "circumscribed interests") are highly prevalent in, and a core diagnostic criterion for, autism spectrum disorder (ASD), a disorder characterized in part by challenges in language and social communication. We explored whether this personalized neuroimaging approach similarly potentiated language activation in a small sample of n=8 ASD children (mean age=11.12±1.6). ASD children also showed higher activation for special interest stories than neutral stories. Together, these results suggest that canonical language regions are more sensitive to personally-relevant or motivating speech than neutral speech. These results have implications for the ways we study language in the brain across typical and neurodevelopmental populations. Our findings suggest that the stimuli used in language research have a large effect on which brain regions are activated and the magnitude of this activation, ultimately influencing our interpretation of language processing in the brain. Personalized neuroimaging studies of language could be particularly valuable for understanding individual differences by taking into account higher-level

modulators of language such as motivation, which varies greatly from person to person. Lastly, individualized neuroimaging approaches may be a more ecologically-valid way to understand language processing in disorders such as autism. *First three authors contributed equally

Topic Area: Development

Poster D11 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Foreign language undermines the modulatory role of medial frontal cortex during affect labeling

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Keywords: Affect labeling, fMRI, bilingualism, language, emotion regulation, gPPI. The process of explicit verbal identification of emotional states, also known as affect labeling, helps to attenuate negative emotional experiences by reducing amygdala activation through neural processes mediated by the ventrolateral and medial prefrontal areas. The effect that the use of foreign language may exert on this process is not clearly understood. A previous study showed that affect labeling in a second language did not produce the expected reduction in amygdala activity (Vives et al., 2021). Given that foreign language processing is a cognitively taxing process that involves a number of frontal control areas, the authors suggested that overlapping activity in these regulatory areas could divert cognitive resources needed for the affect labeling task, thus reducing its effect on amygdala deactivation (the so-called detrimental hypothesis). However, this study did not investigate effects of foreign language on the functional connectivity of frontal control areas, therefore, this hypothesis remained speculative. The current study has two aims: 1) to replicate the previous findings in amygdala using an independent and large sample; and 2) to study foreign language effects on affect labeling in the functional connectivity of frontal modulatory regions. Thirty-four unbalanced Spanish (L1) / English (L2) bilinguals (24 females, mean age = 22.18, sd = ± 2.69) completed an adapted version of the fMRI affect labeling task (Lieberman et al., 2007) that included Affect labeling and Gender labeling conditions in Spanish and English as well as two control conditions (Affect matching and Shape matching). Structural 3D and functional EPI sequences were acquired on a 3T GE Signa-Architect scanner. Functional data was pre-processed according to the standard pipeline using SPM12 (Wellcome Trust Centre for Neuroimaging, London, UK). Group analyses centered on investigating the interaction effect between language (L1, L2) and condition (Gender labeling, Affect labeling) and involved two approaches: 1) a ROI analysis to investigate interaction effects in amygdala activity; 2) a whole-brain gPPI analysis to investigate foreign language effects on the functional connectivity of frontal regions previously associated with affect labeling (right inferior frontal cortex and medial frontal cortex). Our ROI analysis revealed a significant interaction between type of matching and language ($F = 5.165$, $p<0.030$) for left amygdala. Post-hoc comparisons showed that left amygdala was significantly more active during Gender labeling compared to Affect labeling in L1 ($t = -3.523$, $p<0.001$), whereas this difference did not prove to be significant for L2 ($t = -0.26$, $p=0.8$) due to the absence of labeling effect. The gPPI analysis showed that medial frontal cortex activity was negatively associated with the activity of inferior occipitotemporal areas during affect labeling in L1 but not in L2 (all cluster-corrected at $p<0.05$, FDR). Our results support the detrimental hypothesis, that is, we replicated the effects of foreign language on amygdala down-regulation during affect labeling. Furthermore, the inverse correlation between the neural activation in the mPFC and occipitotemporal areas during Affect labeling in L1 may suggest the involvement of reentrant mechanisms between amygdala and visual areas that modulate perceptual processing.

Topic Area: Multilingualism

Poster D12 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Predicting non-linear brain processing dynamics beneath the natural speech N400

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The human brain understands natural speech at rates of around 120–200 words per minute. A well-known signature of this process is the N400 electrophysiological component – a prominent centroparietal negativity (N) that peaks 400ms after word onset. The time course of the N400 is very reliable and has been fleshed out over thousands of studies. Indeed, the N400 is so well established that one of its base assumptions – that peak response is time-locked to word onset time – often goes unquestioned. However, this strict time-locking of brain responses to word onsets may be more an experimental convenience than a biological reality. This is because different words take different times to recognize: consider "at" and "atmosphere", and word recognition is constrained by context: consider "The at" vs "The atmosphere". Discovering and predicting such putative non-linearities in word recognition is especially important for building accurate brain models of natural speech comprehension. To this end, we present initial work on a neurophysiological model estimating non-linear processing dynamics hidden beneath the natural speech N400. We trained the new non-linear modelling approach on three pre-collected natural speech comprehension EEG datasets with a total of 73 participants and 1.75 hours speech. Following previous work, we modeled the N400 amplitude using lexical surprisal, estimated using a cutting-edge deep neural network language model (GPT-2). This approach assumes the N400 reflects the signal computed when the brain misanticipates an upcoming word's identity. However, unlike previous models that linearly fit EEG data with surprisal impulses time-aligned to word onsets, we fit EEG to a response distribution spanning 1.5 secs. Critically, this enables predicted EEG response profiles to vary between words, rather than being constantly the same. To fit response distributions we optimized a deep learning network to predict natural speech EEG from a time-series of lexical surprisal entries. The network contains two consecutive modules. The first module maps lexical surprisal onto the response distribution layer via non-linear layers. The second module implements a linear "temporal response function" that maps the predicted lexical surprisal response distribution to EEG data. The network was optimized using backpropagation of RMS error of EEG prediction across both modules. To evaluate the non-linear model, we contrasted how accurately it could predict a testing EEG dataset with the traditional approach of modelling surprisal as impulses at word onset. The non-linear model on average yielded 16% improvement of prediction accuracies (signedrank=640, p-value=1e-4,n=73). To interpret the non-linear model, we examined how estimated peak response times covaried with lexical surprisal. We found that unexpected words have delayed responses relative to word onset that could not be accounted by factors such as word length (partial r = 0.46, controlling word length). This suggests brain responses to surprising words may be magnified not only in amplitude but also in time. More generally these results provide early evidence that: (1) the natural speech N400 is underpinned by non-linear dynamics and thus may be less rigid than thought. (2) Non-linear N400 dynamics can be learnt from natural speech EEG using artificial neural networks.

Topic Area: Computational Approaches

Poster D13 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

The inlfuence of the early visual deprivation on phonological processing.

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Reading is a cognitive process in which graphic symbols are mapped onto the spoken language to convey meaning. Phonological awareness is a capacity to understand and manipulate the sound structure of spoken words and is strongly connected to reading efficiency in sighted readers. This relationship was also demonstrated in the blind Braille readers in several small sample studies. The neural correlates of phonological processing were also found to be similar between the blind and the sighted. However, recently we have shown that temporal areas typically involved in phonological processing are disengaged during Braille reading by blind subjects, who additionally engage the left ventral occipitotemporal cortex (vOT) in both spoken and written language processing. Therefore, in the current study, we tested the relationship between phonological processing and reading in a large sample of blind Braille

readers. Additionally, we tested the left vOT involvement in phonological processing in the blind. Fifty-three blind and 53 sighted subjects (age: 6-60) completed a battery of behavioral tests measuring their reading and reading-related skills and were subjected to a phonological task on spoken language stimuli during fMRI. We tested the association between phonological awareness and reading efficiency on the behavioral level. On the neural level, we used whole-brain and region-of-interest fMRI analyses. Contrary to the results of previous studies on small samples we have found that the relationship between phonological awareness and reading is different between the blind and the sighted. The blind subjects were more proficient in phonological processing than the sighted subjects. In contrast to the sighted participants, phonological awareness was not significantly related to reading efficiency in the blind. In this group, it was rapid automatized naming, along with working memory span and tactile acuity that explained the largest proportion of variance in word reading. At the same time, blind subjects engaged the left vOT to a larger extent than the sighted subjects during both phonological and control spoken language tasks. However, our results did not indicate that phonological processing is the sole function of the vOT in the blind. The left vOT presented similar activation to other language-network nodes and was related to the reading level only in the blind group. Visual deprivation and tactile literacy seem to alter behavioral and cognitive correlates of reading. It is possible that due to the sequential nature of tactile Braille reading blind subjects become much more proficient in phonological awareness as they are confronted with the inner sound structure of words more often than sighted readers who rely on whole-word processing. Visual deprivation changes the neural correlates of phonological processing to some extent, probably due to the reorganization of the language network. We hypothesize that in the sighted the sensitivity to spoken language in the left vOT is secondary to its involvement in reading whereas in the blind the sensitivity to speech in this region comes first, although it is further refined by reading. The results show that the blinds' vOT is capable of assuming various cognitive functions, in line with the pluripotent cortex hypothesis.

Topic Area: Phonology and Phonological Working Memory

Poster D14 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Investigating the role of speaker gaze in response mobilization: Evidence from corpus, behavioral, and EEG data

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In conversation, speakers coordinate speaking turns in a highly efficient manner, with most turn gaps lying in the range of 0 – 200 ms for question-response sequences (Stivers et al., 2009). These short intervals indicate that speakers must begin preparing their response before the end of the ongoing utterance, with experimental evidence corroborating this (Barthel et al., 2017; Barthel & Levinson, 2020; Bögels et al., 2015; 2020; Sjerps & Meyer, 2015). But studies to date have investigated responding to unimodal, speech-only utterances. The most common environment for conversation, however, is face-to-face interaction, where speaking turns are embedded in a rich visual infrastructure. One prominent visual signal is speaker gaze, but its potential effect on early response planning is entirely unknown. While some studies suggest that perceiving direct gaze captures attention and thus may delay response planning, others suggest it may speed it up (Burra & Kerzel, 2021). We here test these hypotheses. Corpus analyses of 5967 questions revealed that in the majority of questions, speaker gaze was directed at the addressee for the entire duration of the question, while 19.8% of questions overlapped with gaze shifts. The mean onset of the gaze shift away from the addressee was 184ms after question onset, and gaze returned to the addressee before the end of the question in the majority of questions. Turn gaps were shorter in questions with static direct gaze (median: 280 ms), compared to questions with gaze shifts, where questions that ended with averted gaze had longer turn gaps (median: 476 ms) than those that ended with direct gaze (median: 347.5 ms). As gaze was typically directed to the addressee within the first half of the question, it did not appear to be a reliable indicator of turn end, thus suggesting that its function in conversation may lie more in signaling that a response is expected at all (Stivers & Rossano, 2010).

We developed two experiments (online behavioral, EEG) to experimentally test the influence of speaker gaze on response time and EEG correlates of response preparation. In both behavioral and EEG experiments, participants respond to 240 polar questions (yes/no) by means of button press. Questions are asked by an avatar, whose gaze was manipulated in three conditions: static direct (SD), dynamic direct (DD), and dynamic averted (DA). In the SD condition, the avatar's gaze remains directed at the participant for the duration of the question. In both dynamic conditions (DD and DA), the avatar's gaze started from an intermediate starting point (15° averted) and either shifted toward the participant (DD) or was further averted (DA) at the beginning of the question. In line with the corpus data, we hypothesize our manipulation to affect response times, with static direct gaze resulting in the fastest, and dynamic averted gaze the slowest responses. EEG analyses will examine the lateralized readiness potential (LRP), providing an indicator of how early the hypothesized differences in response preparation arise. Data collection will launch in June, and we expect to present preliminary results at the SNL meeting.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster D15 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Utterance-level analyses of grammatical errors in aphasic discourses

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Considerable research has focused on agrammatism, but scant research has focused on paragrammatism (Goodglass, 1997; Matchin et al., 2020; Thompson, 2019; Wilson et al., 2010). Recent work by Matchin et al. (2020) has focused on dissociating behavioral or lesion correlates of paragrammatism from agrammatism, analyzing 53 patients' discourse samples holistically to determine whether perceptual ratings were reliable/meaningful. Each sample was labeled as AGRAMMATIC, PARAGRAMMATIC, BOTH, or NEITHER. The present study advances Matchin et al., analyzing samples at the utterance level using transcriptions. An initial sampling of 15 patients was randomly selected, 4 previously analyzed as AGRAMMATIC, 6 as PARAGRAMMATIC, 1 as BOTH, and 4 as NEITHER. Each utterance received an overall code of (u)ngrammatical, (g)rammatical, (f)ragment or (h)esitation. Strictly defining agrammatism and paragrammatism, utterances received a secondary code of error type: Ungrammatical utterances were coded as: (o)mission if the sentence was illicit from omission of a single grammatical morpheme, (a)grammatic if there are multiple grammatical morphemes omitted, (p)aragrammatic if the sentence is illicit from disagreeing, inserted grammatical morphemes, (v)erb if the sentence is only missing the lexical verb, or (a+p) if there are violations arising from disagreeing, inserted and from omitted grammatical morphemes. Grammatical utterances were coded as: (g)rammatical if there were no errors, (s)emantic if there were semantic violations, or (n)eologism for utterances characterized primarily by paraphasias. Fragments were analyzed at the constituency level and could be coded with the above codes. (H)esitations were coded twice. Samples original labels were compared to the proportion of codes from transcriptions. On average, 82% of AGRAMMATIC samples' utterances were coded (a). On average, 61% of PARAGRAMMATIC samples' utterances were coded (p). 0% of the BOTH sample's utterances were coded (a), while 67% were coded (p). On average, 6% NEITHER samples' utterances were coded (a) while 63% were coded (p). Our preliminary results reinforce original perceptual ratings, with caveats. There was no correlation to fluency or aphasia type from either perceptual ratings or transcription codes. Further, AGRAMMATIC samples were symmetrically classified with transcription codes. PARAGRAMMATIC and NEITHER samples had less correspondence, which might be explained by lower inter-rater reliability in Matchin et al. for these samples. Further analyses will target the source of these discrepancies. Another avenue for investigation is the relationship between speech rate (e.g., words per minute (wpm)) and type of grammatical error. Of the initial 15 samples, AGRAMMATIC discourses averaged 27wpm, PARAGRAMMATIC discourses 78wpm, the BOTH discourse 36wpm, and NEITHER discourses 49wpm. AGRAMMATIC labels correlated to wpm (R2=0.523) more than PARAGRAMMATIC labels (R2=0.030). Similarly, (a) codes correlated (R2=0.382), more than (p) codes (R2=0.184). Since potential bias from perception of speech rate was not possible with

transcription analyses, these parallel correlations suggest that there may be relationship between speech rate and grammatical processing that could aid in identifying how these syndromes dissociate. Lesion symptom mapping will be conducted with the 53 samples upon completion of utterance coding toward this aim. Thus, this novel coding scheme from transcribed utterances has the potential to clarify double dissociations in grammatical deficits of these syndromes.

Topic Area: Disorders: Acquired

Poster D16 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Language Performance After Mild Traumatic Brain Injury: An Event-Related Potential Study

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Worldwide, sixty-nine million people will sustain a traumatic brain injury (TBI) and most will be mild in severity (mTBI). Recently, public awareness of the persistent neurobehavioral symptoms (NBS) following mTBI has increased. Common NBS such as pain, slow processing speed, headache, and sleep problems have been associated with poor language performance, but the underlying neural correlates remain largely unknown. While many studies have examined non-linguistic ERP components following mTBI, few have examined language-related ERP components like the N400 and P600. To investigate linguistic processing after mTBI, we developed a self-paced reading ERP paradigm using Osterhout & Nicol (1999) stimuli to measure brain and behavioral responses to semantic and syntactically anomalous sentences from 44 community-dwelling adults with (+mTBI, n=18; Female=10) and without (-mTBI, n=26; Female=15). We will compare N400, P600 and reading time responses between groups and use NBS, sleep, and communication problems as correlates. This study will broaden the limited methodological knowledge of self-paced reading ERP paradigms, begin to clarify the effects of mTBI on language function, and set a baseline for future ERPs to investigate language processing in mTBI.

Topic Area: Disorders: Acquired

Poster D17 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Considering all the stars visible: MEG correlates of English post-nominal modification

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While adjectival modification is canonically pre-nominal in English, many adjectives describing temporary “stage-level” properties, such as “visible” or “available,” can also occur post-nominally. Since the pre- and post-nominal instances of these adjectives create meanings that are very close to each other, they offer an opportunity to examine neural correlates of syntax. Here we embedded pre- and post-nominal modifications into full sentences, in three different positions within the subjects of the sentences (for generality) as shown below, with the adjectives and nouns serving as critical stimuli for magnetoencephalography (MEG) measurements. The stimuli were presented visually in RSVP. Pre-Early: All visible stars have … Post-Early: All stars visible have … Pre-Middle: All the visible stars have … Post-Middle: All the stars visible have … Pre-Late: All of the visible stars have … Post-Late: All of the stars visible have … While the nouns in both positions are “canonical” (as encountered by an incremental parser), the post-nominal adjective is not. The main question for our 2(pre/post) x 2(noun/adjective) x 3(early/mid/late) ANOVA analysis was to identify neural differences between the pre- and post-nominal adjectives that are absent for the comparison between the nouns in first vs. second position. We conducted both an ROI analysis of regions hypothesized to participate in

sentence level combinatory processing (left BA38, BA21, BA20, BA44+45, BA39, BA11 + right hemisphere homologues) as well as a more exploratory full brain analysis. Results from 9 participants (so far) show increased activation for the post-nominal adjectives as compared to their pre-nominal counterparts in the left middle temporal gyrus, inferior temporal gyrus and the angular gyrus, potentially reflecting the higher syntactic integration cost of the post-nominal adjectives. Nouns in pre-adjectival vs. post-adjectival positions did not show any parallel effects. Also, no parallel effects were obtained in the right hemisphere, suggesting strict left laterality. The timing of all activity increases was at ~300-400ms. The left anterior temporal lobe, implicated for conceptual aspects for composition (Pylkkänen, 2019), showed no effects, as predicted by the fact that conceptual combination did not vary in our design. The explorative spatio-temporal clustering analysis showed that our left lateral increase for post-nominal adjectives was clearly centered in posterior middle temporal cortex, consistent with accounts positing this area as a locus of syntactic composition (e.g., Matchin & Hickok, 2020; Flick & Pylkkänen 2020). This work contributes to our understanding of the neural indices of syntax in the absence of any (major) semantic confounds, which is a difficult experimental contrast to create. Our preliminary results suggest a rather strong left-lateral effect of our manipulation, showing that neural activity can be affected by relatively pure manipulations of just structure.

Topic Area: Syntax

Poster D19 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Human grid electrode ECoG reveals that local neural activity in anterior temporal cortex expresses semantic information

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Converging evidence from neuropsychology, positron emission tomography (PET), magnetoencephalography (MEG), and transcranial magnetic stimulation (TMS) supports the theory that the anterior temporal lobe functions as a semantic “hub”, binding modality-specific semantic information into generalisable transmodal and transtemporal representations of meaning (Lambon Ralph et al., 2017). Recent evidence from human grid electrode electrocorticography (ECoG) showed that stimulus animacy can be decoded from voltages recorded from the surface of the ventral anterior temporal lobe during a picture naming paradigm (Rogers et al., 2021). However, the raw voltages used in this work may obscure information present in different frequency bands, making it difficult to judge whether animacy is encoded by gamma- and/or high-gamma-band activity characteristic of local processing, lower-frequency activity characteristic of long-range transmission, or some combination of these. To disentangle these possibilities, we reanalysed ECoG data collected from ventral anterior temporal cortex in ten participants while they named line drawings of animals and inanimate objects. We conducted a time-frequency decomposition using complex Morlet wavelets, then used logistic regression with elastic net regularisation and 10-fold nested cross-validation to decode animacy from time-frequency power spectra. Comparing this approach to the results from decoding voltage, we found that classifiers trained on time-frequency power data performed as well as or better than those trained on voltage data. Large classifier weights were placed on power features from across the frequency spectrum, indicating that a wide range of frequency bands carry information about animacy. However, a large number of the selected features came from gamma or high-gamma bands, and classifiers trained only on these features performed as well or almost as well as those trained on a wider frequency spectrum in all but one participant. These results suggest that, during picture naming, information about animacy is represented in local neuronal activity (on the assumption that processing frequency is inversely proportional to the size of the underlying processing network). In several participants we also observed that, at some time points, decoding with power succeeds while decoding with voltage fails, while at other time points the reverse is true. This raises the possibility that voltage and time-frequency power may each independently encode animacy information. Implications of these results for theories about the neural basis of semantic representation will be considered.

Topic Area: Meaning: Lexical Semantics

Poster D20 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Contribution of Executive functions in Oral Naming and Spelling in Primary Progressive Aphasia

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Introduction: Primary progressive aphasia (PPA) is a disease hallmarked by a progressive impairment of language functioning. In the early onset of PPA, one of the first detected symptoms is word-finding difficulties (Gorno-Tempini et. al, 2011). It has been claimed that word-finding difficulties depend on a sequence of executive and language processes which reflect a breakdown at one or more of the stages involved in word retrieval (Schwartz et. al, 2006). Behavioral studies have revealed three executive functions that are shifting, monitoring, and selection among competing alternatives that could possibly mediate naming performance (Themistocleous C. et . al, 2020). The goal of the study is to determine whether selection, monitoring, and shifting contribute to oral naming and spelling tasks. Methods: Forty-seven individuals diagnosed with PPA (mean age 66.96 ± 7.49 years) had comprehensive cognitive and linguistic evaluations. The oral language tasks included noun naming (Boston Naming Test) and verb naming (Hopkins Action Naming Assessment). As written spelling tasks, we included spelling of low probability words to test the contribution of the ventral language stream and spelling of nonwords as a proxy for the dorsal language stream (Hopkins Dysgraphia Battery). For selection amongst alternatives, we used the semantic fluency task (Fruits, Animals, Vegetables). For monitoring of information, we used Digit Span Forwards and Backwards and Trail-Making Task A. Finally, for shifting we used Trail-Making Task B. Scoring for the spelling of real words and nonwords was computed using an algorithm that computes the average orthographic distance between the subject's written response and the target response 3. We performed Pearson's correlations to determine the degree of correlation between executive functions and oral naming/spelling tasks. Results: Performance on oral noun and verb naming was significantly correlated with the semantic fluency task (noun naming, $r(47) = 0.69$, $p<0.0001$; verb naming $r(47) = 0.74$, $p< 0.0001$). Performance on spelling of low probability words was also significantly correlated with semantic fluency ($r(47)=0.56$, $p<0.0001$). Spelling of nonwords, however, was significantly correlated only with Digit Span Forward ($r(47)= -0.64$, $p<0.0001$) and Trail-Making Test A ($r(47)= -0.008$, $p<0.0001$). Trail-Making Task B did not correlate with any naming or spelling tasks. Conclusions: The preliminary results of this study suggest that oral noun naming, verb naming, and spelling of low probability words, which are all lexical access tasks, are associated with the process of selection amongst competing alternatives, as represented by the semantic fluency task. Spelling of nonwords, however, a task which is preferably associated with the dorsal language stream, was significantly associated with the process of monitoring of short-term memory, as demonstrated by Digit Span and Trail A. Therefore, we conclude that naming and spelling are indeed associated with executive functions: naming and spelling of real words are associated with selection and spelling of nonwords is associated with monitoring and updating. Regression analyses are also to be performed to determine the exact contribution of each executive function to language tasks as well as their common or different neural substrates.

Topic Area: Language Production

Poster D21 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Individual differences in cortical gray matter volume reflect differences in speech sound encoding and phoneme categorization

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Individual differences are prevalent in language processing. An open question concerns the extent to which differences in brain structure can be mapped to behavioral and physiological measures of language comprehension. We analyzed data from Toscano et al. (2018), which includes structural MRI data (T-1 weighted images), as well as EEG and behavioral data for sounds varying along a /b/-/p/ voice onset time (VOT) continuum. We measured correlations between gray matter volume (GMV) and the two other measures: (1) the slope of the listener's VOT categorization function, providing a measure of how strongly their behavioral responses are shaped by phoneme categories, and (2) the amplitude of the auditory N1 ERP component, which varies linearly with changes in VOT and provide a measure of early acoustic cue encoding. We predicted that areas involved in the bottom-up processing of speech, the superior temporal gyrus (STG), the planum temporale (PT), and Heschl's gyrus (HG), would be positively correlated with the slope of the N1, as greater GMV could allow for more precise acoustic encoding. We also predicted that areas that may be involved in top-down feedback to early speech areas, including the medial temporal gyrus (MTG) and inferior frontal gyrus (IFG), would be negatively correlated with the slope of the N1, as listeners with greater GMV in these areas would be more susceptible to top-down effects and show poorer bottom-up cue encoding. Lastly, we predicted that MTG and IFG would be positively correlated with the slope of the categorization function (i.e., larger GMV in these areas would result in more discrete behavioral responses) and predicted negative correlations for PT and HG. The T-1 weighted images were filtered, corrected, segmented, skull-stripped, and parcellated before volumes were calculated and segments were normalized to a reference space using DARTEL. As predicted, we found that GMVs of IFG (left IFG: r=-0.59; right IFG: r=-0.47) and MTG (left MTG: r=-0.31; right MTG: r=-0.47) were negatively correlated with the slope of the N1, whereas GMVs of HG (left HG: r=0.14; right HG: r=0.35) and PT (left PT: r=0.44; right PT: r=0.17) were positively correlated with the slope of the N1. Surprisingly, we found that STG was negatively correlated with the slope of the N1 (left STG: r=-0.08; right STG: r=-.20), though this is consistent with some intracranial work arguing that STG represents phonemes rather than acoustic cues. As expected, GMVs of HG (left HG: r=-0.42; right HG: r=-0.41) and PT (left PT: r=-0.26: right PT: r=-0.57) were negatively correlated with the slope of the categorization function. In contrast to our predictions, GMVs of MTG (left MTG: r=-0.57; right MTG: r=-0.43) and IFG (left IFG: r=-0.23; right IFG: r=-0.07) were also negatively correlated with categorization slope. More work is needed to better understand the relationship between GMV and listeners' categorization functions. Nevertheless, our results suggest that listeners with greater GMV in PT and HG were more precise in their acoustic encoding, whereas listeners with greater GMV in MTG and IFG were more susceptible to top-down effects, resulting in poorer bottom-up encoding.

Topic Area: Speech Perception

Poster D22 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Causal Representation of Abstract Phonological Properties in Temporal Cortex

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The generativity shown in language users ability to evaluate or generate novel, well-formed linguistic structures depends on abstract representations (variables). Linguistic variables enable generalization by allowing a single computation or structural constraint to apply to a potentially open set of specific instances independent of first order similarity to other members of the set. Variable-dependent models describing the patterning of classes of speech sounds in words or syllables, or the classes of words defined by grammatical and semantic roles are used to capture structural constraints on the acquisition, perception, and production of language, as well as its breakdown after pathology. Given the variable's foundational role in the theory, it is striking that the neural basis of variable representation has been largely unexplored. Here, we present evidence for a neural basis for the representation of linguistic variables. Our test case was syllable repetition or reduplication, a morphophonological process in which words or parts of words are duplicated to change their meaning or grammatical properties. We aimed to identify localized patterns of brain activity associated with reduplication and determine whether they function as variable representations. We collected simultaneous magnetoencephalography (MEG) and electroencephalography (EEG) data in 12 subjects (native speakers of Standard American English) while they completed an artificial grammar learning task used to explore abstract rule learning in infants (Marcus et al., 1999). In each block, subjects first heard a series of trisyllabic CVCVCV nonsense words (exposure stimuli) with a common syllable reduplication pattern (e.g., AAB as in ba-ba-di or di-di-ba) and then were asked to indicate by button press whether subsequent nonsense words composed of different syllables (e.g., fu-fu-ni) “came from the same imaginary language”. We compared the neural responses in the three-syllable reduplication conditions (AAB, ABA, and ABB) using three complementary approaches: activation contrast, neural decoding, and effective connectivity analyses. Specifically, to determine whether there is an algebraic variable representation of reduplication, we examined whether previously unheard nonsense words evoked localized patterns of activation that support machine learning categorization (i.e., neural decoding) of syllable reduplication and explored potential causal downstream consequences of those localized activations using effective connectivity measures. Neural results showed that the within-region activity of a small set of temporal lobe regions known to be associated with the representation of phonetic and phonological structure supported the decoding of syllable reduplication. Control analyses demonstrated that decoding effects were separable from low-level repetition enhancement or task-specific processing demands. Effective connectivity analyses demonstrated that decodable signals from these early posterior middle temporal gyrus regions causally influenced downstream processes to influence sensitivity to reduplication patterns in more anterior middle temporal regions. Collectively, the results suggest that the localized activation patterns function as neural representations of a property, i.e., syllable reduplication, which appears to require variable representation. While these results do not resolve questions about the nature of the processes that rely on variable-based representations of stimulus properties to produce generative thought, future progress will benefit from developing independent, empirically derived characterizations of the representations upon which any mechanism must depend.

Topic Area: Phonology and Phonological Working Memory

Poster D23 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Does the N400 index prediction error? Neurophysiological evidence using the Prediction Potential (PP)

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The ability to accurately anticipate upcoming words in sentence context is of great importance to process a message easily, quickly, and accurately. Consistently, recent EEG studies have shown a functional neurophysiological correlate of semantic anticipation before words predictable from their sentence contexts (Prediction Potential) and a functional relationship between the prediction potential and post-stimulus (N400, Mismatch Negativity, MMN) responses. We here demonstrate the interplay between pre- and post-word brain responses during sentence comprehension. In particular, sentence fragments that lead one to expect a specific upcoming word elicited large PP responses before the expected target word, whereas such a slow-wave, predictive, response was absent for sentence fragments not associated with strong next-word expectations. That the PP response was related to predictive processing was further demonstrated by significant correlations (across sentences) between the PP and both subjective, and objective (corpus-based) measures of predictability of the upcoming word. Crucially, a negative correlation between the PP and the following N400 response indicated that these two signals are functionally linked. As the N400 increases with smaller PP size, this is consistent with the claim that the N400 is a prediction error response. The main sources underlying the PP and the N400 appeared in inferior prefrontal and posterior temporal regions, respectively; whereas category-specific clusters of activation in posterior, visual, and prefrontal, motor, brain areas for animal- and tool-related nouns, respectively, indicated that both these signals reflected aspects of sentence meaning. Overall, these

data reveal that the N400, has a causal antecedent, the PP, which may determine important features of N400 dynamics and topographies.

Topic Area: Speech Perception

Poster D24 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neural Tracking of Rhythmically Presented Morpheme Structure

Tovah Irwin[1], Alec Marantz[2,1]; [1]New York University Abu Dhabi, [2]New York University

[INTRODUCTION] Understanding speech requires the brain to parse a continuous signal into a hierarchical structure of discrete units of meetings. Morphemes are the smallest meaningful lexical units of language. The word “millisecond” is composed of two morphemes - the stem “second”, and prefix, “milli-”. The extent to which morphemes are represented as structural units in the brain during language processing is debated. Hypothesis 1 is that words are first recognized as whole units. Hypothesis 2 is that the lexicon is organized around morphemes and that words are morphologically decomposed during language processing. Previous studies reveal that the brain shows frequency peaks in neural oscillations associated with the presentation rate at various levels of language structure, including syllables/words, and phrases (Ding et al. 2016). If morphological structure is automatically constructed in the brain along with words and phrases during speech recognition (Hypothesis 2), we expect also to see frequency peaks associated with morpheme presentation rates. [METHODS] We recorded the brain activity of 11 adults using Magnetoencephalography (MEG). Participants listened to lists of unrelated words, blocked by condition. Each condition contained 200 syllables, with two runs of each condition per participant. Syllables were presented at a rate of 3 Hz, with all audio generated syllable by syllable by a text to speech program to avoid including acoustic information on the locations of word or morpheme boundaries. Conditions included (a) single syllable single morpheme words such as “cat”, (b) two syllable single morpheme words such as “money”, (c) two syllable two morpheme words such as “artful”, and (d) four syllable two morpheme words such as “millisecond”. [RESULTS] The statistical analysis of significant peaks in the responses was performed by averaging power spectra from each run across subjects, and significance was tested based on the average of every 0.5 hz bins from 0.25-5 Hz following Ding et al. (2016) . The single syllable/word condition (a) evoked a strong 3 Hz peak associated with the word and syllable rate of presentation ($p = 0.26$), but no other lower frequency peaks indicative of a higher level structure. Both the two and one morpheme two syllable word conditions (b-c) revealed both a 3 Hz peak associated with syllable rate ($p = 0.0361$ and 0.0317) and a 1.5 Hz peak associated with word boundaries ($p=0.1793$ and 0.1780). The 3 morpheme 4 syllable condition (d) produced a 3 Hz syllable peak ($p=0.0369$), as well as a 1.5 Hz morpheme-rate peak ($p=0.2893$), and a 0.75 Hz word-rate peak ($p=0.0011$). Data collection and analysis is ongoing, and future analysis will also reveal the source localization of frequency peaks. [SUMMARY] The results support Hypothesis 2, which predicts the word, morpheme and syllable peaks for condition (d) “millisecond”, over Hypothesis 1, which does not predict the 1.5Hz morpheme peak in this condition. The experiment indicates that words are decomposed into a morphemic structure from the speech stream similarly to other layers of language structure.

Topic Area: Morphology

Poster D25 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Multiple brain regions show modality-invariant responses to event semantics

Anna Ivanova[1,2], Carina Kauf[1,2], Nancy Kanwisher[1,2], Hope Kean[1,2], Tanya Goldhaber[1], Zachary Mineroff[1], Zuzanna Balewski[3], Rosemary Varley[4], Evelina Fedorenko[1,2]; [1]MIT, [2]McGovern Institute for Brain Research, [3]UC Berkeley, [4]University College London

Whenever we perceive an event unfolding in the world, we evaluate it using not only the percept itself, but also our existing semantic knowledge — generalized, abstract information about entities, actions, and ideas associated with that event. The ability to flexibly leverage this body of knowledge to achieve specific goals is a key component of human behavior. Here, we investigate the brain basis of task-driven semantic processing of events. We isolate semantic processing from lower-level processing by comparing representations of events across input modalities: sentences vs. pictures. We report the results from three fMRI experiments. In each experiment, participants viewed blocks of events presented as either sentences or pictures. In half of the blocks, participants performed a semantic task, which required accessing information about the event content. In the other half of the blocks, they performed a low-level perceptual task, which required tracking the stimulus on the screen rather than processing its contents. To test generalizability of our findings across semantic tasks (plausibility vs. reversibility judgments), event types (animate-animate vs. animate-inanimate interactions), and picture types (photos vs. drawings), we varied these design features across the three experimental setups. In addition, each participant completed two well-validated 'localizer' tasks: one for the language-selective network (Fedorenko et al., 2011) and one for the multiple demand network, which has been implicated in task-driven goal-directed behaviors across domains (Duncan, 2010). We additionally used the multiple demand localizer to localize the default mode network. We first conducted a whole-brain univariate analysis to identify brain regions that showed higher responses to the semantic task compared to the perceptual task for both sentences and pictures, validating these results using held-out data. To account for inter-individual variability in the functional organization of the brain, we used the group-constrained subject-specific (GcSS) localization method (Fedorenko et al, 2010). This analysis revealed a set of brain regions that show strong, modality-invariant responses to semantic tasks. These regions are located in left lateral prefrontal cortex, left temporo-occipito-parietal cortex, and right cerebellum. We then compared the locations of these amodal semantic regions and three well-characterized cognitive networks (language, multiple demand, and default mode) and found little overlap between them. Our results highlight the distinction between linguistic and semantic processing and suggest that event semantics engages dedicated, non-domain-general neural machinery.

Topic Area: Meaning: Combinatorial Semantics

Poster D26 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Structural connectivity subserving language: the role of the cerebellum in comprehension

Katie Jobson[1], Jamie Reilly[1], Ingrid Olson[1]; [1]Temple University

Prior lesion and fMRI studies have shown that portions of the posterior cerebellum are sensitive to language tasks, such as sentence comprehension. Are these regions structurally connected to regions of the "eloquent" brain, like the left inferior frontal gyrus? In the current study, functional imaging data from the Human Connectome Project (HCP) dataset were used to create language-specific cerebellar regions of interest (ROIs) implicated in sentence comprehension, verbal working memory and motor function. These ROIs were used as seed regions for a probabilistic diffusion-weighted imaging study. We found that (a) working memory, motor activity, and language comprehension activated partially overlapping but mostly unique regions of the cerebellum; (b) the linguistic portion of the cerebello-thalamo-cortical circuit had greater volume than the linguistic portion of the cortico-ponto-cerebellar tract; (c) there was a frontal-lobe bias in the structural connectivity; and (e) individual differences in a naming task correlated with variation in the cerebellar peduncles. These findings indicate that language-sensitive regions of the cerebellum are structurally connected to language-sensitive regions of the cerebrum, with a bias towards frontal lobe, and relatively fewer connections to temporal lobe regions. This provides evidence that the cerebellum is involved high-level language functions, like language comprehension.

Topic Area: Perception: Auditory

Poster D27 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Communicative Challenges in Social Anxiety: Preliminary Findings and Future Directions

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Patients with social anxiety disorder (SAD) are afraid of situations that expose them to possible negative evaluation by others, causing them to endure those situations with excessive fear or to avoid them altogether (APA, 2013). Cognitive models postulate that SAD patients overestimate how anxious they appear, while underestimating their actual social performance (Clark, 2001). However, there is also evidence for decreased social performance in social anxiety, which might pull patients into a downward cycle of decreased likability and social rejection (Voncken ea., 2008, 2010). This project investigates the relatively unexplored territory of social communication deficits in SAD. Currently, several empirical obstacles limit our understanding of communicative challenges in social anxiety. Previous studies quantified social performance using ratings of anxious appearance and social behavior in the form of Likert scales and questionnaires. However, these social performance ratings are subjective, meta-cognitive, and unable to identify exactly which aspects of communication are affected in social anxiety. Furthermore, objective neurobiological measures have been almost universally ignored, hampering mechanistic understanding of communication deficits in SAD. Here we set out to identify neurocognitive mechanisms underlying communicative challenges in social anxiety by manipulating uncertainty of communicative signals and addressee's characteristics during communicative exchanges in the context of live interpersonal interactions. We are conducting a dual-fMRI study in which pairs of high and low socially anxious individuals solve novel communication problems, namely how to jointly reproduce a spatial configuration of geometric tokens on a digital gameboard. Only one participant (the Communicator) sees the goal configuration, and can share this knowledge with the other pair member (the Addressee) by moving his token on the gameboard. These roles are alternated every trial. Communicative problems consist of Known trials, with previously established joint solutions, and of Novel trials, requiring the creation of novel signals. Given heightened intolerance of uncertainty in SAD (Carleton ea., 2010), we expect that communicative performance and interpersonal coordination in brain activity will decrease on Novel trials, but not in Known trials, as a function of social anxiety. We are also investigating whether socially anxious participants build different cognitive models of an Addressee, namely their reliance on apriori stereotype beliefs about Addressee's communicative abilities, versus reliance on interpersonal cues about those abilities based on communicative interaction. We administer an online communicative game where participants are told they are playing with two partners in alternating blocks: a child and an adult. In fact, a role-blind confederate plays both roles, such that the two partners differ only in terms of participant's stereotype beliefs about their cognitive abilities. Given difficulties in interpreting social situations in SAD (Buhlmann ea., 2015), we hypothesize to find less sensitivity to interpersonal cues during the unfolding interaction in social anxiety. Results of the dual-fMRI study and online communication game will be presented, as well as future research directions aimed at quantifying social communication difficulties in social anxiety. Gaining mechanistic insights in these social deficits may ultimately lead to improved treatment of SAD aimed at enhancing social skills, thereby breaking the social anxiety - social rejection cycle.

Topic Area: Disorders: Acquired

Poster D28 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam D session.

EEG-based neural tracking of linguistic speech representations in people with post-stroke aphasia

Jill Kries[1], Pieter De Clercq[1], Marlies Gillis[1], Ramtin Mehraram[1], Robin Lemmens[2], Tom Francart[1], Maaike Vandermosten[1]; [1]Experimental Oto-Rhino-Laryngology, Department of Neuroscience, Leuven Brain Institute, KU Leuven, Leuven, Belgium, [2]Laboratory of Neurobiology, Department of Neuroscience, Leuven Brain Institute, KU Leuven, Leuven, Belgium

People with aphasia (PWA) often have diminished lexical semantic processing as shown by results on behavioral studies as well as event-related potential (ERP) studies, e.g. an altered N400 response. In this study, we will use the neural tracking paradigm, which offers, in contrast to ERPs, a way to study the brain's response to specific speech representations during continuous speech, hence allowing for an ecologically valid assessment of aphasia. Therefore, we investigated (1) whether neural tracking of two word-level speech representations would differ between a group of 27 PWA (age:72.8±11 y/o) and a group of 22 healthy, age-matched controls (age:71.3±7.4 y/o). Moreover, we explored (2) whether neural tracking can provide information on individual differences in aphasia severity by correlating neural tracking scores with behavioral language test scores. PWA were tested in the chronic phase post-stroke, i.e., min. six months following a left-hemispheric or bilateral lesion. Behavioral testing encompassed a naming test (NBT), a receptive lexico-semantic test (Screeling) and a semantic word fluency test (CAT-NL). EEG was recorded while participants listened to a 24-minute-long Flemish story. The two word-level speech representations of interest were word surprisal and word frequency. The relationship between the EEG signal and these two stimulus-derived speech representations was computed, i.e., the temporal response function (TRF). From the TRF we extracted peak latencies (EEG-outcome-measure-1) and amplitudes (EEG-outcome-measure-2) by searching for local maxima within defined time windows. The TRF was further used for estimating EEG prediction accuracies. To control for the influence of lower-level speech processing, we used the difference in prediction accuracy between two models (see Gillis et al., 2021) (EEG-outcome-measure-3). This outcome measure can be interpreted as unique contribution of word-level speech representations. For all three EEG outcome measures, we performed group comparisons and, within the aphasia group, correlation analyses with the behavioral test scores. These analyses were explorative and thus not corrected for multiple comparisons. The behavioral tests showed significant differences between groups (NBT:W=57.5, p<.001; ScreeLing:W=101, p<.001; CAT-NL:t=-4.94, p<.001). The TRF peak analysis revealed a group difference in the amplitude of the word surprisal peak between 0ms and 265ms in a predefined posterior electrode selection (W=187, p=.027). No other TRF peak showed a group difference in amplitude, nor in latency. Within the aphasia group, the semantic subscale of the receptive lexico-semantic test and the naming test correlated respectively with the peak amplitudes (R=-0.43, p=.04) and latencies (R=0.49, p=.021) of the word frequency peak between 70 and 140ms in a predefined frontal electrode selection. The unique contribution of the word-level representations did reveal neither group differences nor correlations with the behavioral tests. The TRF peak analysis revealed a smaller peak of word surprisal in PWA than in controls. However, word surprisal did not reflect language performance within PWA. Conversely, no group difference was found for word frequency, but it did reflect language performance. A larger sample size may help clarifying these findings. Overall, these results suggest that neural tracking of linguistic speech representations may be a suitable biomarker for the diagnosis of aphasia, but further analyses are needed.

Topic Area: Disorders: Acquired

Poster D29 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Revisiting the processing of English wh-dependencies – an EEG study

Keng-Yu Lin[1], Edith Kaan[1]; [1]University of Florida

English wh-dependency sentences contain a wh-word that must be integrated with a thematic-role assigner downstream (e.g., Who[i] did the clerk help ___[i]?). Memory/resource-based approaches claim that the wh-word is stored in memory before it can be integrated, with longer storage being more cognitively costly (e.g., Just & Carpenter,

1992; King & Just, 1991). While integration of the wh-word has been associated with a P600 (Kaan et al., 2000), it is debated whether the extra cognitive/memory costs of the dependency distance are reflected in the sustained anterior negativity (SAN) and/or (left) anterior negativity ((L)AN, Fiebach et al., 2002; Phillips et al., 2005). We therefore revisited this issue, hoping to replicate the P600 difference in wh-dependency vs. non-wh-dependency and to examine whether extra cognitive costs of the dependency distance could be observed in SAN and/or (L)AN. We conducted a 2x2 design experiment, with the factors wh-word (whether, who) and distance (short, long), as exemplified in “Sam wondered whether the clerk (at the counter) had helped the customer in the shoe aisle” vs. “Sam wondered who[k] the clerk (at the counter) had helped ___[k] in the shoe aisle.” The long-distance condition contained a prepositional phrase (at the counter) between the wh-word and the thematic-role assigning verb (helped) while the short-distance condition did not. A total of 144 experimental sentences (36 per condition) and 144 distractor sentences were latin-squared and were visually presented word-by-word (SOA=500 ms, ISI=200 ms). EEG data from 29 monolingual English speakers (age 18-27) were preprocessed (EEGLAB/ERPLAB) and were analyzed using linear mixed effects models (R/RStudio). Models included wh-word, dependency distance, and their interactions as fixed effects, and by-participant and by-item random intercepts. We started with a maximum random effect structure, but reduced the number of random slopes until the model converged without warnings. The SAN, (L)AN, and P600 were examined. The SAN was time-locked to the onset of the wh-word, spanning multiple words until the target verb (0-2500 ms for the short-distance condition, 0-4000 ms for the long-distance condition). The LAN and P600 were time-locked to the verb onset and were examined between 300-500 ms and 500-900 ms, respectively. No main effects of wh-word and dependency distance and no interaction effects were found in SAN, P600, and (L)AN. Our results failed to replicate findings of previous studies in which P600 showed sensitivity to dependency vs. non-dependency processing (Kaan et al., 2000; Phillips et al., 2005), though the amplitude of the who condition (0.14 μV) was numerically larger than the whether condition (0.12 μV) in our study. Our SAN and (L)AN did not show sensitivity to the dependency difference, as is consistent with Phillips et al. (2005). Based on the results, it is unclear whether the wh-dependency and the long dependency distance imposed extra cognitive costs on processing in our study. We plan on conducting time-frequency analyses to further examine if extra processing/cognitive costs can be observed in different frequency bands.

Topic Area: Syntax

Poster D30 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Delta-band Neural Tracking Reflects Speech Chunking Instead of Semantic Relatedness between Words

Yuhan Lu[1], Nai Ding[2], Xing Tian[3]; [1]East China Normal University, [2]Zhejiang University, [3]New York University Shanghai

Chunking is an important mechanism for language comprehension: the brain applies a set of syntactic rules to recursively integrate words into a large linguistic structure, e.g., phrase and sentence, and then derives meaning of the structure. Delta-band cortical activity tracking the time course of different levels of linguistic hierarchy (e.g., syllable, word, phrase, and sentence) has been viewed as evidence that the brain applied syntactic rule to group linguistic units into superordinate chunks. Challenging this position, it has been argued that the brain does not construct multi-word chunks at all but simply combines semantic features of individual words via statistical and semantic analysis. For example, the context-dependent neural response is generally expected to be high at the beginning of a sentence and to be low at the end of a sentence, forming an apparent neural tracking of sentences. It remains elusive, therefore, whether delta-band neural tracking of sentences truly reflects the mental representation of sentences or is merely caused by the neural encoding of semantic relatedness between words. The current study investigates to what extent the delta-band neural responses to speech can be explained by semantic relatedness between words. We used word sequences and sentence sequences to dissociate semantic relatedness from sentential structure, and asked listeners to attend to semantic features of words while cortical activity was recorded using magnetoencephalography (MEG). Semantic relatedness between adjacent words, simulated using a word2vecbased model, predicted a weaker 1-Hz response to word sequence than sentence. Consistent with the model prediction, empirical neural activity showed a weaker 1-Hz response to word sequence than sentence, when participants performed a word-level task that did not require sentential processing. However, when listeners performed a chunk-level task that explicitly parsed the word sequences into multi-word chunks repeating at 1 Hz, 1-Hz response to word sequence was stronger than the response during word-level task. These results suggest that delta-band neural activity primarily reflects the mental representation of multi-word chunks defined by either implicit syntactic rule or explicit chunking rule, instead of neural encoding of semantic relatedness between words.

Topic Area: Syntax

Poster D31 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neural correlates of transitive and finite verb production deficits in Primary Progressive Aphasia: the role of inferior parietal and frontal regions.

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Verb retrieval deficits are often reported in individuals with Primary Progressive Aphasia (PPA), a clinical dementia syndrome due to neurodegenerative disease affecting (primarily) the left hemisphere perisylvian network. Verb retrieval difficulties can be affected by verb-argument structure complexity (intransitive versus transitive verbs) and verb-morphology (verb tense, regularity, and subject-verb agreement factors); however, cortical atrophy patterns associated with these deficits remain unclear. The present study examined the relationships between regions of cortical atrophy and deficits in production of transitive and finite inflected verbs in 80 patients with PPA (39 nonfluent agrammatic (PPA-G), 26 logopenic (PPA-L), and 15 semantic PPA (PPA-S) subtypes). Verb transitivity and morphology were assessed using the Northwestern Assessment of Verbs and Sentences (NAVS; Thompson, 2011) and the Northwestern Assessment of Verb Inflection (NAVI; Lee and Thompson, 2017) tests, respectively. Across patients, we used surface-based morphometry to measure cortical thickness in perisylvian language regions, including inferior frontal and temporo-parietal regions-of-interest and correlated that with properties of verb production across patients. The PPA-G patients had greater difficulties producing transitive compared to intransitive verbs, and finite compared to nonfinite verbs. However, neither the PPS-L or PPA-S variants showed significant transitivity effect. While deficits across inflection types (inflection of finite verb forms regardless of regularity and agreement) were associated with PPA-G, irregular verb inflection deficits were associated with PPA-S, and subject-verb agreement deficits were associated with PPA-L. Across patients, deficits in producing transitive verbs (adjusted for intransitive verbs) were associated with inferior parietal atrophy (i.e., the left Angular Gyrus), whereas deficits in inflecting finite verbs (adjusted for uninflected nonfinite forms) were associated with posterior inferior frontal atrophy (i.e., the left Inferior Frontal Gyrus). Our results identified distinct brain regions where atrophy was predictive of verb retrieval deficits, supporting the dual-system view for complex lexical-semantic (i.e., multiple thematic roles) and syntactic (i.e., inflectional morphology) information.

Topic Area: Disorders: Acquired

Poster D32 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Using frequency selectivity to examine category-informative dimension-selective

attention

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In everyday listening, individuals selectively attend to acoustic dimensions (e.g., frequency or duration) within a complex sound and ignore other simultaneous dimensions. This dimension-selective aspect of auditory attention has been less studied than classic "cocktail party" scenarios that involve spatially selective attention. Speech sound categories are defined over multiple dimensions that vary in informativeness; thus, speech perception may demand selective attention to diagnostic dimensions. However, we do not yet understand how listeners learn to selectively attend to informative acoustic dimensions during category learning, how selective attention impacts cortical representations of relevant dimensions, and whether selective attention involves suppression of irrelevant dimensions as well as enhancement of relevant dimensions. In this ongoing fMRI study (target N=30), we are examining these questions using novel non-speech auditory categories requiring reliance on information in high or low spectral bands. Prior to scanning, participants complete five days of stimulus-response-feedback training during which they learn four novel nonspeech categories to criterion (Obasih et al., in preparation). Exemplars are composed of three concatenated high-bandpass-filtered hums and three simultaneous low-bandpass-filtered hums; these hums are nonspeech pitch contours, derived from multiple talker productions of Mandarin words varying in lexical tone. Within a frequency band, concatenated hums can be drawn either from a single lexical tone category or multiple categories. Two nonspeech categories are defined by category-consistent hums in the high-frequency band and inconsistent (between-category) hums in the low band. The other two categories have category-consistent hums in the low band and category-inconsistent hums in the high band. Thus, category learning requires reliance on – and perhaps selective attention to – category-diagnostic acoustic patterns within high or low frequency bands. Control trials involve categorization across an orthogonal dimension, stimulus amplitude ('big' Category A, 'small' Category A). During a single post-training MRI session, listeners categorize sounds in a 2AFC task where categories are differentiated by information in either high or low spectral bands, or on relative amplitude. We combine this with tonotopic mapping across auditory cortex and "attention-o-tonotopic" mapping driven by overt endogenous attention to high and low frequency bands. We will examine how dimension-selective attention driven by the demands of categorization may impact cortical activation across informative and uninformative dimensions and how selective attention effects may differ when demands are driven implicitly by task relevance (categorization) versus by directed attention ('listen high'). This work will illuminate the cortical mechanisms supporting dimension-based auditory selective attention; through a comparison with our control condition (stimulus amplitude judgments), it will also allow us to assay a putative role for suppression when listeners deploy selective attention for categorization. It will provide a theoretical bridge from effects of explicitly directed attention (i.e., "listen high") to effects of selective attention that may emerge over the course of auditory category learning, as listeners learn which dimensions are informative for categorization. Finally, the study links human studies of auditory attention to speech and non-human animal studies of frequency-selective auditory attention with non-speech stimuli.

Topic Area: Perception: Auditory

Poster D33 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam D session.

Real-time feedforward and feedback lateralization in speech motor control

Francesco Mantegna[1], Joan Orpella[1], David Poeppel[1,2]; [1]New York University, [2]Ernst Struengmann Institute

Speaking requires the accurate coordination of multiple articulators at fast temporal rates. The ease with which we speak belies the complexity of the motor task. One foundational hypothesis is that speaking feels effortless because we use both feedforward and feedback mechanisms that allow us to anticipate the sensory consequences of speech and apply corrections as needed. The State Feedback Control (SFC) model suggests that these control mechanisms can be deployed not only when speech movements are executed but also in the absence of movement. In other words, feedforward and feedback mechanisms can be based on the external as well as the internal estimation of speech consequences. This internal estimation is crucial for many cognitive tasks such as motor preparation, internal rehearsal, and sensory prediction. Although feedback perturbation studies provide indirect evidence in the context of external estimation, direct evidence for both internal and external estimation is largely lacking. Speech imagery is an ideal tool for investigating speech motor control, assuming that it involves the same stages associated with overt speech except for motor execution. Here, we use speech imagery and magnetoencephalography to investigate the temporal dynamics underlying the internal estimation process. In particular, because of the distributed nature of the computational tasks (i.e., interregional communication between motor and sensory areas) we investigated how functional connectivity unfolds over time. Participants (N=45) imagined isolated syllables immediately after visual cue presentation. In line with the limb motor control literature, we observed that imagined speech was associated with alpha-beta power suppression with respect to the baseline, arguably reflecting internal motor execution. We considered this spectral signature as a reference, and we expected to find connectivity patterns reflecting feedforward and feedback control in the preceding and following time-windows, respectively. We measured functional connectivity across multiple regions in the peri-Sylvian language network in different frequency bands. We used a connectivity measure (weighted phase lag index) which accounts for the volume conductance problem inherent to electrophysiological measurements. Then, we identified network components that were consistent across subjects using non-negative matrix factorization. Our results reveal that alpha/beta power suppression was preceded by a left-lateralized network component in alpha and beta bands and was followed by a right-lateralized network component in the gamma band. The variance explained by these two network components in the current dataset was significantly higher than a control dataset obtained using surrogates having the same spectral properties but randomized phase relationships. The observed lateralization pattern is in line with an emerging trend in the literature suggesting that feedforward control is left-lateralized while feedback control is right-lateralized. Moreover, the spectral profiles of the observed connectivity patterns are consistent with the biophysical implementation proposed for the predictive coding model. Overall, our findings support the SFC model by showing that feedforward and feedback control mechanisms are used for internal estimation during speech imagery. Moreover, we provide, to our knowledge for the first time, a time-resolved characterization of the functional connectivity network underlying internal estimation processes.

Topic Area: Speech Motor Control

Poster D34 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

The Wernicke conundrum revisited: evidence from connectome-based lesion-symptom mapping

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---INTRODUCTION--- Wernicke's area has been assumed since the 1800s to be the primary region supporting word and sentence comprehension. However, Mesulam et al. (2015) raised the 'Wernicke conundrum', noting widespread variability in anatomical definitions and presenting conflicting data from primary progressive aphasia. To resolve the conundrum, they posited a 'double disconnection' hypothesis: word and sentence comprehension deficits in stroke-based aphasia result from disconnection of anterior temporal and inferior frontal regions from other parts of the brain due to white matter damage, rather than dysfunction of Wernicke's area itself. Here we test this hypothesis using combined lesion-symptom mapping (LSM) and connectome-based lesion-symptom mapping (CLSM) in four large, partially overlapping groups of English-speaking chronic left hemisphere stroke survivors. ***---METHODS---*** All subjects were assessed on the Western Aphasia Battery-Revisited. Our primary measures were

Word Comprehension (WAB-R auditory word recognition, with Pyramids and Palm Trees, PPT, as a covariate), Noncanonical Sentence Comprehension (performance on a sentence-picture matching task for complex, noncanonical structures), WAB-R Repetition, and perceptual assessments of Expressive Agrammatism. Lesion maps were manually drawn from anatomical MRI scans, and connectomes assessed using diffusion tensor imaging. Using NiiStat (https://www.nitrc.org/projects/niistat/) we performed both voxel-based and ROI-based LSM analyses relating each of the four selected behavioral variables to lesion location, using total lesion volume as a covariate. Analyses were only performed within voxels/regions that had at least 10% of subjects with damage located there and were corrected for multiple comparisons using permutation tests (10,000 permutations) with a corrected alpha threshold of $p < 0.05$. For CLSM, we analyzed the diffusion-weighted images that were acquired for each subject and estimated the pairwise connection strength between all regions within the JHU atlas, including both the left and right hemispheres. We combined the LSM and CLSM data by assessing whether lesion-deficit correlations would still be statistically robust when incorporating relevant connection strength as a covariate. See Matchin et al. (https://www.biorxiv.org/content/10.1101/2021.10.25.465746v3) for full methodological details. ***---RESULTS---*** After removing variance due to object recognition and associative semantic processing, the same middle and posterior temporal lobe regions were implicated in both word comprehension deficits and complex noncanonical sentence comprehension deficits. Connectome lesion-symptom mapping revealed similar temporal-occipital white matter disconnections for impaired word and noncanonical sentence comprehension, including the temporal pole. We found an additional significant temporal-parietal disconnection for noncanonical sentence comprehension deficits, which may indicate a role for phonological working memory in processing complex syntax, but no significant frontal disconnections. Moreover, damage to these middle-posterior temporal lobe regions was associated with both word and noncanonical sentence comprehension deficits even when accounting for variance due to the strongest anterior temporal and inferior frontal white matter disconnections, respectively. ***---CONCLUSIONS---*** Our results largely agree with the classical notion that Wernicke's area, defined here as middle superior temporal gyrus and middle-posterior superior temporal sulcus, supports both word and sentence comprehension, suggest a supporting role for temporal pole in both word and sentence comprehension, and speak against the hypothesis that comprehension deficits in Wernicke's aphasia result from double disconnection.

Topic Area: Disorders: Acquired

Poster D35 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Activation of Speech, Taste, and Visual Scene Experiential Content During Concept Retrieval

Stephen Mazurchuk[1], Leonardo Fernandino[1], Jia-Qing Tong[1], Lisa L Conant[1], Jeffrey R Binder[1]; [1]Medical College of Wisconsin

INTRODUCTION: Some authors have proposed that concept retrieval involves reactivation of the perception, action, and other systems that contributed to the formation of the corresponding concept, although this idea remains controversial. We investigated this hypothesis by mapping the cortical regions that encode information about specific experiential features of word meaning, as derived from human ratings. We chose to study "speech," "taste," and "scene" features as they are highly distinct types of experience. "Speech" represents the degree to which a word refers to "someone or something that talks." We hypothesized that such content would be represented in left superior temporal and inferior frontal regions involved in speech perception and production. "Taste" codes the degree to which a word refers to something "having a defining taste," which we hypothesized would engage insular and orbitofrontal cortices involved in taste perception. Finally, "scene" codes the degree to which a word "brings to mind a particular setting or physical location," which we hypothesized would engage parahippocampal and posterior medial cortices involved in scene perception. METHODS: Forty right-handed native English speakers were scanned using simultaneous multi-slice fMRI. Stimuli consisted of 320 nouns, each presented 6 times over 3 sessions occurring on separate days. Stimuli were presented visually in an event-related design while participants performed a familiarity judgment task. BOLD time series data were preprocessed and projected to a common surface using fMRIprep. Word specific activation maps were generated via GLM. For the RSA regression, the three features of interest were transformed into representational dissimilarity matrices (RDMs) and these RDMs were then individually normalized to unit length. The three predictors were then used in Ordinary Least Squares regression to fit individual participant neural RDMs in a surface-based searchlight analysis with 5-mm radius patches. The resulting beta values from the 40 participants were tested for significance by a t-test against zero, with p-values family wise error corrected using permutation testing. We used a cluster-forming threshold of $p < .001$ and a cluster-level significance level of $\alpha < .01$. RESULTS: Beta values for the Speech feature were significantly different from zero in several left hemisphere structures, including the inferior frontal gyrus, inferior precentral gyrus, anterior and posterior superior temporal sulcus, angular gyrus (AG), and posterior cingulate cortex (pCC). The Scene feature was significant bilaterally in retrosplenial cortex and pCC, left parahippocampus, left superior frontal gyrus, and the left AG. Taste was significant in the orbitofrontal cortex and inferior frontal sulcus. DISCUSSION: The feature maps align with the hypothesis that cortical networks supporting the representation of each feature during semantic word processing include areas involved in the perception of the corresponding features. One exception, namely the insula not being significant for the Taste feature, becomes significant at cluster-level significance threshold of $\alpha < .03$. In future work we plan to analyze other experiential features, and compare RSA based feature maps to those derived from voxel-wise encoding models.

Topic Area: Meaning: Lexical Semantics

Poster D36 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Effects of deafness and sign language fluency on white matter connectivity

Stephen McCullough[1], Karen Emmorey[1]; [1]SDSU

Previous literature has shown that auditory deprivation and sign language exposure alter the gray and white matter structure of the human brain; however, not much is known about the changes in the white matter (WM) connectivity between brain areas in deaf signers. Using diffusion tensor imaging (DTI) and quantitative anisotropy (QA) based connectometry (Yeh, 2016), we investigated the effects of deafness and fluency in American Sign Language (ASL) on the macroscale connectome of the human brain. A total of 27 participants, 14 deaf signers (8 female, mean age = 29.4, SD = 4.3) and 13 hearing controls (7 female, mean age = 25.3, SD = 5.8), underwent MRI. We used the extended (35 sentence) version of the ASL Sentence Reproduction Test (ASL-SRT; Supalla et al., 2014) to measure ASL fluency. The preprocessing and analyses of structural and diffusion MRI data were carried out using AFNI and DSI Studio. Diffusion MRI data for each participant was acquired using 25 diffusion sampling directions with 2 mm in-plane resolution and 3 mm slice thickness. The diffusion data were reconstructed in the MNI space using q-space diffeomorphic reconstruction to obtain the spin distribution function (Yeh et al., 2010; 2011). A T-score threshold of 3.0 and tract length threshold of 20 mm were used in the deterministic fiber tracking algorithm (Yeh., 2013) to find tracts. To estimate the false discovery rate (FDR), 4000 randomized permutations were applied to the data to obtain the null distribution of the track length. To examine the effect of deafness on WM connectivity, we performed a regression analysis on each groups' normalized quantitative anisotropy (QA) values with sex and age variables partialled out. To determine the effect of ASL fluency on the WM connectivity in deaf signers, we calculated Pearson's correlation between normalized (QA) values with z-transformed ASL-SRT scores while partialling out the effects of age and sex. Group connectometry analysis results (thresholded at $FDR \leq .01$) revealed increased QA in left and right inferior fronto-occipital fasciculus (IFOF), left inferior longitudinal fasciculus (IFL), left uncinate fasciculus, right corticospinal tract, corpus callosum forceps major, and right medial lemniscus for the deaf group. No tracts with increased QA were found for the hearing group. Higher QA for the deaf group in the IFOF, left IFL, and right medial lemniscus suggests more robust connections between visual areas, proprioceptive sensory, and language areas for the deaf group, possibly due to neural changes arising from congenital deafness and/or to the visuo-spatial and motoric processing demands of ASL. Correlational tractography results of sign language fluency and QA showed positive correlations ($F \leq .001$) for the IFOF bilaterally, right medial lemniscus, right IFL, right corticospinal tract, and left corticospinal tract. In addition, the results showed negative correlations ($F \leq .001$) for corpus callosum forceps minor, corpus callosum tapetum, corpus callosum forceps major. The tracts showing positive QA correlation with the ASL fluency, again, suggest increased connectivity changes specific to visuo-spatial language processing. Moreover, negative QA correlations suggest increased connectivity between hemispheres for less fluent ASL signers.

Topic Area: Signed Language and Gesture

Poster D37 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Sensory Encoding and Decision-making in Speech Perception in Noise

Jacie R. McHaney[1], Bharath Chandrasekaran[1]; [1]University of Pittsburgh

Speech processing in noise (SPIN) has been predominantly analyzed through the lens of sensory processing. SPIN requires reconstructing sound properties and meaningfully mapping them onto established object representations. Object identification has sensory and decisional components that have been mapped to the auditory cortical network and an extended non-auditory network. As noise levels increase, the non-auditory network shows increased activation and more information in representation. Our goal of the current study is to re-examine SPIN using a neurobiologically inspired drift-diffusion model (DDM) of decisional processes that accounts for accuracies and response times. Per the DDM, listeners noisily accumulate sensory evidence until they have acquired sufficient evidence to make a decision. Model parameters tied to the efficiency of evidence accumulation and response caution relate to different neural operations of the decision-making process. Here, we examine the extent to which these computational model parameters relate to objective and subjective experiences of SPIN with an extensive battery of sensory and neural tests. Young adult, native English speakers with normal hearing thresholds participated in this study. To assess decision-making processes during SPIN, participants completed a phoneme in noise categorization task that consisted of 380 trials. Stimuli were synthetically-generated /ba/, /da/, and /ga/ phonemes in quiet or masked in speech-shaped noise at +8, -2, -6, and -9 dB signal-to-noise ratios (SNR). Participants were instructed to categorize phonemes as quickly and as accurately as possible. Accuracies and response times from this task were implemented into a DDM. Here, we examined the evidence accumulation and decision threshold parameters from the DDM to understand the processes underlying decision-making during SPIN. Evidence accumulation reflects extraction of information from the stimulus that is relevant for decision making, wherein lower evidence accumulation rates reflect more difficulty extracting relevant information. The decision threshold parameter is a measure of response caution that reflects the tradeoff between speed and accuracy, where larger decision thresholds indicate greater response caution. Participants also completed a self-report of hearing using the Speech, Spatial, and Qualities of Hearing Scale, measures of cognition, and QuickSIN, a standardized measure of SPIN abilities. In a separate session, participants listened to continuous speech in quiet and in noise while electroencephalography was recorded. Results from the DDM indicate robust relationships between evidence accumulation in noise and self-reported measures of speech abilities. Additionally, both evidence accumulation and decision thresholds in noise strongly correlated with pure tone averages. These results indicate that listeners with better hearing thresholds who report fewer listening difficulties, accumulate evidence more efficiently and are more cautious responders, favoring accuracy over speed of decision-making. Ongoing work in phase two examines the extent to which DDM parameters predict cortical tracking of the continuous speech envelope in quiet and in noise in the same individuals. Taken together, these results suggest that incorporating response times into models of SPIN provides valuable information that could lead to the development of fast, clinically-relevant tests that capture real-world SPIN performance.

Topic Area: Speech Perception

Poster D38 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Is Feature Timing the Key to Phonological Acquisition? Naturalistic Evidence from EEG Encoding Models across the First Five Years of Life

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Infants rapidly tune into their native language (Kuhl, 2004): By the age of 6 months, they show enhanced processing of native phonemes (Kuhl et al., 2007; Ortiz-Mantilla et al., 2013). Sensitivity to phonemes presumes the ability to segment the corresponding acoustic segments in speech, which are as short as ~50 ms (Leong & Goswami, 2015). This is a challenge for the newborn brain, where slow electrophysiological activity prevails (Anderson & Perone, 2018) that only offers long temporal receptive windows (Hochmann & Kouider, 2022). How do infants acquire a native phoneme inventory at an early age despite their initial electrophysiological slowness? A high phoneme rate does not mean that all individual phoneme features change at a high rate. In speech, some features (e.g., voicing, place of articulation) extend over sequences of multiple adjacent phonemes. This results in feature-continuous stretches that would fit infants' long temporal receptive windows. We thus hypothesized that feature duration explains the early acquisition of native phoneme features in the absence of fast electrophysiological activity. We recorded the electroencephalogram (EEG) from $n = 77$ children aged 0;3–4;6 years. Children heard translation-equivalent stories in their native language (German) and an unfamiliar language (French). We quantified the processing of phonological features through the prediction accuracy of EEG encoding models (temporal response functions, TRFs). We compared the prediction accuracy of the TRF models to a permutation baseline, for which the EEG data was paired with time-shifted speech signals over 100 permutations. We found an increase of prediction accuracy across age that was specific to the native language (mixed-effects model interaction: $t(75) = 2.46$, $p = .016$; native: $t(76) = 3.54$, $p < .001$, non-native: $t(1.06) = 1.06$, $p = .29$), indicating an increase in infants' sensitivity to native phoneme features with age. Fitted confidence intervals across the native age trajectory suggest that native categorical processing of phoneme features significantly deviated from baseline from an age of 16 months onwards. Importantly, the developmental trajectory across individual features showed a significant correlation between a feature's age of acquisition and its average duration in continuous speech ($r(16) = .53$, $p = .014$). This means that infants display categorical sensitivity earlier to those features that extend over longer stretches of speech. This effect remained significant after controlling for the overall frequency of occurrence of each feature. This means that even at equal exposure, infants' sensitivity to a given feature is higher when it tends to extend in time. Our results show that the developmental trajectory of phonological acquisition is a function of feature duration in speech. Rather than individual phonemes, longer feature stretches in speech may ideally fit infants' extended temporal receptive windows. The electrophysiological slowness of the infant brain might lead to an initial focus on slowly alternating phonological features, progressing to faster features when higher electrophysiology frequencies become available during ontogenesis. This suggests that infants use feature timing to accommodate initial electrophysiological constraints and bootstrap into their native phoneme inventory.

Topic Area: Development

Poster D39 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam D session.

A novel and effective language-specific training: The BCI-supported aphasia training

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Introduction: Since now language therapy for aphasia following stroke focuses on patients' specific language deficits and it is guided and controlled by an external person, the speech therapist or a trained volunteer (Kelly, 2010). In contrast, close-loop approaches, as brain-computer-based interventions (BCI) already successfully used for motor impairments after stroke, are guided and controlled by the patients self. This study aimed to verify if this therapeutic approach can improve language deficits. For the first time, we developed and implemented a BCI-based training protocol for chronic aphasia patients after stroke. Analyzing the ongoing EEG signals while attending word stimuli, patients receive BCI feedback based on the strength of task-relevant EEG signals. Feasibility of the protocol was previously evaluated in an offline study with 20 NACs. Material and Methods: 10 patients with a left A. cerebra media infarct and chronic aphasia underwent about 30 hours (4 days per week) of effective BCI-supported online training. During each training-session, patients, seated in a ring of 6 loudspeakers, became EEG (32 channel passive Ag/AgCl electrodes) and heard a cueing sentence following to a series of 6 bisyllabic words (concrete nouns) from which one correctly finished the sentences. After each trial, they became a feedback based on whether the attended-word predicted by ERP responses matched the target word of one trial. Each of the 6 words was trained since the patients perfectly produced it and showed a stable ERP response by processing it. Than, a novel word/sentence replaced the trained word. Before and after training all patients underwent an aphasia test battery for language assessment (Aachen Aphasie Test (AAT) [4] and Snodgramm naming test) as well as for executive functions (TAP, Corsi, digit span and word-fluency test). Two EEG-sessions (64 EEG channels) without feedback were conducted prior to the training to calibrate the BCI system and to determine parameters of the stimulation for each patient as well as after training to compare ERP response. Before and after the training, rs-fMRI scans, anatomical images and diffusion-weighted echo-planar imaging image were acquired. Results and Discussion: First, we found that the BCI-training was feasible, despite a high-word presentation speed and unfavourable stroke-induced EEG signal characteristics. Second, the training induced a sustained recovery of aphasia, which generalized to multiple language aspects beyond the trained task. Specifically, all tested language assessments (Aachen Aphasia Test, Snodgrass & Vanderwart, Communicative Activity Log) showed significant medium to large improvements between pre- and post-training, with a standardized mean difference of 0.63 obtained for the Aachen Aphasia Test, and five patients categorized as non-aphasic at post-training assessment. Third, our data show that these language improvements were accompanied neither by significant changes in attention skills nor non-linguistic skills. Investigating possible modes of action of this brain–computer interface-based language training, rs-functional MRI showed an increase of functional connectivity of the language-network and a decreases of functional connectivity of posterior cingulate cortex with other regions of Default-mode network. We discussed the importance of the rebalancing between the language- and default mode networks for recovery from aphasia.

Topic Area: Language Therapy

Poster D40 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Electrophysiological signatures of Working Memory during Sentential Language Processing

Megan Nakamura[1], Beverly Cotter[2], Yanina Prystauka[3], Eleonora Rossi[1]; [1]University of Florida, [2]University of California Davis, [3]University of Tromsø-UiT The Arctic University of Norway

Recent work on neural oscillatory correlates of sentence processing suggests power decreases in alpha and beta can be associated with the processing of syntactic and semantic violations (Kielar et al., 2014). Some findings also suggest changes in alpha may reflect neural processes underlying Working Memory (WM) (Wianda & Ross, 2019). More recently, Rossi & Prystauka (2020) found that when individuals process linguistic information in their second language, alpha and beta oscillations decline earlier in time. In this study we investigated the role of WM during language processing by manipulating WM itself to create a 'taxing condition' while processing in the native language. Method: Participants (n=34; f =28; mean age = 19.5) were native monolingual English speakers with no history of neurological diagnosis and/or learning disorders. All participants completed a behavioral Operational Span (O-Span) (Turner and Engle; 1989) and were randomly assigned to complete an EEG Grammaticality Judgment Task (GJT) either with an additional WM component i.e., "memory load" or without "no-memory load". Participants in the no-memory group were instructed to complete the GJT consisting of (180) sentences: (60) correct–without violations, (60) with syntactic violations, and (60) with semantic violations. The memory group did the same but with the additional ongoing WM component which required participants to memorize a sequence of three words, to monitor the sentence for those words, and to randomly recall if a specific word was present in the sentence. All sentences were presented in rsvp. Preliminary Results: The data demonstrate a main effect of sentence condition; a larger P600 for sentences containing syntactic violations and a larger N400 for sentences containing semantic violations. Currently, the main effect of group (memory vs no-memory) has not reached statistical significance. However, the data demonstrates a potential qualitative difference between the two groups. For both groups, there is a biphasic negative to positive pattern only in the syntactic violation condition. This early negativity (between 300-500ms) with a left anterior distribution is indicative of ELAN/LAN and is larger for the non-memory group. The presence of ELAN/LAN for the syntactic condition is inline with previous findings reporting it as a marker of first-pass parsing (e.g. Neville et al., 1991; Münte et al., 1997; 1999; Friederici & Frisch, 2000; Friederici et al., 2002). It is thus possible that the manipulation of working memory is reflected in the shape and distribution of this biphasic signature. However, bearing in mind that this preliminary analysis has only considered grand averages, it is also possible that this apparent ELAN/LAN is more so indicative of averaging across individuals who elicit more N400-like ERPs during syntactic processing. For this reason, the final analysis will critically take into account individual variability in both ERPs and WM capacity as measured by the O-span. The time-frequency analysis is currently underway, but we predict to observe the same decline in alpha and beta band for the memory-loaded group as seen in Rossi & Prystauka's, (2020) L2 processing condition, considering that this oscillatory signature may be a marker of differential WM resources during language processing.

Topic Area: Syntax

Poster D41 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neural mechanisms of learning and consolidation of novel morphologically derived words: Evidence from Hebrew speakers

Upasana Nathaniel[1], Stav Eidelsztein[1], Kate Girsh Geskin[1], Brianna L. Yamasaki[2], Bracha Nir[1], Vedran Dronjic[3], James R. Booth[4], Tali Bitan[1,5]; [1]University of Haifa, Israel, [2]Emory University, Atlanta, GA, [3]Northern Arizona University, Flagstaff, AZ, [4]Vanderbilt University, Nashville, TN, [5]University of Toronto, Toronto, Canada

We examined the neural mechanisms associated with learning of morphologically complex words within the Complementary Learning Systems (CLS) framework (McClelland et al., 1995), and its extension to word learning (Davis & Gaskell, 2009). According to CLS, new words are initially encoded within the hippocampus as episodic memories and over time consolidated into long-term lexical representations within neocortical structures. During consolidation repeated aspects of discrete events are extracted to form regularities and induce generalization (Lewis & Durrant, 2011). Extraction of repeated units and generalizing them is fundamental to learning morphological regularities. We therefore predict that morphologically complex words, which can be decomposed and generalized, will be learned and consolidated faster than morphologically simple words, and will show more reliance on neocortical regions, and independence from hippocampal areas, in the earlier stages of acquisition. We included two types of complex words: Linear which have a more salient structure, and Non-Linear, which is a prominent derivational structure in participants' first language. 29 adult native-Hebrew speakers were trained across 4 sessions on 72 novel nouns from three morphological conditions: Complex Non-Linear (CNL, 'gulbaki'=fisherman, root: g-l-b-k=fish, pattern:

XuXXaXi=person), Complex Linear (CL, ‘zomgine’=birdwatcher, root: zomg=bird, suffix: -ine=person), and a mono-morphemic Simple condition (‘bunkut’=shoemaker) which served as a baseline. In the first and last sessions, training was followed by testing in an MRI scanner. In the last session, participants were tested on their ability to generalize learning. Behavioural results showed better overall learning and generalization of the morphologically complex conditions compared to the simple condition, particularly CL. fMRI results across scans revealed greater activity in left inferior frontal gyrus (LIFG) pars orbitalis for CNL > Simple. Only for CNL, overall performance across scans correlated with activity in LIFG pars opercularis, suggesting reliance on morphological decomposition. Similarly, only for CNL, improvement in performance during session 1 correlated with activity in LIFG pars triangularis in the first scan. The CNL condition also showed greater recruitment of hippocampus in comparison to the Simple condition. Furthermore, performance across sessions in the CL condition correlated with activity in hippocampus, suggesting reliance on episodic retrieval. Finally, the Simple condition showed greater activity compared to CL in temporal regions, associated with whole-word processing. Overall, behavioural findings show better learning and generalization of the morphologically complex conditions, indicating decomposition of morphologically complex words in the early stages of learning. The linear condition being more salient and easily learned (based on behavioural results) showed less cortical involvement in comparison to the non-linear condition, while processing of the non-linear structure involved higher load on mechanisms of decomposition in frontal regions. Finally, while our fMRI results did not reveal an effect of session, the learning of both morphologically complex conditions across sessions involved greater engagement of hippocampus than the Simple condition, suggesting that in contrast to our hypothesis, extraction of morphological regularities and neocortical activation were not associated with independence of hippocampal processing.

Topic Area: Morphology

Poster D42 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam D session.

Cognitive control in thematic role assignment: Evidence from neural oscillations

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A key function in language comprehension is determining who did what to whom, i.e., assigning thematic roles to an event. Real-time thematic role assignment can generate conflict between multiple representations when syntactic and semantic cues support different interpretations (e.g., ‘…which waitress the customer had served…’). Previous research has indicated that cognitive control engages to resolve such conflict: role reversals increase activity in frontal brain regions associated with cognitive control across linguistic and nonlinguistic domains; and upregulation of cognitive control facilitates the resolution of competing event roles (Thothathiri et al., 2012, 2018). These findings, however, do not address the temporal dynamics of how and when cognitive control influences sentence comprehension. Here, we ask whether neural oscillatory EEG activity in the theta band (4-8 Hz) — which is widely associated with cognitive control in tasks like Stroop and Flanker (e.g., Cavanaugh & Frank, 2014) — can provide a real-time index of cognitive-control engagement during language comprehension. Specifically, we tested whether theta activity increases for role-reversal sentences, which create two competing interpretations, but not for implausible sentences in which syntactic and semantic cues do not conflict. We hypothesized that cognitive control is rapidly recruited during sentence processing, exclusively when conflict arises, and that this manifests in EEG as increased theta-band activity. We conducted a reanalysis of EEG data from Chow, Smith, Lau, and Phillips (2016; Experiment 1; N=24). Participants read two types of semantically implausible sentences and their baseline counterparts: Role-Reversal sentences (e.g., ‘…which waitress the customer had served…’), which were rendered implausible by swapping argument roles from a highly plausible baseline sentence (‘…which customer the waitress had served…’); and Argument-Substitution sentences (e.g., ‘…which realtor the landlord had evicted…’), which were rendered implausible by substituting an argument from a highly plausible baseline sentence (‘…which tenant the landlord had evicted…’). The critical word

('served'/'evicted') was unpredictable and implausible in both sentence types. In Role-Reversal but not Argument-Substitution sentences, conflict arises between the thematic-role assignment supported by world knowledge and that signaled by the sentence's structure. We computed time-frequency representations of EEG activity during the critical words (5-cycle Morlet wavelets at 30 log-spaced scales 2-80). Role-Reversal sentences elicited increased theta-band power versus baseline, 500-950ms after word onset (cluster-level p = 0.039 in a cluster-based permutation test). No increase in theta-band activity was observed in Argument-Substitution sentences (versus baseline). Notably, the theta effect is functionally distinct from the P600 effects observed in the original ERP analysis, which were observed in both implausible conditions. Our findings provide a new neurophysiological index of cognitive-control engagement during sentence processing: increased theta-band activity. The time-course of theta effects, beginning around 500ms, suggests rapid, reactive cognitive-control engagement in response to conflict. Increased theta-band activity was exclusive to Role-Reversal sentences, which suggests that cognitive control engages specifically when multiple competing interpretations of a sentence are temporarily pursued, and not in implausible sentences involving no conflict, as in Argument Substitution. These patterns show that EEG activity in the theta band can clarify the temporal dynamics of when cognitive-control mechanisms deploy during language processing.

Topic Area: Control, Selection, and Executive Processes

Poster D43 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Exploring the Neural Mechanisms of Executive Function in Bilinguals with ADHD

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Executive functions (EF) are a set of cognitive skills that include self-regulation, inhibition of behaviours, attention switching, and working memory (Miyake et al., 2000). Prior research suggests that the experience of bilingualism can enhance EF, while clinical diagnoses, such as attention deficit hyperactivity disorder (ADHD), are associated with EF difficulties. Interactions between these variables – and underlying neural processes – are not well understood. Considerable research has found that bilinguals outperform monolinguals on certain EF tasks, including faster reaction times (RT) during monitoring, inhibition, and switching (Costa et al., 2009). Bilinguals also show enhanced neural processing during EF tasks, reflected by faster and larger N2 (inhibition, conflict monitoring) and P3 (response evaluation, attentional resource allocation) event-related potential responses compared to monolinguals (Botezatu et al., 2021; Moreno et al., 2008). Inversely, significant deficits in inhibition, shifting, and working memory have been observed in individuals with ADHD (Rubia et al., 2005). Electrophysiological studies have found reduced N2 amplitude during inhibition tasks in individuals with, compared to without, ADHD, suggesting differences in neural processing underlying EF (Liotti et al., 2007). Despite disparate EF profiles, little research has explored how bilingualism and ADHD interact to predict EF, and none at the neural level. One prediction is that positive effects of bilingualism on EF could buffer executive dysfunction for bilingual compared to monolingual individuals with ADHD. However, conflicting behavioural evidence exists. Some studies report slower RT and lower accuracy during EF tasks for bilinguals compared to monolinguals with ADHD (Bialystok et al., 2017; Mor et al., 2015), potentially due to the increased cognitive load that bilingualism may place on a disrupted EF system. However, studies were small and effects of bilingual age-of-onset, proficiency, and ADHD symptom severity – variables that could shape neural processes underlying EF – were not fully explored. The present study will address this gap by testing two groups of adult participants: bilinguals and monolinguals with ADHD. Diagnostic measures of ADHD and language assessments will be collected. Participants (n = 40) will complete EF tasks during electroencephalogram recording using a high-density 128-channel MagStim EGI system. Inhibition will be measured using a standard flanker task and set shifting using a Dimensional Change Card Sort task. Amplitude and latency of N2 and P3 components, and behavioural RT and accuracy, will be measured. If bilingualism supports EF, bilinguals with ADHD should show a) decreased latency and increased amplitude of the N2 and P3 components and b) faster RT and higher accuracy, compared to monolinguals with ADHD. If bilingualism does not support EF, the reverse pattern is expected. ADHD symptom severity, duration of

bilingual exposure, and age of second language onset will be tested as predictors of neural and behavioural outcomes. With increasing bilingualism and ADHD diagnoses worldwide, understanding how these variables interact to drive EF is critical. The proposed study is the first to test neural mechanisms underlying interacting EF processes in these groups. It will further a mechanistic understanding of how individual differences in experience and neurodevelopment interact to shift EF.

Topic Area: Disorders: Developmental

Poster D44 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Decoding of speech imagery as a window to speech planning and production

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Speech imagery (the ability to generate internally quasi-perceptual experiences of speech events) is recognized as a fundamental ability tightly linked to important cognitive functions such as inner speech, phonological working memory, and predictive processing. Speech imagery is also considered an ideal medium to test theories of overt speech. Despite its pervasive nature, the study and use of speech imagery for clinical or basic research has been tremendously challenging. The lack of direct observable behavior and the difficulty in aligning imagery events across trials and individuals have prevented a better understanding of the underlying neural dynamics and limited use as a research tool. We aim to map out the generation of speech imagery by pairing magnetoencephalography (MEG) with a novel experimental protocol designed to overcome these difficulties. Thirty participants (22 women; mean age=26, std=7) imagined producing isolated syllables (e.g., pa, ta, ka) immediately after these were presented on a screen and a second time 1000ms later, while we recorded their neural activity with MEG (157-channel whole-head axial gradiometer). This Imagery condition was contrasted with a Reading condition, in which participants read the syllables but were asked not to imagine them. We recorded electromyographic data from participants' upper lip and jaw to monitor micromovements. We also acquired magnetic resonance imaging data (T1) from a subset of participants to source project their speech imagery data. Participants were trained on an overt version of the task prior to the MEG session. Their overt productions were recorded to estimate timings and durations. We used a decoding approach to (1) classify participants MEG data as Imagery or Reading, (2) classify the imagined syllables, (3) explore different levels of representation (syllable, consonant-vowel transition) during imagery, and (4) ensure that our results could not be explained by participants' micromovements. Participants' MEG data was projected to source space to investigate the temporal dynamics of speech imagery. Robust classification scores were obtained for the contrast between Imagery and Reading and between the syllables. Syllable decoding revealed a rapid sequence of representations from visual encoding to the imagined speech event. Participants' micromovements did not discriminate between the syllables. The neural correlates of the decoded sequence of representations maps neatly onto the predictions of current models of speech production (e.g., State Feedback Control; SFC) providing some evidence for hypothesized internal and external feedback loops for speech planning and production, respectively. Additionally, a novel decoding approach (Windowed Multinomial Classification) revealed the presence of two nested and concurrent levels of representation (syllable and consonant-vowel transition) while exposing the compressed nature of representations during planning. The results show an evolving sequence of representations for speech imagery with neural dynamics and characteristics consistent with SFC. It is assumed that the same sequence underlies the motor-based generation of sensory predictions that modulate speech perception and the articulatory loop of phonological working memory. The results highlight the potential of speech imagery for research, based on these new experimental approaches and analytical methods, and further pave the way for successful non-invasive brain-computer interfaces.

Topic Area: Speech Motor Control

Poster D45 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam D session.

Probing the categorical structure of fifty abstract words

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Our lexicon can be divided into concrete concepts that describe perceivable entities, such as “dog” and “truck,” and abstract concepts that refer to intangible entities, such as “frustration” and “truth.” While concrete concepts are relatively easy to categorize based on shared physical and functional properties, attempts to characterize the categorical structure of abstract concepts have not been as successful. We sought to uncover the categorical structure of abstract concepts using a rigorous, multipronged approach in which we first found categorical boundaries within a set of abstract words using data from an implicit judgement task and then tested the behavioral validity of those category boundaries using automatic semantic priming. First, we chose fifty words that were identified as abstract in a prior study. Next, 414 participants (194 female; mean age=40.3, s.d.=12.2) made implicit similarity judgements about the fifty abstract words during an odd-one-out triplet task on Amazon’s Mechanical Turk. We used the results from this task to derive a similarity matrix for the fifty abstract words. To ensure that the similarity matrix was stable, we ran the same task online in a separate group of 414 participants. The matrices were highly similar (r=0.93). We then used principal components analysis and k-means clustering to analyze the matrix and divide the words into candidate categories. Next, we removed clusters that contained less than three words and then removed any unstable words from the remaining clusters. We determined cluster stability by comparing them with clusters from a word embedding obtained using fastText to represent the fifty abstract words in a 300-dimensional space, then applying UMAP to reduce the dimensions, followed by HDBSCAN and k-means to group similar words together. After comparing the clustering solutions, we were left with thirty abstract words that were separated into five categories for the automatic semantic priming experiment. We also included thirty concrete words from five categories as a necessary control condition. During the priming experiment each participant (N= 12, to-date) was presented with 1312 trials, so that every possible pair from within each category was shown twice along with an equal number of between-category and between-word-type pairs. In each trial, a prime word was presented for 100 ms, followed by a 50 ms mask and 100 ms blank screen, then a probe word for 250 ms, and finally a blank screen for 1000 ms. The participants were asked to respond using the keyboard whether the probe word was abstract or concrete. Overall, accuracy was very high (95.1%) and did not differ across within- and between-category trials for abstract or concrete words (both p’s>0.15). Paired t-tests revealed significantly faster response times to within-category word pairs relative to between-category pairs (i.e., priming) for both abstract and concrete words (both p’s<0.05). These results demonstrate that abstract words can be organized into behaviorally relevant categories assumed to reflect yet-to-be-determined shared properties. We plan to further probe the categorical structure of abstract words using other methods, including neuroimaging, behavioral tasks, and computational modeling.

Topic Area: Meaning: Lexical Semantics

Poster D46 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Cortical Underpinnings of Conceptual Composition and Lexical Polysemy: The Many Meanings of English have

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Phenomenon: English speakers readily accept ambiguous sentences like "the maple tree has a car" with a locative meaning, if followed by facilitatory locative contexts like "there is a motorcycle under the pine tree". This indicates that English 'have' can express not only possession but also location without the support of a prepositional phrase,

raising the question of have’s meaning encoding given its polysemy(1,2,3). Question: Is 'have''s meaning encoded in the brain, as measured through fMRI, as a unified conceptual structure or as two 'haves', one for possession and another for location, the latter expressed through syntactic cues? This leads to competing hypotheses (2): (I) Unified Meaning Hypothesis: Comprehension of 'have' involves the activation of a parametrized conceptual space determined by the degree of causality perceived from linguistic and contextual cues, and from which possession-location readings emerge. If so, comprehension of NP-have-NP sentences involves (a) lexical-semantic composition where the first NP is composed with the lexico-semantic conceptual structure of have and (b) conceptual contextualization when the complement is composed determining the specific relation (possession vs. location) between the two NP entities. (II) Two-Meanings Hypothesis: Comprehension of 'have' involves the implementation of a syntactic repair operation triggered by failure of possessive interpretation. Syntactic-repair inserts a locative-PP (overt or covert) to support the alternative, normally dispreferred, locative meaning. Methods: Thirty native English speakers (16 female, ages 18-29). 100 target NP-have-NP sentences followed either a facilitatory locative context (50_context+sentence) or a non-facilitatory possessive context (50_context+sentence) plus 50 fillers. Context+sentence pairs analyzed as two events: Event_1:context+subject of target sentence; Event_2:have+NP-complement. Subtraction: Event_2 "has a car that is red" after location_context minus Event_2 "has a car that is red" after possession_context. Event_2 is the segment where location interpretation is determined. Crucially, the Event_2 subtraction involves identical linguistic material. Accordingly, any neural activation differences observed are due to the contexts (location_v_possession). Contexts are captured, separately, in Event_1. The Unified Meaning hypothesis predicts preferential activation for Event_2 of the left posterior and of the prefrontal cortex previously reported as implicated in lexico-semantic composition and contextualization (4). In addition, given the high context dependence of have-interpretation, we expect that Autism Quotient (AQ) scores (5), our measure of variability in linguistic meaning context-sensitivity, will correlate with individual participants’ activation magnitudes in the Event_2 contextualization operation. The Two-Meanings Hypothesis predicts preferential activation of the LiF cortex reflecting morphosyntactic composition, and no interaction with context-sensitivity metrics, as syntactic repair is only dependent on presence/absence of a prepositional-phrase. Findings: The key subtraction Locative>Possessive associated with Event_2 revealed bilateral angular gyrus, left supplementary motor area, precuneus and right frontal cortex_(BA 8) activation consistent with lexico-semantic composition and contextualization processes (p<.001, corrected). AQ scores correlated in opposite ways for the composition and contextualization areas, suggesting that context matters for the interpretation of the target sentence. Conclusions: Brain activation patterns of meaning of English 'have' are consistent with the Unified Meaning hypothesis, suggesting a compositional role for conceptual structure independent of syntactic composition and grounding cases traditionally viewed as lexical polysemy. References: 1:Zhang et al. 2018;2:Zhang,2021;3:Zhang_et_al.2022;4:Lai_et_al.2017;5:Baron-Cohen_et_al.2001.

Topic Area: Meaning: Lexical Semantics

Poster D47 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam D session.

Structural differences in the cortex and subcortex between healthy aging bilinguals and monolinguals from the Human Connectome Project

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Introduction: There has been a tremendous increase in studies examining how bilingualism changes the structure of the brain (Liu et al. 2021). In this study, we accessed a database of over 1200 healthy aging adults from the Human Connectome Project (Bookheimer et al. 2019) to examine cortical and subcortical brain structure in bilinguals compared to monolinguals. Based on several recent models of brain restructuring in bilinguals (e.g., DeLuca et al.

2020; Pliatsikas et al. 2019; Grundy et al. 2017), we hypothesized that, compared to monolinguals, bilinguals would have smaller anterior brain regions and larger posterior (cortical and subcortical) brain areas. Methods: Using a brain atlas with detailed parcellations (HCP-MMP v1.0 cortical atlas, Glasser et al. 2016), we measured cortical surface area, thickness, and volume in bilinguals and monolinguals. Subcortical volume was extracted with the Automatic Subcortical Segmentation atlas (Fischl et al. 2002). Following prior work (Anderson et al. 2018), we applied propensity score matching to match bilinguals and monolinguals on five confounding variables: sex, handedness, age, education, and MRI scanner ID (160 bilinguals, 169 monolinguals; mean age: 56 years). In addition, we also report comparisons between a subset of bilinguals that included active (i.e., currently using their languages) proficient bilinguals with at least 10 years of language experience in their second language and matched monolinguals (35 participants per group, mean age: 51 years). Based on previous literature, we selected 34 of 180 regions of interest (ROIs) per hemisphere from the multi-modal parcellation of the HCP-MMP atlas (Glasser et al. 2016) that centered around six larger structures: the inferior frontal gyrus, middle temporal gyrus, anterior temporal lobe, superior posterior temporal lobe, the inferior parietal cortex, and anterior cingulate cortex (e.g., Ressel et al. 2012). Seven structures were chosen from the subcortical atlas (Burgaleta et al. 2015). All statistical analyses were completed using R and RStudio (version 2021.9.0.351). One-way analysis of variance tested for differences in the three cortical parcellation measures (34 ROIs each), and differences in volume for the subcortical ROIs. P-value adjustments were performed using Benjamini and Hochberg correction for false discovery rate (two-sided alpha <0.05). Results: Relative to monolinguals, bilinguals from the primary matched sample had less cortical area and thickness in the anterior ROIs, more thickness in the posterior ROIs, and the same cortical and subcortical volume. We observed robust differences between the subset of active proficient bilinguals and monolinguals for surface area, thickness, and cortical and subcortical volume. Specifically, we report: (a) smaller values for the three cortical measures in the anterior ROIs (e.g., area a24 in the left anterior cingulate cortex, q=0.03), (b) larger values in the posterior ROIs (e.g., area LBelt in the right auditory cortex, q=0.01). Conclusion: We used detailed brain parcellations to examine differences in the cortex and subcortex in bilinguals and monolinguals from the Human Connectome Project in Aging study. Our findings confirm the predictions of the bilingual restructuring models showing that bilinguals have smaller anterior brain areas and larger posterior structures than monolinguals.

Topic Area: Multilingualism

Poster D48 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

An fMRI investigation of the interplay between representational content and syntactic function during the comprehension of language describing state change

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Comprehending language describing change, e.g. “The chef will chop the massive onion”, requires comprehenders to represent the changed object in, minimally, its initial and end states (Altmann & Ekves, 2019). Previous work (Hindy et al., 2012; Solomon et al., 2015) shows that once instantiated, both the initial and end states are maintained in memory, allowing the unfolding language to refer to either state, e.g. “The chef will chop the massive onion, and then/but first he will smell the onion”. But what brain mechanism might control which representations become (more) activated, and when? What is its role in mediating between the syntax used to convey event structure and the intended meaning of that structure? Behavioral evidence (Prystauka et al., submitted) shows that representations of both the chopped and unchopped onion are active after “…will chop the massive onion”, but the unchopped state is considerably less active (if at all) after the participial form “… will choose the chopped onion”. Hindy et al. (2012) and Solomon et al. (2015) had shown, for “…will chop…”, that this simultaneous activation of the distinct states of the onion results in increased activation, relative to “…will weigh…”, in left posterior ventrolateral prefrontal cortex (pVLPFC); they equated this effect with increased competition (for selection) between the distinct object-state representations of the onion. Here, we ask about “…the chopped onion”; whereas after “…will chop…”, representations of both the unchopped and chopped onion are available for subsequent reference, they are not after "…the chopped onion" – what are the consequences of this for pVLPFC activation and its role in the construction of event representations? fMRI was acquired while participants (N=22) performed a sentence reading task in which we manipulated the degree of change described by the verb (chop/weigh) and the modifier type (massive/chopped). Following Hindy et al., (2012), we used a Stroop task to first identify conflict-sensitive voxels in pVLPFC per individual and used these as our region of interest (ROI); increased activation in these voxels is an index of competition (January et al., 2009). We anticipated increased activation in the chop-massive condition relative to the weigh-massive condition. Of critical interest was how the weigh-chopped condition would pattern – more like weigh-massive (suggesting no or little competition between object states), or more like chop-massive (suggesting competition and dual activation)? Activation in the ROI was higher in the chop-massive condition than in the weigh-massive condition, suggesting dual state activation following state-change verbs (replicating our prior studies). Critically, activation was higher for sentences with participles (weigh-chopped) than sentences with adjectives (the weigh-massive and chop-massive conditions). We propose that whereas greater activation of stroop-sensitive voxels in pVLPFC after chop-massive than after weigh-massive reflects competition (i.e. representational conflict that interferes with selection), the additional increase after weigh-chopped reflects the additional control required to actively suppress (c.f. Grindrod et al., 2008) the representation of the onion in its unchopped state, reflecting the function of the participial form. pVLPFC is thus central to controlling the accessibility of key components of event representation during event comprehension.

Topic Area: Meaning: Combinatorial Semantics

Poster D49 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

What Can Glioma Patients Teach Us about Language (Re)Organization in the Bilingual Brain: Evidence from fMRI and MEG

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A remarkable feature of the central nervous system is its inherent capacity to dynamically reorganize its structure and function depending on the environment 1-5. Recent evidence suggests that the presence of brain tumors (e.g., low-grade gliomas) triggers language reorganization 3,6-9. Neuroplasticity mechanisms called into play can transfer linguistic functions from damaged to healthy areas unaffected by the tumor 3,6-9. This phenomenon has been reported in monolingual patients, but much less is known about the neuroplasticity of language in the bilingual brain. A central question is whether processing a first or second language involves the same or different cortical territories and whether damage results in diverse recovery patterns depending on the language involved. This question becomes critical for preserving language areas in bilingual brain tumor patients so as to prevent involuntary pathological symptoms following resection. In the current study, we combined the high spatial resolution of fMRI with the high temporal resolution and oscillatory information provided by MEG to map the language network and its functional (re)organization in the bilingual brain, both prior to and following tumor-removal surgery. Specifically, we tested five Spanish-Basque bilingual patients with low-grade gliomas before and four months after surgery for tumor resection, evaluating their neural capacity to negotiate L1 (Spanish) and L2 (Basque) language information before and after the resection of critical language-hubs. This longitudinal approach (post vs. pre-surgery) granted us a unique opportunity to estimate functional neuroplasticity at the individual level considering patient's cognitive status both prior to and following tumor removal surgery. We present three main findings. First, all patients preserved linguistic function in both languages after surgery suggesting that the surgical intervention, together with the intra-operative language mapping, were successful in preserving cortical and subcortical structures necessary to allow brain plasticity at the functional level. Second, we found reorganization of the language network after tumor resection in both languages, mainly reflected by a shift of activity to right hemisphere nodes and by the recruitment of ipsilesional left nodes. Third, we found that this reorganization varied according to the language involved, indicating that L1 and L2 follow different reshaping patterns after surgery. Importantly, these effects were observed with both fMRI and MEG. Our fMRI-MEG findings suggest that language reorganization takes place in the bilingual brain after tumor resection following neuroplasticity mechanisms similar to those observed in monolingual patients (i.e., recruitment of frontal ipsilesional and contralesional nodes). Furthermore, they show that this language rearrangement occurs in both the L1 and L2, underscoring the necessity of mapping all the languages that a patient speaks. Finally, they also hint at differential post-surgery reorganization of L1 and L2, suggesting that distinct languages may not completely overlap in terms of their neural representation or, alternatively, that the changes necessary to preserve function engage different networks depending on language proficiency. Overall, from a clinical standpoint, these findings help delineate personalized surgical strategies that respect a patient’s linguistic profile in order to preserve language function in an integral fashion.

Topic Area: Disorders: Acquired

Poster D50 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Locally coherent phrases drive delta band phase synchronization

M. Blake Rafferty[1], Tim Saltuklaroglu[1], Kevin Reilly[1], Eun Jin Paek[1], Devin M. Casenhiser[1]; [1]University of Tennessee Health Science Center

Recent findings in electrophysiology have shown that low-frequency neural oscillations may become synchronized at the boundaries of constituent phrases, possibly indexing the internal generation of hierarchical syntactic structures. However, psycholinguistic evidence also suggests that such constituent boundaries are often underdetermined or ambiguous during online processing, due in part to the fact that language is produced and perceived through serial channels. In the present study, we investigated the possibility that low-frequency oscillations may instead be driven into synchrony at the boundaries of locally coherent phrases as they are incrementally constructed online, rather than constituent boundaries within global (i.e., sentence-level) syntactic structure. To do this, we recorded EEG for 23 participants (17 female and 6 male) while they read syntactically well-formed English or jabberwocky sentences (e.g., The boy kicked the ball in the net or The pob hinked the doal in the jarm) and ungrammatical English or jabberwocky word-lists, one word at a time. To assess cortical synchronization to syntactic units, we calculated delta band (1-4Hz) inter-trial phase (ITPC) coherence at each word. In line with previous work, we anticipated increased synchrony at the boundaries of syntactic units, with the expectation that these may correspond to sentence-level constituent boundaries (e.g., boy, ball, and net in the English sentence above). However, given that words were presented one at a time, we anticipated that verbs (e.g., kicked) or prepositions (e.g., in)—which, do not comprise phrase boundaries within the sentence-level hierarchical structure—may also elicit increased ITPC, since each can comprise phrase boundaries in locally licensed sentence configurations (e.g., The boy kicked and The boy kicked the ball in are both well-formed English sentences). Monte-Carlo permutation tests with false-discovery rate correction revealed that English and jabberwocky sentences, both of which contained well-formed syntax, elicited significantly greater delta ITPC in comparison to the wordlists. These differences were observed following all items that could form phrase boundaries in their local contexts, even if they did not correspond to constituent boundaries within the global hierarchical structure. These findings provide neurophysiological evidence that syntactic structures are likely generated in incremental fashion, based on local syntactic coherency.

Topic Area: Syntax

Poster D51 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Coordinate-based meta-analyses and connectivity profiles of an implicit language learning brain network in healthy adults

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Baddeley (1993) proposed that rehabilitation should center on modifying a behavior through experience-based learning. However, approaches to understanding recovery of language in aphasia focus on characteristics of the brain and the presenting language deficits. Previous work has identified favorable brain-based biomarkers of recovery, but not how rehabilitation efforts enhance brain changes to result in favorable recovery of language. That is, the learning that is required for successful rehabilitative outcomes following brain injury is not often considered relative to how the damaged brain learns. Thus, we embark on a program of research that begins with identifying language learning paradigms and their corresponding brain networks. While language rehabilitation is not synonymous with learning a grammar, we focus first on learning known to be involved in language acquisition – implicit or statistical learning, to identify the network of brain regions actively involved in implicit language learning in healthy adults. Multiple coordinate-based meta-analyses (CBMA) were conducted to identify common and distinct brain activity across studies. Inclusion criteria for studies were: study of healthy adults 18+ years, use of implicit language learning tasks, reporting of coordinates for whole brain analyses, and reporting of experimental contrasts indicating rule learning. Papers were coded for meta-data and experimental contrasts were categorized as grammatical (rule-following) or non-grammatical (rule-violating). Activation likelihood estimation (ALE) was used to compute the activation probabilities across all voxels, generating regions of interest (ROI) that were common across studies. Connectivity amongst the ROIs was characterized by using them as seeds in task-independent and task-dependent functional connectivity analyses. Hierarchical clustering of the connectivity profiles grouped brain regions into subnetworks associated with grammatical/non-grammatical processes. Functional decoding further characterized the mental operations associated with those sub-networks. The CBMAs were conducted on 25 functional magnetic resonance imaging (fMRI) studies that used artificial or natural language learning tasks, with adjacent/non-adjacent or pairwise dependency learning, hierarchical, chunk-based, or phrase structure rule learning. ALE results identified bilateral ROIs in frontal, insular, and parietal cortex. However, regional activity did not differ when participants were distinguishing rule-following versus rule-violating stimuli. There was more left-lateralized activation as well as left superior temporal gyrus activation when the stimuli were rule-following (grammatical). Connectivity profiles indicated strong connections amongst the ROIs, as well as inclusion of subcortical structures (e.g., thalamus, pallidum, putamen), but the general pattern was consistent with structures of the frontoparietal network. These data support a left-dominant cognitive control network as a scaffold for grammar rule identification, maintenance, and rule application in healthy adults. This suggests that cognitive control is necessary to track regularities across stimuli and imperative for rule identification and application of grammar, as has been predicted by others reporting frontoparietal activity during language learning tasks. The frontoparietal brain network is domain general and largely overlaps with the cognitive control (e.g., multi-demand) networks, the integrity of which is known to be a positive prognostic sign for language recovery in individuals with aphasia. Future study will determine whether connectivity of the additional subcortical structures, and other temporal structures, are also relevant to successful language learning.

Topic Area: Disorders: Acquired

Poster D52 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam D session.

Neural representation of prosody

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Supra-segmental prosody refers to acoustic features of spoken language beyond the phonetic information, and is sometimes described as “the melody of language”. Prosodic cues, which include pitch, loudness, and duration, can convey linguistic, emotional, and other socially relevant information. Does the brain contain areas specialized for processing prosody or is prosodic information processed by some combination of areas that process pitch, speech, language, or some aspects of social interaction? Previous neuroimaging studies have reported sensitivity to various aspects of prosodic information in a number of brain regions, but have typically only included a limited number of conditions, making it difficult to establish functional selectivity for prosodic processing and thus to infer the underlying neural computations. Here, we designed a new robust fMRI paradigm for localizing regions sensitive to prosody in individual participants, and also included several other extensively validated ‘localizer’ tasks for auditory, linguistic, and social brain areas. Our critical experiment included six conditions: A. Content+prosody+: spoken sentences (extracted from spoken-language corpora) pronounced with an expressive prosody by a native English speaker; B. Content+prosody-: the same sentences as in A, but with reduced/distorted prosody (each word was recorded separately and then re-combined); C. Content-prosody+: sentences made up of phonologically matched pseudo-words and recorded with a matched prosody to the sentences in A; D. Content-prosody-: the same pseudo-word sentences as in C, but recorded one word at a time and re-combined, as in B; E. invertedC: the stimuli from condition C temporally inverted; and F. invertedD: the stimuli from condition D temporally inverted. Conditions A-D constituted a 2x2 design crossing linguistic content and prosody, whereas E-F served as controls for low-level acoustic differences between the prosody+ and prosody- conditions. In addition, each participant completed a localizer for pitch perception areas (Norman-Haignere et al., 2013), speech-selective areas (Overath et al., 2015), high-level language areas (Fedorenko et al., 2010), social perception areas (Pitcher et al., 2011), and domain-general multiple-demand areas (Duncan, 2010; Fedorenko et al., 2013). Two main results emerged: First, the left-lateralized language-processing areas (Fedorenko et al., 2010) and their right-hemisphere homotopes were both sensitive to prosody but only in the absence of linguistic content, as evident by a significant effect for C>D and no effect for A>B, in both hemispheres. This result suggests that previous reports of the right-hemisphere’s role in prosody could not be arising in the right homotopes of the language areas. And second, a set of brain areas in frontal and temporal cortex showed functional specialization for prosody, in materials with and without linguistic content (A>B and C>D), relative to pitch perception, speech perception, language comprehension, social perception, and general cognitive demands. Our results elucidate the neural mechanisms that support prosodic processing, including critically demonstrating the existence of regions that are functionally selective for prosodic processing and distinct from several other well-established functional areas. This work lays a critical foundation for further investigations of prosodic processing and its neural basis.

Topic Area: Prosody

Poster D53 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Meet my associates: Neural correlates of free word association measures

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Introduction: Free word association provides a measure of the likelihood that one word can prompt another word to come to mind with minimal constraints. Therefore, large-scale associative networks of words can capture shared lexical-semantic and socio-cultural experiences of many people. How these associative structures influence the neural representation of words remains understudied. It stands to reason that associative properties (e.g., how many associates a word has or how strongly a word is associated to other words) could be represented in putative lexical-semantic ‘hub’ areas such as the anterior temporal lobe (ATL), angular gyrus (AG), posterior cingulate cortex (PCC), and medial temporal lobe (MTL). Here, in an fMRI study, we investigated the relationship between brain activity and free word association measures provided by University of South Florida Free Association Norms (USF-FAN). Methods: Twenty-one healthy volunteers participated (10 female, mean age 25). In the scanner, participants completed a lexical decision task while being presented with concrete and abstract words (matched in frequency and length) and pronounceable pseudowords. Participants indicated via button press whether the word was real or not. For each word, three associative measures were gathered from USF-FAN and used as parametric regressors of interest: que set size (QSS), que probability resonance (QPR), and que resonance strength (QRSG). QSS is a measure of how many strong associates a word has (e.g., farm may have many strong associates such as cow, chicken, barn, etc.). QPR is the probability that each associate in a cue word's association set will produce the original cue word as an associate (i.e., if presented with cow, chicken, or barn, what is the probability that someone will respond with farm?). QRSG is a measure of how large and strongly connected a given word's associative network is. A region-of-interest (ROI) analysis was conducted to examine the relationship between brain activity and these associative measures within four bilateral ROIs: ATL, AG, PCC, and MTL, with each of these ROIs being broken into smaller subregions defined by the Human Connectome Project atlas. Within each subregion, two-tailed t-tests were conducted against zero, and Bonferroni corrected for multiple comparisons ($p<.05$). QSS results: Set size was significantly negatively associated with activity in left MTL and ATL, including entorhinal and perirhinal cortices and the superior temporal gyrus pole (STGp; all $p<.05$), especially for abstract words. No other areas were significantly associated with QSS. QPR: Probability resonance was significantly positively associated with right hemisphere AG subregions (anterior inferior parietal), as well as bilateral ATL (left STGp, right superior temporal sulcus). No other areas were significantly associated. QRSG: Resonance strength was significantly positively associated with activity in bilateral PCC subregions, as well as left entorhinal cortex and left temporoparietal junction. No other areas were significantly associated. Conclusions: As set size decreases, activity in left MTL and ATL increases, suggesting that MTL and ATL may help represent words without many strong associates. High QPR and QRSG were associated with increased bilateral AG, PCC, and ATL activity, suggesting that words with strong resonant associations are represented bilaterally.

Topic Area: Meaning: Lexical Semantics

Poster D54 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

White matter differences in bilingual and monolingual children: An ABCD data study

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Emerging evidence suggests that brain structure changes not only result from maturation but also through environmental experience, including the active use/exposure to two languages. Limited studies have examined the structural impacts of bilingualism with inconclusive and mixed findings due to small sample sizes and assessments at various stages of development. The Adolescent Brain Cognitive Development (ABCD) Study dataset provides an opportunity to investigate structural differences associated with bilingualism, leveraging neuroimaging and behavioral data from a large sample of adolescents. We used the ABCD baseline release to compare white matter (WM) organization of bilingual and monolingual children (ages 9-10). We identified bilingual children using parental and youth questionnaires for children exposed/using another language equally or more often than English. First, we compared WM organization as indicated by fractional anisotropy (FA) values in prominent language-related WM tracts between bilinguals and monolinguals using multiple regressions, controlling for age, sex, nonverbal IQ, pubertal status, handedness, parental education, and household income. We found significant differences between bilinguals and monolinguals in 18 of 27 WM tracts, including bilateral language network tracts, and the splenium and genu of the corpus callosum. FA values were greater across all tracts for monolinguals compared to bilinguals. These results replicate findings in some studies of WM organization in bilingual children, but using a much larger sample of children. However, these findings differ from what has been observed in WM comparisons of bilingual and monolingual adults, which tend to indicate higher FA values among bilinguals relative to monolingual adults. We then explored the impact each of the covariates in our regression models on FA values for monolinguals and bilinguals

separately. We found that, for this group of children, handedness, pubertal status and household income did not significantly impact FA values within either the bilingual or the monolingual group. Further, in the bilingual group we found no significant effects of sex, non-verbal IQ and English vocabulary levels on FA values while there were significant differences as a result of this covariates within the monolingual group in various WM tracts. Finally, we found that there were significant effects of age and maternal education on FA values in both the bilingual and monolingual groups. However, although both age and maternal education were positively related to increased FA values in both groups, the amount of the impact and the WM tracts where there were significant differences as a result of age and maternal education varied in the bilingual and monolingual groups. Further studies examining structural changes longitudinally in monolingual and bilingual children are necessary to understand how bilingualism (and other environmental factors) shape neuroanatomy in development.

Topic Area: Multilingualism

Poster D55 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Using deep learning models to explore the contextual dynamics of communicative interactions and its alterations in autism

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People communicate rich ideas with remarkable flexibility and ease, delivering appropriate signals in spite of the irregularities and shifts in context that are characteristic of our everyday social interactions— why are some people good at this while others struggle? For instance, deficits in communication and social interaction are among the core diagnostic criteria for Autism Spectrum Disorder (ASD), even though the precise sources of these deficits remain largely unknown. In an attempt to address this core issue, empirical studies have largely focused on how autistic individuals process social stimuli isolated from the context of interaction with others. Here, we plan to look at autistic communication through the lens of the conceptual alignment framework (Stolk et al., 2016), and test whether the deficits arise from a reduced ability to align communicative context with an interlocutor. To this end, we analyze communicative behaviors evoked during live social interaction with recently developed context-sensitive neural networks. We build on a body of behavioral and neuroimaging studies which use a controlled, yet open-ended non-verbal communication game (de Ruiter et al., 2010). In the game, two players are instructed to interact on a digital game board with a 3x3 matrix layout and jointly reproduce target configurations of two geometric shapes on a trial-by-trial basis. This paradigm is particularly notable because communicators do not have access to contextual priors or communicative conventions (i.e., linguistic expressions, gestures, body language, etc.), providing privileged access to the full communicative context and history. Furthermore, the game creates experimental conditions which require communicators to 1) invent new communicative movements (i.e. signals) on the fly, 2) coordinate with each other to impute a shared meaning into these signals, and 3) modify the signals to meet the demands of the changing context (determined by trial type and difficulty), and thereby the specific goals of the interaction. Under these circumstances, it was shown that autistic individuals struggle to rapidly find relevant context for each other's signals (Wadge et al., 2019). We use deep learning models, specifically a transformer architecture (Vaswani et al., 2017), to closely examine 1) the abovementioned signal dynamics 2) contextual dynamics of communication, herein defined as shifts in signal dependency structures across time, and explore how these dynamics interact with the signals being produced. By deploying Transformers iteratively, we aim to precisely define contextual dynamics generated by communicators. Our process is threefold: we 1) iteratively train models on progressively expanding interaction histories of behaviors from the same individual; 2) transform network embeddings into a dependency structure based on the distances of signals in the embedding space; and 3) correlate the dependency structures across consecutive interactions, generating a metric of contextual dynamics, namely interpersonal alignment of signals' embeddings at each communicative turn. In sum, using this computational tool on precisely quantified neurotypical and autistic interactions, our study will characterize how people navigate the contextual dynamics of communication.

Topic Area: Computational Approaches

Poster D56 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam D session.

White matter associations with performance on a difficult English spelling task

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Producing written language is an everyday life skill that supports effective communication. Multiple neuro-cognitive components are involved in the highly complex process of spelling written words. Yet, spelling remains a relatively under-studied field in terms of its underlying white matter substrates. fMRI studies identified a wide, mostly left-lateralized network of frontal, parietal and temporal active sites that are responsive during spelling tasks (Purcell et al., 2011; Planton et al., 2013). A few studies examined white-matter spelling-related tracts in children with dysgraphia (Gebauer et al., 2012; Banfi et al., 2019), but little is known about the neuroanatomical connections that support spelling in typically developing adults. We evaluated the associations between performance on a difficult spelling-to-dictation task and microstructural properties of language-related white-matter pathways, in 73 English-speaking adults (mean age: 21y ± 4.2, 57 females). Participants were scanned on a 3T Siemens scanner, using a diffusion weighted, single-shot EPI sequence (64 diffusion directions at b = 1000 and 1 volume at b = 0 s/mm^2, voxel size: ~2*2*2mm^3). We used constrained spherical deconvolution (CSD) modeling and probabilistic tractography to reconstruct, in each participant, the three branches of the superior longitudinal fasciculus (SLF I, II & III), the frontotemporal segment of the arcuate fasciculus and the inferior longitudinal fasciculus (ILF). All participants completed a wide cognitive assessment including vocabulary, spoonerism, sight word and phonemic decoding efficiency (TOWRE), nonword repetition (CToPP) and rapid automatized naming (RAN). Spelling scores significantly correlated with vocabulary, spoonerism, phonemic decoding efficiency and nonword repetition, while no correlations were found between spelling and sight word efficiency or RAN. Using a stepwise linear regression model, we found that, out of all tracts of interest, only mean fractional anisotropy (FA) in the left ILF and the right SLF III significantly predicted spelling scores. Next, we calculated Spearman's correlations between spelling scores and FA along these tracts. Because spelling performance was bimodally distributed across individuals, we used the local minimum of the bimodal model to divide participants into two groups of low- (N = 41) and high- performing (N = 32) spellers. Interestingly, while high-performing spellers showed a significant positive correlation between spelling scores and FA within the left ILF ($r = .53$, $p < .05$, family-wise error corrected), low-performing spellers did not show such an association. Conversely, low-performing spellers showed a negative correlation between spelling scores and FA within the right SLF III ($r = -.47$, $p < .05$, family-wise error corrected), while high-performing spellers did not show such an association. These findings demonstrate the complexity of the neurocognitive architecture of the spelling process. Specifically, spelling is shown to be associated with both dorsal, phonologically-related, frontoparietal pathways, and ventral, lexically-related, occipitotemporal pathways. The distinct association patterns detected in low and high performing spellers could point to their reliance on different cognitive components involved in spelling, such as phoneme-to-grapheme conversion, lexical orthographic representations and orthographic working memory.

Topic Area: Writing and Spelling

Poster D57 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam D session.

Prediction of Language and Social Communication Deficits from fMRI Functional Connectivity in a Cross-Diagnostic Developmental Sample

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Impairments in language and social communication skills are common in early development and form the basis for deficits in social interaction and learning. These deficits are often cross-diagnostic and are present in a range of disorders, such as social communication disorder (SCD) and autism spectrum disorder (ASD). Here, we investigate functional connectivity (FC) differences during naturalistic movie-watching that underlie language and social communication deficits in a large cross-diagnostic developmental sample. We address the following question: To what extent are FC patterns predictive of diagnostic status and language deficits? We analyzed FC fMRI data acquired during movie-watching in a cohort of 368 children and young adults (123 individuals with ASD, 116 individuals with a language disorder and 129 controls) aged 6-20 from the Healthy Brain Network dataset (Alexander et al. 2017). The dataset was preprocessed with the Human Connectome Project minimal preprocessing pipelines (Glasser et al. 2013). To isolate parcel-level and network-level signals we used the whole-brain CAB-NP parcellation (Ji et al. 2019) derived from the HCP atlas (Glasser et al. 2016). The data were analyzed using PrimeNet, a predictive modelling approach that quantifies binary and continuous phenotypic predictions from brain-wide FC patterns (Sanchez-Alonso et al., 2021). Planned analyses include running 1,000 iterations of PrimeNet's multi-level model to select FC edges (pairwise correlations) for each iteration. The edge-features selected in each iteration will be used to train single-feature SVM binary classifiers using leave-one-out cross-validation. We will apply the trained models to held-out data across the 1,000 iterations. Finally, we will identify the edges across all 1,000 iterations for the main effect of diagnostic status. Preliminary analyses with a subset of the data (30 individuals with a language disorder, 30 individuals with ASD, and 30 age- and IQ-matched controls) using a single iteration of the multi-level model show a classification accuracy of ~70% to distinguish diagnostic status (ASD/language disorder versus controls). In turn, we will derive a dimensionality-reduced symptom space via principal component analysis (PCA) across core language deficit symptoms and social communication skills. Specifically, we will quantify the correlations between 77 symptom measures across all subjects that received a diagnosis (n=239) and will quantify the variance explained by each of the components from a PCA performed using all symptom measures. Using PrimeNet, we will test whether symptom axes map onto distinct FC patterns that allow prediction of language and social communication skills at the individual-subject level. Collectively, there are two key potential outcomes of the planned analyses. First, we predict that there will be a set of FC patterns that can distinguish individuals with a language disorder and ASD (versus controls) in a large-scale developmental sample. These data would provide evidence for a 'core' functional network organization in development that varies by diagnostic status. Second, we expect to show that heterogenous language and social communication deficits can be reduced into a low-rank symptom solution that is cross-diagnostic. These derived symptom axes are expected to map onto distinct neural patterns, which are predictive at the individual-subject level.

Topic Area: Disorders: Developmental

Poster D58 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Brain dynamics of speech mode: Whispered versus Standard speech

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Speech production (SP) involves a complex interplay of several sub-systems that result in the production of intelligible and normally phonated speech in typical speakers. Multiple studies have investigated the main brain regions responsible for Speech Motor Control (i.e., Tourville & Guenther, 2011). However, the temporal dynamics of the brain regions involved in Speech Motor Control remains largely unexplored (Tourville & Guenther, 2011). Studying speech modes, which are specific variations of SP (Kelly & Hansen, 2021; Zhang & Hansen, 2007), could provide relevant insights on the mechanisms that underly the encoding of speech. More precisely, whispered speech is a speech mode which is unique to humans (Tsunoda et al., 2011). Whispering means speaking without vibration of the vocal folds

(Kelly & Hansen, 2021) resulting in reduced intelligibility and perceptibility (Zhang, 2012). Behavioral observation of whispered speech suggests intentionality and adaptation of the vocal tract. Therefore, whispering can be conceptualized as a switching mechanism which overlay onto the mechanisms of normal SP (Tsunoda et al., 2011). In this study, we will investigate the electrophysiological signatures of the brain processes that differ between normal and whispered speech and the encoding time-window at which the switching mechanism occur. 20 participants produced non-words in a delayed production task under high density Electroencephalography (EEG) recording. They did several blocks alternating between normal SP and whispered SP. Event related potential (ERP) were extracted aligned to the vocal onset of speech backwards (response-locked). Waveform amplitudes, microstates and time frequency analyses will be analysed by comparing the standard to the whispered condition. As the analyses are in progress, only preliminary results on six participants are presented here. Participants had overall good accuracy in both conditions, although slightly inferior in the standard condition (91.74% versus 93.02%). Reaction times were 18 ms slower in the whispering condition (653.75 versus 636.62 ms). On ERPs, the microstate analyses highlighted a difference on topographies between the two conditions around 150 ms before the vocal onset. The preliminary analyses do show different ERP correlates in the response-locked signal, which will have to be confirmed on the entire group of participants and with further analyses. The investigation on brain mechanisms underlying different speech modes is promising and will probably contribute to a better comprehension of the different mechanisms underlying Motor Speech Control.

Topic Area: Speech Motor Control

Poster D59 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Altered processing of communication signals in the subcortical auditory sensory pathway in autism

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Human communication requires the fast and accurate processing of sensory signals, such as the voice. Traditionally, it is assumed that the cerebral cortex and limbic structures are specialised in processing speech, vocal identity, and emotional components of the sensory signal. Much less is known about the role of subcortical sensory pathway structures for communication and its impairments. For example, it is to-date unclear at which processing stage voice processing difficulties arise in autism. Here, we assessed the functional integrity of auditory pathway nuclei for processing voices in autism. We tested functioning of the auditory midbrain (inferior colliculus; IC) and thalamus (medial geniculate body; MGB) in three independent functional magnetic resonance imaging (fMRI) experiments in groups of adults with autism and pair-wise matched typically developed controls (matched on age, sex, handedness, and full-scale intelligence quotient (IQ)). We focused on two aspects of voice processing that are impaired in autism: voice identity perception, and recognising speech-in-noise. First, participants performed tasks on speaker identity and speech recognition (voice identity recognition experiment, $n = 16$ per group). Second, both groups passively listened to blocks of vocal and non-vocal sounds (vocal sound experiment, $n = 16$ per group). In the third experiment participants performed speech recognition tasks on speech that was either presented with or without noise (speech-in-noise recognition experiment, $n = 17$ per group). All participants had normal hearing (confirmed with pure tone audiometry) and did not take psychotropic medication. All participants in the autism group had previously received a formal clinical diagnosis and underwent additional clinical assessment including the ADOS and ADI-R. For the fMRI analysis we used a general linear model implemented in SPM12. We focused on four regions of interest (left and right IC and left and right MGB). We found reduced blood-oxygenation-level-dependent (BOLD) responses for the autism as compared to the typically developed control groups in the IC – the central midbrain structure of the auditory pathway ($p < .0125$ family wise error (FWE) corrected, and Bonferroni corrected for four ROIs). The right IC responded less in the autism as compared to the control group for voice identity, in contrast to speech recognition. The right IC also responded less in the autism as compared to the control group when passively listening to vocal in contrast to non-vocal sounds. Within the control group, the left and right IC responded more when recognising speech-in-noise as compared to when recognising speech without additional noise. In the autism group, this was only the case in the left, but not the right IC. The autism and the control group did not differ significantly in the average amount of head movements (all p values > 0.1 in all three experiments). Our results show that communication signal processing in autism is associated with reduced subcortical sensory functioning in the midbrain. The results highlight the importance of considering sensory processing alterations in explaining communication difficulties, which are at the core of autism.

Topic Area: Disorders: Developmental

Poster D60 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neural Network Bases of Thematic Semantic Processing in Language Production

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Semantic processing is a central component of language. The dual hub hypothesis proposes a neuroanatomical dissociation between taxonomic processing in the anterior temporal lobe (ATL) and thematic processing in the temporoparietal junction (Schwartz et al., 2011). However, other studies suggest a role of the ATL in thematic processing also (Teige et al., 2019). These regions may act together in a network linking the ATL with posterior structures to support thematic processing during language production. However, prior investigations of thematic processing focus on grey matter. This study investigates whether the integrity of white matter connections post-stroke is associated with the production of thematic errors during naming. Seventy-nine English-speaking adults with chronic aphasia (≥ 12 months post-stroke) completed the Philadelphia Naming Test (PNT; Roach et al., 1996). Participants were excluded if they had profoundly limited speech or auditory comprehension, bilateral or right-hemisphere stroke, or other brain injuries. Taxonomic and thematic error scores were measured by calculating the proportion of taxonomic or thematic errors out of total errors on the PNT. Inter-rater reliability was 94%. Whole-brain T1-weighted, T2-weighted, and echo-planar images were acquired. Manually drawn lesions were mapped into standard space and participant connectomes were reconstructed. Before performing connectome-based lesion-symptom mapping (CLSM; Gleichgerrcht et al., 2017), we residualized taxonomic and thematic error rates to remove shared variance between error types and control for semantic comprehension abilities via the Pyramid and Palm Trees Test (Howard & Patterson, 1992). Univariate and multivariate CLSM were then performed on 20 left-hemisphere regions to examine the relationship between white matter connection strength and residualized taxonomic and thematic error rates. A Wilcoxon signed-rank test showed that participants produced significantly more taxonomic than thematic errors on the PNT ($z = -6.12$, $p < .001$; M: 5.4 taxonomic, 2.7 thematic). Univariate CLSM revealed two white matter connections that were significantly associated with residualized thematic error scores, controlling for lesion volume: connections between the 1) pole of the middle temporal gyrus and posterior cingulate gyrus (PCG), and 2) inferior temporal gyrus (ITG) and insula. Multivariate CLSM revealed a model with 28 connections, including the two mentioned above, significantly predicting residualized thematic error scores above chance ($r = .232$, $p = .02$). No white matter connections were significantly associated with the residualized taxonomic error scores in either analysis. Behavioral results showed that participants produced more taxonomic than thematic errors, which has been reported previously in aphasia (Schwartz et al., 2011). The PCG has been linked to spatial/action semantic processing (Barrett et al., 2019). Therefore, the connection between the temporal pole and PCG may represent integration of action/event information with transmodal semantic representations in the ATL. The ITG is associated with semantic processing (Binder et al., 2009), and the insula may be involved in language, but its exact role in semantics is unclear

(Ardila et al., 2014). Our data suggest these two areas and the connection between them could be involved in thematic processing. These results indicate that thematic processing is supported by an anteroposterior network involving several regions, including cortex outside temporoparietal region.

Topic Area: Meaning: Lexical Semantics

Poster D61 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Influence of affective context on prediction in L1 and L2 of Chinese-English bilinguals

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Predictive processing models have proven useful in explaining first-language (L1) processing and how individuals learn from exposure to language, but we know much less about the ways predictive coding affects processing and learning of second languages. The focus of the current study is specifically on the anticipation and processing of emotional words in sentence context in bilinguals. Previous work in monolingual speakers of Chinese has shown that emotional words can allocate additional attentional resources to facilitate prediction (Ding et al., 2020). Emotional words showed anticipatory effects regardless of contextual constraint. These effects were seen in the presence of a sustained negativity for highly, but not weakly, constraining contexts with neutral verbs. However, it is unknown if these effects are present in bilinguals. While semantic prediction is similar in L2 as compared to L1, bilinguals report less emotional salience in L2 (Dewaele, 2015). Experimental work with ERPs has shown that rapid emotional language processing requires direct social experience— something that L2 speakers often lack (Sendek et al., 2021). I will examine if emotional language has a different effect on predictive processing for those operating in their L2 by manipulating contextual constraint and emotional content both participants' L1 and L2. Additionally, I will investigate if these effects are influenced by proficiency and immersion. To do so, 48 Chinese/English bilingual participants with immersion experience will read 496 sentences in Chinese or English (translated from Ding et al., 2020), while their neural responses are recorded. ERP components (P1, N400, LPC) will be measured at the same critical nouns in all four conditions and at the verbs preceding the critical nouns, which will be manipulated for emotionality. Analysis will be done using ANOVA to compare ERP components across conditions. Additionally, regression analysis will be used to determine relationships between critical words and their preceding verbs to determine the influence of emotional words on predicted elements, as well as the influence of language proficiency and experience on these processes. If bilinguals process emotion and generate predictions similarly in L1, then results for L1 will replicate those found in Ding et al. (2020). Given that bilinguals show semantic prediction— but reduced emotional salience— in L2, then there are two potential outcomes for L2 processing. If bilingual experience within L2 is sufficient to both generate predictions and rapidly access emotional features, then processing of L2 will replicate findings in L1. If bilingual language experience in L2 is not sufficient to generate of predictions or rapidly access emotional features, then effects will only be seen in L1. Additionally, if emotion effects are the result of direct social experience in a language, then emotional processing effects will correlate with length of immersion in L2 context. This study will expand knowledge of the effects of emotional words on predictive processing to bilinguals, as well as investigate how differences in language experience may interact with these effects for L1 versus L2.

Topic Area: Multilingualism

Poster D62 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Characteristics of a Language: A Longitudinal Study of the Influence of Bilingual Education on Literacy Acquisition

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Objectives. The study of learning disabilities across languages has concurrently increased with the rise of multilinguals in the United States. Research has shown that it is possible to have dyslexia in one language but not another because literacy acquisition is shaped by the unique characteristics of each language (Pilcher, 2004). This longitudinal study investigates whether literacy acquisition is shaped by bilingual education. We hypothesize that learning a phonetic language, like Spanish, will improve performance on phonologically-based tasks in English. Comparatively, we expect learning a language based on an orthographic system, like Cantonese, will improve performance on semantically-based English tasks. Methods. Participants (n=107) were native English speakers recruited from the San Francisco Unified School District. Our sample included 63 males and 44 females. Forty-eight identified as White, 34 mixed race, 22 Asian, and 3 Latinx. Fifty-eight students were from upper class homes, 38 from middle class, and 11 from lower or working class. Forty-two children were in general education English programs (GENED), 35 in Spanish immersion programs (Sp), and 30 in Cantonese immersion programs (Cn). Each child was assessed on a core language/behavioral battery at Kindergarten (T1) and 2nd-3rd grade (T2). Time 2 participants were between 7 and 9 years old. Those that scored at least one standard deviation below the mean (SS=85) on a nonverbal intelligence screener (KBIT-2 Matrices) were excluded to mitigate confounds of intellectual disabilities. Groups' performance in English was compared on phonological (CTOPP-2 Blending Words) and orthographic learning tasks (KABC-II Rebus). Results. To establish a baseline, at T1 there were no significant group differences in performance on either task. At T2, a one-way ANOVA revealed a significant effect of bilingual education on phonological task performance at the $p < .05$ level [$F(2, 66.4) = 3.52$, $p = .035$]. As predicted, the Spanish-immersion group performed better on the phonological task (Blending Words, $p = .035$; GENED M = 8.55, Sp M = 10.49, Cn M = 9.03). Performance on the semantic task did not significantly vary among groups [$F(2, 67) = 3.11$, $p = .051$]. Post hoc analysis was significant for the mean difference of monolingual English speakers and bilingual Spanish speakers (mean difference = -1.94, $p = 0.023$). Conclusions. As hypothesized, after 3-4 years of bilingual education, Spanish-immersion participants performed better on an English phonological task than those in General Education and Cantonese-immersion. Our chosen measure of semantic learning did not significantly vary between groups. However, the literature demonstrates that the characteristics of a language may influence literacy acquisition; thus, future research may consider alternative methods to characterize the impact of different orthography on English acquisition. A limitation of our study was that a majority of the participants came from upper and middle class homes. Research has shown that education and socioeconomic status are correlated with stronger performance on measures of intelligence, specifically on academic achievement tasks, because of access to greater resources (von Stumm & Plomin, 2014). Future considerations would include a more heterogeneous sample to reflect the general population.

Topic Area: Multilingualism

Poster D63 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Tackling endogenous theta oscillations in primary auditory cortex

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Accumulating evidence shows that auditory cortex is tracking rhythmic fluctuations of the speech signal, often framed as entrainment. The underlying mechanism, resonance or entrainment, and its functional significance, however, are still unclear. Following Notbohm et al. (2016), who have investigated individual alpha peaks in the visual cortex, we created ~19 sec long, amplitude modulated sweeps accelerating from 3 to 8 Hz, hence, spanning across the commonly reported range of theta oscillations. While recording EEG, 20 participants listened to 60 repetitions of the sweep at two different levels of loudness (at 52dB SPL and 12dB below; 120 trials in total). This pure listening task was interrupted twice by a short behavioral auditory discrimination task. Additionally, we recorded 3 minutes of resting state EEG in silence and 3 minutes in white noise. In total, the experiment lasted for about 60 minutes. We quantified the normalized Shannon Entropy (Notbohm et al., 2016) and the phase-locking value (PLV; Duecker et al., 2021) between the envelope of the sweep and the EEG signal. Interestingly, we found a u-shaped function of Entropy in the theta range over auditory areas compared to an occipital control region, but not compared to rest. The PLV, however, exhibited a linear decrease with increasing frequency compared to rest and occipital regions. Both findings are contrary to the notion of resonance and entrainment that would predict amplified responses at certain preferred frequencies. In sum, our preliminary data suggest that there is no oscillatory behavior in the theta range in auditory cortex.

Topic Area: Perception: Auditory

Poster D64 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Elderly speakers describe non-core topics in a picture more frequently than young speakers: a topic annotation analysis in the Cookie Theft picture

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Introduction: Speakers' linguistic behavior changes over time. Previous studies on aging have examined various linguistic aspects and shown, for example, that elderly speakers exhibit reduced fluency and long pause duration but produce more words compared to younger speakers. While many previous studies used brief picture descriptions in comparing elderly and young speakers, they did not compare how elderly and young speakers differ when describing topics in the picture. Picture description tasks involve speakers' active selection process of which topic to describe in the picture, revealing which topic they consider important. We expected elderly and young speakers would differ in their topic choice, and this study examined the age group difference in topic selection using the Cookie Theft picture descriptions. Methods: We analyzed Cookie Theft picture descriptions produced by healthy elderly (n=45, mean age=67.6±8.7, 25 females (56%)) and young speakers (n=76, mean age=20±0.9, 35 females (46.1%)). Using the MAT annotation toolkit, we manually annotated non-overlapping spans of text that identified one of nine topics: six core to the picture, Stealing, Washing/Cleaning, Overflowing, Not Noticing, Helping, and Falling, and three non-core topics, Indoor, Outdoor, and Abstract. We obtained an inter-annotator of 88.52% across a 25 double annotated document subset comprising 525 classification pairs. The other files were annotated by one of the three annotators. After annotating the files, the number of each topic count was converted to counts per 100, controlling for the total number of topic tokens, and the results were compared by group using Wilcoxon signed-rank and chi-squared tests. Results: Elderly speakers (54.5±19.9%) produced core topics, which involved the characters in the picture, less frequently than young speakers (61.6±14.5%; W=1134.5, p=0.04), whereas they (45.5±19.9%) produced non-core topics, which were related to the background and outdoor scenery in the picture, more frequently than young speakers (38.4±14.5%; W=1836, p=0.04). Specifically, elderly speakers described the events of "kids stealing cookies" (W=1137.5, p=0.04), "girl helping the boy" (W=892.5, p=0.0005), "boy falling" (W=1041, p=0.01), "water overflowing" (W=1105.5, p=0.03) less frequently than young speakers. Elderly and young speakers did not differ in the number of unique topic types described (W=1476, p=0.95) or the total number of topic tokens described (W=1778.5, p=0.09). The most frequently first described event by both elderly and young speakers was an indoor-related topic, such as "this is a kitchen" ($\chi 2$=11.17, p=0.08). Conclusion: This study investigated how the two age groups differed in topic selection when describing pictures. Our results showed that elderly speakers described fewer core topics than younger speakers, demonstrating that the analysis of topic selection may be a useful tool for understanding the effect of aging in speakers' linguistic behavior. In future work, we plan to train an automatic topic tagging system using this manually tagged dataset and apply the automatic system to the study of patients with neurodegeneration.

Topic Area: Language Production

Poster D65 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Local and Global Context Models in non-native English speakers

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When hearing speech, listeners continuously anticipate upcoming concepts, words and phonemes using prior context (Ferreira & Chantavarin, 2018). Previous work has shown that expectations are formed using context at both the sublexical level (local) and sentence level (global) where representations at each level can be dissociated from one another in the neural data and are spatially separated in cortex (Brodbeck et al., 2022). We leverage the existence of such neurally dissociable representations in native speakers to investigate how naturalistic speech processing in context differs in L2 learners of English. We are recording MEG responses while native Mandarin and Korean speakers listen to an audiobook. We use temporal response function analysis (Ding & Simon, 2012) to investigate the tradeoff between a local context model where upcoming phonemes are predicted solely at the sublexical level and global context models where phonemes are predicted using sentence and lexical information. This analysis allows us to explicitly model the levels of representation of linguistic context in continuous data and investigate where these representations differ from those of native listeners. We measure English proficiency using cloze and lexical decision tasks, letting us investigate how knowledge of English impacts our results. First, we will investigate the integration of context at different levels in L2 listeners, expecting that the use of lower-level and higher-level contexts in non-native listeners will differ from native listeners due to differences in the strength of context representations. Prior literature suggests that L2 learners may not anticipate upcoming material to the extent of native listeners - particularly that they may not rely as heavily on syntactic context information to constrain predictions of upcoming material. (Hopp, 2016). This may be attributed to differing frequency distributions and the strength of lexical representations in non-native listeners (Kaan, 2014). Secondly, we test whether difficulties with non-native phonetic perception affect this integration of contextual information. Non-native speakers have difficulty distinguishing between phonetic categories that are not in their native language - particularly where two phonetic categories in the second language form only one phonetic category in the native language (Goto, 1971) - meaning these cues cannot always be utilized during sentence comprehension (Pelzl et al. 2021). Neural encoding of phonemes also scales with L2 proficiency (Di Liberto et al. 2020). This could influence anticipation of upcoming material, whereby listeners must rely more on higher-level contexts to compensate for the quality of the bottom-up signal. We predict listeners may rely more on higher-level contexts when the incoming signal is ambiguous to them, leading to a global context model more accurately predicting the neural signal in these situations. We will perform exploratory analysis aimed at teasing apart the relationship between the listeners' native language and neural responses, taking into account phonemic inventory and phonotactic constraints. Finally, this project creates a new corpus of neural responses to naturalistic listening of speech in L2 listeners. While fMRI and EEG datasets exist, our work creates a novel corpus of naturalistic neural responses in L2 listeners that provides good spatial and temporal resolution.

Topic Area: Multilingualism

Poster D66 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Sensory Modality and Spoken Language Shape Reading Network in Blind Readers of Braille

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The neural basis of reading is highly consistent across languages and scripts (Rueckl, 2015, PNAS). All scripts studied

thus far recruit regions of ventral occipitotemporal cortex (vOTC), which contains a posterior/anterior word-form gradient: a progressively changing preference from simple visual features (posterior) to larger orthographic structures (anterior) (Vinckier, 2007, Neuron). What anatomical principles constrain the neural basis of reading? Does the sensory modality of written symbols (tactile vs. visual) influence their neural representations? To address these questions, we compared the neural basis of Braille reading in proficient congenitally blind readers (n=19) to that of visual print in sighted readers (n=19). Based on connectivity theories of brain function, we hypothesized that regions in parietal cortex, with strong connectivity to early somatosensory cortices, play a special role in Braille reading. Additionally, we tested effects of reading hand and spoken-language lateralization on the laterality of Braille. We hypothesized that the effect of reading hand would decrease, and effect of spoken language would increase, along the processing hierarchy. Participants were presented with written (real words, consonant strings, non-letter control shapes) and spoken stimuli (real words, backward speech) that varied in word-likeness. To ensure attentive processing, participants read/heard blocks of 6 stimuli, then judged whether a probe stimulus was present during the block. Consistent with connectivity-based predictions, individual-subject ROI analysis revealed that PPC of blind readers contains patches that prefer Braille over spoken language and tactile control stimuli. No such pattern was observed in sighted readers, supporting the hypothesis that PPC develops specialization for Braille. Data-driven topographic maps further showed the most anterior portions of PPC, immediately adjacent to S1, prefer tactile control shapes, whereas posterior PPC and parieto-occipital cortex prefer Braille words. A vector-of-ROIs analysis along the anterior/posterior extent of PPC revealed a position-by-reading condition interaction in blind readers. In contrast, in sighted readers, most areas of the PPC preferred visual shapes, with no differences in responses to visual and auditory stimuli. The response profile in blind readers suggests an anterior-to-posterior Braille processing stream: with anterior regions supporting recognition of tactile patterns and posterior regions performing Braille-specific, orthographic processing. This gradient is analogous to the posterior-to-anterior gradient observed in vOTC of sighted print readers. With respect to Braille laterality, we observed effects of both reading hand and spoken-language lateralization but with different anatomical distributions. The effect of reading hand was strongest at early stages of processing (the hand regions of S1), weaker at intermediate stages (in PPC and vOTC), and absent in inferior frontal cortex (IFC). By contrast, the effect of spoken language on laterality of Braille increases along the processing hierarchy from PPC to vOTC and peaking in high level language region (IFC). These results suggest that written and spoken language co-lateralize regardless of reading modality. In sum, the neural basis of visual and print reading is constrained by connectivity, the entry point of symbols to the cortex (S1 vs. V1) and the neural basis of spoken language. These common principles give rise to different anatomical distributions across Braille and visual print.

Topic Area: Reading

Poster D67 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Category-specific representation of animal, food, tool, and vehicle concepts in the brain

Jiaqing Tong[1], Leonardo Fernandino[1], Stephen Mazurchuk[1], Lisa L. Conant[1], Jeffrey R. Binder[1]; [1]Medical College of Wisconsin

Many functional imaging studies have addressed the neural representation of distinct object categories, providing evidence for differential responses in high-level visual cortex to images of faces, scenes, body parts, tools, animals, and other categories. Studies using words to elicit concepts in different categories have been less numerous and less conclusive. We examined object category effects in a large fMRI study using word stimuli to elicit concept retrieval while controlling for a range of word form nuisance variables. A second aim was to test a prediction of an experiential account of category specificity, which claims that category effects arise from systematic differences in experiential content between categories, and thus there should be no residual category effects on brain activation after accounting for item-level experiential content. Thirty-nine participants were shown 160 English nouns consisting of 40 items in each of 4 object categories using a fast event-related design during 3T fMRI. Data were also obtained for 160 event nouns from 4 categories, which are not used in the current analyses. Each stimulus was presented 6 times across 3 sessions on separate days. Participants rated the familiarity of each word on a 1 to 3 scale. MRI data were preprocessed with the HCP pipeline. Functional data were processed under a general linear model that included each of the object and event categories as 8 regressors of interest. Other lexical variables coding length, orthographic and phonological properties, and word frequency, were included as nuisance regressors. Paired t tests were performed for all possible object category pairs. Thresholded ($p < .001$) t maps were corrected for multiple comparisons via permutation testing ($\alpha < 0.05$). As a strict test for category-specific effects, a conjunction map was created for each category compared to the other 3 object categories. In a second analysis, we included 65 experiential (sensory, motor, affective, temporal, spatial, social, etc.) feature dimensions, derived from crowd-sourced ratings of each word, as nuisance regressors. Conjunction maps for each category compared to the other categories were created as before. Tool words activated the left posterior middle temporal gyrus (pMTG) compared to the other categories. Food words activated bilateral insula and orbital frontal cortices (OFC). Vehicle words activated bilateral parahippocampal cortex and right posterior cingulate gyrus. There were no regions where animal words produced stronger activation than the other categories. When the 65 experiential feature regressors were included in the model – but not when 65 random regressors were used instead – all category-specific activation differences disappeared. Category-specific representation for tool concepts in pMTG and food concepts in OFC are consistent with several prior studies using word stimuli. Insular activation for food concepts likely reflects involvement of this region in gustatory and olfactory processing. Vehicle concepts activated regions previously identified with processing visual scenes. We found no evidence for category-specific animal concept representation. When experiential content was taken into account, category-specific effects disappeared. These results suggest that the preferential representation of these categories may be the result of cortical specialization for the representation of specific experiential features.

Topic Area: Meaning: Lexical Semantics

Poster D68 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Subcortical contributions to language: The fruit below the rind

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The study of the neurobiology of language has highlighted cerebral cortex while often overlooking subcortical structures. This proclivity for cortex (‘rind’ or ‘bark’ in Latin) is found in both basic and translational research on language as well as other higher cognitive domains such as reading, music, and math. We suggest that, for both anatomical and evolutionary reasons, multiple subcortical structures likely play substantial roles in language and other higher domains. To examine the relevant evidence thus far, we performed a comprehensive review of the literature. The review reveals that numerous subcortical structures throughout the brain, from the lower brainstem through the upper brainstem (midbrain), diencephalon, and telencephalon, contribute to language and other domains—even structures such as the pons, red nucleus, and mammillary bodies, let alone multiple substructures in the thalamus and basal ganglia. We argue that the findings are overall both real and important. Next, based on this and other evidence, we propose a new theoretical framework, the many-to-many (MaMa) dynamic network model of (sub)cortical contributions: each (sub)cortical structure supports multiple functions in language and other domains via basic computations (which operate analogously across domains); each function depends on multiple structures that can play both complementary and redundant roles; and these roles vary dynamically according to factors such as time (e.g., during different stages of learning or processing), context, and population (e.g., across individuals and groups). Finally, we lay out how the structure-function map revealed by our review can be expanded: we suggest that new subcortical roles can be identified by leveraging anatomical and evolutionary principles, and we lay out specific methods that can be employed to reveal subcortical involvement. Altogether, this work (see Janacsek, Evans, Kiss, Shah, Blumenfeld & Ullman, 2022, Annual Review of Neuroscience) aims to advance basic and translational neurocognitive research on language and other aspects of cognition by highlighting subcortical contributions and facilitating their future investigation.

Topic Area: Meaning: Lexical Semantics

Poster D69 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

To be or not to bey? Written Lexical Decision Accuracy in Neurotypical Aging and Left-Hemisphere Stroke Survivors

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Alexia, an acquired reading disorder, is diagnosed using single-word oral reading assessments (Coslett & Turkeltaub, 2016). However, reading in daily life usually occurs silently through word-form recognition and comprehension. Word frequency, spelling-to-sound regularity, and imageability affect reading accuracy. Prior research indicates that these psycholinguistic effects may differ in oral versus silent reading (Fischer-Baum et al., 2014). Research on silent reading in alexia is vital to developing comprehensive diagnostic tools and understanding the neurobiological basis of reading. In order to understand silent reading deficits in chronic stroke, we must first investigate how demographic and psycholinguistic factors affect performance in neurotypical aging. Here, we investigate the psycholinguistic patterns of silent word-form recognition in stroke survivors and demographically-matched neurotypical adults through written lexical decision. Participants were 118 native English speakers. Fifty-nine were left-hemisphere stroke survivors (22F:37M; 24 Black:35 White; mean age=60.6 years (SD=11.8), mean education=16 years (SD=3.0); average years post-stroke=4.0, (SD=4.6)). The remaining 59 participants were neurotypical adults (34F:25M; 21 Black:38 White; average age = 60.2 years (SD=11.8); average education=17 years (SD=2.4)). Participants completed a 400-item written lexical decision task, consisting of 200 words crossed on frequency (high/low), imageability (high/low) and regularity (regular/irregular), and 200 length-matched pseudowords. Logistic mixed effects models, using the maximal random effects structure justified by the data, tested the effects of age, education, and psycholinguistic features on accuracy of lexical decision in both groups. Neurotypical participants' mean accuracy was 97.4% (SD=2.4). Higher education related to higher overall accuracy (OR=1.56, CI=1.27-1.92, $p<.001$). Accuracy on real words was positively related to education (OR=1.63, CI=1.25-2.11, $p<.001$) and age (OR=1.39, CI=1.07-1.79, $p=.013$). We observed significant effects of frequency (OR=13.88 (CI=6.25-30.81), $p<.001$) and frequency × imageability (OR=0.13, CI=0.03-0.61, $p=.010$), such that low frequency words were less accurate, more so if they also had low imageability. Stroke participants' mean accuracy was 88.5% (SD=10.5). Again, higher education related to higher overall accuracy (OR =1.45, CI=1.00-2.09, $p=.048$). Low frequency (OR=9.81, CI=6.46-14.88, $p<.001$) and imageability (OR=2.11 CI=1.52-2.93), $p<.001$) related to lower accuracy. Additionally, two interactions were observed: age × frequency (OR = 0.65, CI 0.49-0.86, $p=.003$) such that increased age related to higher accuracy on low frequency words; and education × regularity (OR=0.81, CI=0.66-0.99, $p=.044$) such that higher education related to higher accuracy on irregular words. Greater education and age relate to better lexical decision performance in neurotypical adults and stroke survivors, possibly due to the association of these factors with vocabulary size (Salthouse, 2019). These findings demonstrate the importance of considering demographic factors in alexia assessment. In stroke survivors, the specific relationships of these factors with low frequency and irregular words may reflect increased reliance on lexical representations for reading due to damage to the phonological system. Notably, the patterns observed in written lexical decision here are somewhat different from those previously observed in oral reading in a subset of this study's cohort (Dickens, 2021). Future directions include direct comparison of lexical decision performance between stroke survivors and neurotypical adults, a comparison of

oral reading and lexical decision performance, and lesion-symptom mapping of lexical decision deficits.

Topic Area: Reading

Poster D70 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neural entrainment reveals simultaneous, implicit learning of adjacent word and non-adjacent phrasal structure

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Recently, a number of studies using EEG have shown that cortical activity recorded during continuous speech perception tracks linguistic structure at different hierarchical levels, namely syllables (e.g., Batterink, 2020; Batterink & Paller, 2017; Buiatti, Peña, & Dehaene-Lambertz, 2009), words (e.g., Batterink, 2020; Batterink & Paller, 2017), phrases (Getz, Ding, Newport, & Poeppel, 2018) and even sentences (Ding, Melloni, Zhang, Tian, & Poeppel, 2016). Many of these studies have shown that often, mere distributional information, specifically transitional probabilities between adjacent syllables (Batterink & Paller, 2017) or categories of non-words (Getz et al., 2018), suffices as a cue to evoke such rapid neural entrainment to the frequency of the initiating stimulus. Although speech is a serial acoustic signal, the hierarchical structure of human language requires the listener to track syntactic constituency beyond such an immediately adjacent local context, however. Buiatti et al. (2009) investigated neural tracking of non-adjacent dependencies at the word level (e.g., puXki) and found that power peaks at the word frequency were only visible when pauses additionally highlighted word boundaries. In the present study, we investigated whether neural entrainment to linguistic structure would reflect simultaneous tracking of both local and non-local structure in a hierarchical manner. We created structured streams of syllables, in which adjacent syllables formed bisyllabic non-words (e.g., pelo), which in turn formed non-adjacent phrase-like units (e.g., pelonefutoba). There were no pauses or other prosodic cues that highlighted word or phrase boundaries, so that the only cue to constituency was the available distributional information. Adults (N=23) actively listened to four blocks of structured sequences and four blocks of random syllable sequences while their EEG was recorded. In a grammaticality judgment task alternating with the exposure blocks, participants evaluated individually presented phrase exemplars. Whereas behavioral performance largely remained at chance in the structured condition (m=.55, SD=.15), analysis of steady-state auditory evoked potentials (SSAEPs) revealed significant differences in the cortical response between structured and random condition, with significantly higher neural entrainment at the word (1.6 Hz) and phrasal level (0.53 Hz) frequencies in the structured condition. In addition, a significant increase in power at both of these frequencies between the first and second learning phase of the structured condition suggests a learning effect for both words and phrases. To our knowledge, the present study is the first to show neural entrainment to adjacent word-level and non-adjacent phrasal-level structures simultaneously, and based on mere distributional information without any top-down language knowledge (Ding et al., 2016) or additional prosodic cues (Buiatti et al., 2009). These results provide further evidence for highly automatic, stimulus-bound hierarchical structure building operations involved in language comprehension.

Topic Area: Speech Perception

Poster D72 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Neural encoding of vowels in monolingual English and bilingual Spanish-English vowels

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Children who are exposed to two languages show a different pattern of speech perception development compared to those receiving monolingual exposure. The few studies that have used neural measures to explore speech processing in toddlers indicate a different pattern of speech development in monolingual compared to bilingual groups (e.g., Yu et al., 2021). The current study asks whether bilingual experience modulates encoding of speech sounds, in addition to discrimination of these sounds. Electrophysiological responses were recorded to the American English 250-ms vowels /ɛ/ and /ɪ/ presented in sequences of 10 stimuli with a 400 ms interstimulus interval and 1500 ms intertrain interval while brain responses were recorded from 65 scalp electrodes in 24-month-old children (15 bilingual, 16 monolingual) and 36-month-old children (15 monolingual, 14 bilingual). The monolingual and bilingual children of the same age showed remarkably similar-morphology brain responses to the stimuli. Repetition of the vowel from the first to the second stimulus led to attenuation of the P1 peak (150 ms) and N2 (200 ms) at fronto-central sites between 150 and 250 ms. On the third repetition, the P1 amplitude showed recovery, with positivity beginning earlier than for the first stimulus in a train and reaching a higher positive amplitude, suggesting prediction of the stimulus. The N2 and following waveform remained suppressed. The ERPs showed group differences only after 300 ms. The monolingual and bilingual 24-month-olds and the monolingual 36-month-olds showed significant suppression from the first to second repetition of a negativity around 400 ms (N4), whereas the bilingual 36-month-olds showed no suppression. In addition, the bilingual 36-month-olds showed a large late negativity to the deviant stimuli in the final (10th position of the train) compared to relative positivity to the standard stimuli in this position. These patterns were interpreted to reflect greater attention to the stimuli, which facilitated discrimination. These finding are consonant with other studies (e.g., Shafer et al., 2012; Datta, et al. 2020) suggesting that bilingual experience leads to increased allocation of attentional resources to the speech signal.

Topic Area: Speech Perception

Poster D74 *Friday, October 7, 5:30 - 7:15 pm EDT, Millennium Hall*

Orthographic learning, fast or slow? The role of semantic training

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Orthographic learning involves not only the acquisition of word form knowledge, but also the integration of newly learned word form into the mental lexicon. Previous studies trained participants by providing new word forms (derived from real “base” words) without meaning (form-only training), either in auditory or visual modality, and assessed the integration of newly learned word forms by a lexical competition effect on the real base words, e.g., a delayed response to banana when the novel trained word is “banara”, which, if integrated into the lexicon would be an orthographic neighbor of banana. Because newly experienced word forms are always associated with meanings (or contexts) of some sort, it is important to consider how semantic training (i.e., providing both word form and word meaning during training) affects orthographic learning. Previous research suggests that 24 hours of post-learning consolidation with overnight sleep is sufficient to produce lexical competition effect for words trained with form-only, but insufficient for words trained with both form and meaning (Dumay et al., 2004; Takashinma et al., 2014; but see Hawkins & Rastle, 2016). This implies that semantic training delays the integration of word form. Thus, the sufficiency of 24-hour consolidation with sleep for new word form integration appears to be essential in understanding the impact of semantic training. The present behavioral study addresses this issue by teaching adult participants four sets of new visual words with the training methods (semantic training vs. form-only training) and 24-hour consolidation with overnight sleep (day 1/remote vs. day 2/recent) factorially manipulated, and examining how the two factors affect the orthographic learning immediately after training (day 2) and one week later (day 9). All new words (e.g., banara) were derived from changing one letter of existing hermit base words (i.e., words have no orthographic neighbors in the lexicon, e.g., banana). On both day 2 and day 9, the explicit memory of orthographic knowledge was assessed with the stem completion task, where the first two letters of the newly learned words are given as cues for

the recall of whole word; the integration of new words (e.g., banara) was assessed with the lexical competition effect on existing base words (e.g., banana) in the semantic judgement task, i.e., judging whether the existing base words referred to natural or artificial things. Results of the stem completion task, show that word spellings were recalled more accurately in the semantic training condition than words in form-only condition, suggesting that semantic training benefits the memory retention of word forms. Results of the semantic categorization task on existing base words (e.g., banana) show that the emergence of lexical competition effect is affected by training methods: Without additional training, only words in the semantic training condition, whether in the remote or recent conditions, produced significant lexical competition effect one week later. These results suggest that semantic training not only helps memory retention of orthographic knowledge across time, but also benefits the integration of word form into the mental lexicon.

Topic Area: Reading

Poster E1 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Building a neurolinguistic corpus of naturalistic conversation to investigate second language grammar

David Abugaber[1], Jonathan Brennan[1]; [1]University of Michigan

A critical part of improving second language (L2) teaching involves understanding the brain mechanisms involved when learners comprehend grammatical structures. However, previous research on L2 processing has typically involved artificial tasks/stimuli in isolated laboratory settings different from what a real-world language user typically encounters. To address this, our project harnesses advances in wireless portable brain-scanning and computerized speech recognition to investigate the grammar processing mechanisms underlying naturalistic conversation in native and L2 English. EEG will be recorded during unscripted conversation between native/L2 interlocutors and synchronized with transcriptions. Data will be compared against predictions from computer models based on different possible grammar mechanisms as in prior work from a native audiobook listening study (Brennan & Hale, 2019). Specifically, we test hierarchical models involving nesting of abstract grammatical structures vs. sequential models based on word co-occurrence statistics. First, we ask whether previous findings of hierarchical processing in native speaker audiobook listening also hold for social interaction. Second, we ask whether native and L2 speakers differ in the hierarchical/sequential nature of their grammar processing. Thirdly, turning to the direct effects of social context, we ask whether neural signatures of grammar processing are affected by brain-to-brain synchrony. Piloting was conducted to determine whether neural markers of language processing could be adequately collected using our wireless consumer-grade EEG headset. First, reproducing Brennan and Hale (2019), we recorded EEGs from a single participant during listening to chapter 1 of Alice in Wonderland. Epochs were extracted from each word and baseline-corrected at -0.3s prior to word onset. Average amplitudes in anterior electrodes AF4, AF3, F3, F4, FC5, and FC6 (corresponding to effects in Brennan & Hale, 2019) in an early (300-500ms) and late (600-1000ms) time window (corresponding to timing of N400 and P600 ERPs; Tanner, 2019) were correlated against model predictions from Brennan and Hale (2019). We found significant correlations for the recurrent neural network model in the late time window, $r(2127)=.06$, $p=.005$, and for the n-gram model in both the early, $r(2127)=.04$, $p=.040$, and late time windows, $r(2127)=.07$, $p=.002$. No effects were found for the context-free grammar. This partly replicates Brennan and Hale (2019). Next, we recorded EEGs from a single participant during 30 minutes of unscripted conversation, transcribed using Amazon Transcribe yielding 3,503 words after omitting fillers and proper nouns with no hits in the British National Corpus (BNC, 2007). After preprocessing as above, we found a significant correlation, $r(3501)=.04$, $p=.039$ between early time window amplitudes and log-transformed word frequency, replicating well-attested frequency effects (Kutas & Federmeier, 2011). These findings indicate the viability of consumer-grade wireless EEG to test our grammar model predictions and to detect language processing effects in unscripted speech. This project informs language teaching praxis by revealing how the statistics of L2 input affect grammar learning. It also broadens participation in neuroscience by using a “crowdsource-able” experiment design with relatively affordable portable brain-scanning devices. Finally, our open-access corpus of natural conversation (comprising speech audio, neural signals, and text transcriptions) will be made available to future researchers for address other language-related research questions.

Topic Area: Methods

Poster E2 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Automatic imitation of vocal and manual actions: an fMRI study

Patti Adank[1], Hannah Wilt[1], Anthony Trotter[1,2], Harold Bekkering[3]; [1]University College London, London, [2]King's College London, London, [3]Donders Institute for Brain, Cognition and Behaviour,

Behavioural, neuroimaging, and neurostimulation evidence shows that observing others' manual and vocal actions evoke a covert imitative response. Observing someone perform an action automatically activates neural substrates associated with executing that action. Such covert, or automatic, imitation is measured behaviourally using the Stimulus Response Compatibility (SRC) task as a difference in response times (or accuracy) between incompatible and compatible trials. Responses slower when performing an action ("say ba") that is incompatible to an irrelevant distracter (a video of someone saying "da") compared to when the action in the distracter matches the instruction ("say ba" with a "ba" video). Past studies have investigated the neural network supporting automatic imitation of manual actions using functional Magnetic Resonance Imaging (fMRI) [1,2,3]. These studies outline a network linked to "inhibition of imitation", which is measured as a contrast between neural responses to incompatible and compatible actions. These studies included manual actions only and reported engagement of dorsolateral prefrontal cortex (DLPFC), and temporo-parietal junction (TPJ). No study has thus far explored the neural network associated with inhibiting imitation of vocal actions. It is unclear whether inhibition of automatic imitation engages a neural network in a modality-specific or modality-independent manner. Participants will have their neural responses scanned while they perform an SRC task for vocal (a video-only representation of someone saying "ba" or "da") or manual stimuli (a video of a hand lifting index or middle finger). We will record their vocal and manual response times as well as eye gaze. We expect that we will uncover the network reported for automatic imitation of manual actions, involving DLPFC and TPJ across both modalities and expect we will be able to detect modality-specific differences, e.g., increased activation in left Inferior Frontal Gyrus and Premotor Cortex for automatic imitation of vocal compared to manual actions [4] and will also explore effector-specific differences per modality in Region of Interest analyses, e.g., finger or articulator-specific analyses in speech and hand areas of Primary Motor Cortex. Due to the COVID-19 pandemic data collection for this study was delayed and we expect to have completed data collection and analysis in summer 2022.
References: 1. Darda, K. M. & Ramsey, R. The inhibition of automatic imitation: A meta-analysis and synthesis of fMRI studies. NeuroImage 197, 320–329 (2019). 2. Brass, M., Derrfuss, J. & von Cramon, D. Y. The inhibition of imitative and overlearned responses: a functional double dissociation. Neuropsychologia 43, 89–98 (2005). 3. Spengler, S., von Cramon, D. Y. & Brass, M. Control of shared representations relies on key processes involved in mental state attribution. Human brain mapping 30, 3704–3718 (2009). 4. Molnar-Szakacs, I., Iacoboni, M., Koski, L. & Mazziotta, J. C. Functional segregation within pars opercularis of the inferior frontal gyrus: evidence from fMRI studies of imitation and action observation. Cerebral Cortex 15, 986–994 (2005).

Topic Area: Multisensory or Sensorimotor Integration

Poster E3 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Automated measures of syntactic complexity for spontaneous speech

Galit Agmon[1], Sameer Pradhan[1], Sharon Ash[1], Naomi Nevler[1], Mark Liberman[1], Murray Grossman[1], Sunghye Cho[1]; [1]University of Pennsylvania

Sentences with more complex syntactic structures incur greater burden on cognitive processing. This is reflected in elevated reaction times, increased brain activity, or specific deficits in aphasia. This effect of syntactic complexity has been typically studied in the controlled framework of minimal pairs, where grammatical constructions like passives, object relative clauses, or central embeddings are found to be more taxing than actives, subject relative clauses, or right branching, respectively. In recent years, a growing number of studies have been quantifying syntactic complexity for uncontrolled stimuli such as speech (e.g., Agmon et al. in SNL 2021). However, currently used methods are

heterogeneous, both in terms of their quantification metrics and the language models they rely on (specifically, dependency grammar vs. phrase-structure grammar). In addition, none of these methods has been validated with manually annotated grammatical constructions. In this study, we compared two measures of syntactic complexity, using automated tools, and validated their usefulness in capturing different aspects of syntactic complexity. We examined Mean Dependency Distance (MDD) and Mean Node Count (MNC). MDD is derived from dependency grammar by calculating each word's distance from its head and averaging per sentence. MNC is derived from phrase-structure grammar by counting the number of phrases closed by each word and averaging per sentence. We calculated MDD and MNC for different types of corpora: sentences of minimal pairs (e.g., passive/active, object/subject relative clauses, etc.), sentences extracted from written text (Alice in Wonderland), and spontaneous speech of younger and older healthy speakers. We examined the correlational structure of these measures relative to each other and validated them against a manual count of grammatical constructions. In all corpora, MDD and MNC were not correlated with each other, suggesting that they capture independent aspects of syntax (written text: $\rho=0.3$; younger speech: $\rho=-0.1$; older speech: $\rho=-0.2$). Though MDD was correlated with sentence length ($r>0.7$, $p<0.001$ in all corpora), it was higher for the more complex sentences in minimal pairs of equal length. MNC was positively associated with the number of embedded clauses in both age groups (younger: $p<0.001$; older: $p=0.01$). MDD of older speakers was dramatically lower than that of younger speakers ($p<0.001$), controlling for sentence length. MNC of older speakers was slightly higher than that of younger speakers ($p=0.05$), reflecting their more frequent use of embedded constructions. To conclude, automated measures can be useful for quantifying syntactic complexity in uncontrolled corpora, such as spontaneous speech. We showed that MDD and MNC capture complementary aspects of syntactic complexity. MDD is greater for constructions that are known to be complex, such as passives, object relative clauses and central embeddings. MDD may reflect linguistic working memory, which could explain why it is lower for older speakers. MNC, on the other hand, is greater for deeper phrase-structure trees, and may reflect the linguistic process of merging phrases to build up the syntactic representation. In our future work, we will validate those measures with brain signals, as well as longitudinal analyses, and investigate the trajectory of syntactic complexity during neurodegenerative disease.

Topic Area: Methods

Poster E4 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Computational pressures behind the development of parallel dorsal and ventral stream lexica

Enes Avcu[1], Michael Hwang[2], Kevin Brown[3], David Gow[1,4]; [1]Massachusetts General Hospital / Harvard Medical School, [2]Harvard College, [3]Oregon State University, [4]Salem State University

Words play a pivotal role in almost every aspect of language processing. The dual-stream model of spoken language processing (Hickok & Poeppel, 2007) suggests that processing is organized broadly into parallel dorsal and ventral processing streams concerned with dissociable aspects of motor and conceptual-semantic processing. Drawing on converging evidence from pathology, neuroimaging, behavioral research, and histology, Gow (2012) proposes that each pathway has its own lexicon or lexical interface area, which mediates mappings between acoustic-phonetic representation and stream-specific processing. In the dorsal processing stream, the supramarginal gyrus and inferior parietal lobe mediate the mapping between sound and word-level articulatory representation. In the ventral processing stream, the posterior middle temporal gyrus mediates the mapping between sound and semantic/syntactic representation. We hypothesize that this separation arose in part because of fundamental differences in the computational requirements of these mappings. The mapping between sound and articulation, though complex, is largely systematic and temporally continuous. In contrast, the mapping between sound and syntactic/semantic information, though partially systematic at the level of productive morphology, is largely arbitrary and dependent on identifying larger temporal units. To test this hypothesis, we created two LSTM networks and trained them independently on the same set of auditory word tokens. A dorsal model was trained to identify individual spoken words, while a ventral model was trained to map them onto overlapping sets of word context frames drawn from a corpus of meaningful text as a surrogate representation of semantic content. After training both models to asymptote, we extracted patterns of network activation from the hidden layer of each network and tested how well the features extracted from the dorsal network supported the classification of input based on articulatory versus semantic or syntactic properties. We predicted that: (i) Features from dorsal LSTM models trained on wordform identification should have an advantage for categorization related to articulation but not semantic/syntactic categorization, and (ii) Features from ventral LSTMs trained on sentential context frames should have an advantage for semantic/syntactic categorization but not categorization related to articulation. Our results demonstrate that training the same set of networks on differently structured lexical representations produced different featural representations at the hidden layer of each model and that these emergent representations supported different patterns of performance on secondary tasks. Despite being trained on output vectors that were not structured to reflect the phonological structure, the dorsal model discovered a feature space that supported the classification of word-initial phonemes by articulatory classes. In the same vein, the ventral model discovered a feature set that supported grammatical categorization without explicitly having been trained on grammatical categories. The finding that the ventral model outperformed the dorsal model on grammatical category classification is not surprising, but it again demonstrates that task demands shape feature spaces that are better suited for different types of generalization. These results suggest that the development of parallel lexica in the dorsal and ventral pathways arose from computational pressures for optimizing the primary mapping functions that support lexically organized processes in the dorsal and ventral processing streams.

Topic Area: Computational Approaches

Poster E5 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam E session.

Anomalous morphology of the inferior frontal cortex in children with developmental language disorder

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Developmental language disorder (DLD) is a diagnosis given to children with persistent difficulties in learning their first language without a known cause. With an estimated prevalence of 7%, children with DLD are at a higher risk of behavioural, emotional, social, and academic problems. Our knowledge of the underlying brain abnormalities associated with DLD is limited. Only a handful of studies have examined the neural basis of DLD to date, and even fewer have focused on its anatomical correlates, with mixed results. Inconsistencies in findings have been attributed to the heterogenous nature of DLD, co-occurring diagnoses, small sample sizes, and differences in statistical methods, participant age range, and diagnostic criteria for DLD. In this study, we address some of these issues by reporting our findings from the Oxford BOLD study, the largest neuroimaging dataset of DLD to date. Brain images were available in 158 school-age children aged 10-16 years with different levels of language ability. Our criteria for DLD were non-verbal IQ > 70 and performance of 1 SD below the normative mean on two or more of five standardized language assessments. Fifty-seven children met criteria for DLD (M = 12.35 years, 41 males), a further 26 had a history of speech and language problems but did not meet criteria for DLD (HSL group; M = 12.19 years, 22 males) and the remaining 75 were typically developing controls (TD group; M = 12.47 years, 43 males). We used FreeSurfer to conduct exploratory analyses of the T1-weighted brain images. From this, we hypothesized that there would be differences between TD children and those with DLD in the cortical morphology (i.e., area, thickness, and volume) of perisylvian regions relevant for language. Furthermore, we predicted these measures would be correlated with children's language proficiency scores (calculated from a two-factor confirmatory model) across the whole group. Gender and age were included as covariates of no interest in all analyses. Monte Carlo simulation was used to correct for multiple comparisons (thresholded at a vertex-wise $p < 0.001$, cluster-wise $p < 0.05$). The TD-DLD group comparison revealed significantly lower area in DLD in: (i) strikingly symmetric portions of the left and right anterior inferior frontal gyrus, including pars orbitalis and the anterior insula; (ii) right lateral ventral temporal cortex (mid fusiform gyrus). These areas also showed significant volume reductions in children with DLD, but the two groups did not differ in measures of cortical thickness. Correlational analysis revealed a positive relationship between children's language factors and area in the same anterior portions that showed group differences (i.e., the left and right inferior frontal cortex). Posteriorly, these scores correlated positively with area in left lateral ventral temporal cortex. Our findings provide evidence for abnormal morphology in the inferior frontal and inferior temporal cortex of children with DLD. These results might reflect differences in cortical development of areas necessary for normal language development or a failure of these areas to specialize for language function due to the language impairment itself. Future longitudinal studies will elucidate this causal relationship

Topic Area: Disorders: Developmental

Poster E6 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Writing from dictation in adults with focal brain lesions: Implications for the neural models of writing

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Linguistic-motor models of writing are rooted in lesion studies (Chen et al, 2019., Margolin, 1984., Roeltgen 1995, Roeltgen & Hellman, 1984, 1985) and more recently, in stimulation studies (Roux et al, 2013). Recent brain stimulation studies (Roux et al, 2013)have claimed that the neural underpinnings of writing from dictation is the left temporoparietal cortex, whereas the lesion-based models have recognized a wide-spread neural network including the left and right hemispheres (Davous & Boller, 1994., Ardila & Roselli, 1993., Rothi et al, 1987., Ogden, 1996., Weekes, 1995), subcortical structures (Poncet, Habib, & Robillard, 1987), and the right cerebellum (Dunn et al, 2016). This situation warrants further studies to expand our understanding of the neural underpinnings of writing. The primary objective of this study is to present lesion data and characteristics of agraphia from aphasics to discuss the neural underpinnings of agraphia. Using a case-series analysis, the current study presents lesion data from six adults (f = 5, m = 1) with aphasia and central agraphia. All six aphasics (JL, PP, CBH, LK, SE, and SA) were native speaker of English, except one (SA). Subjects were tested on Boston Diagnostic Aphasia Examination. In addition, two experimental tests were also administered: PALPA and JHUDB. The task was to write words on dictation. Results. Lesion analyses: SA a 48-year-old female with a history multiple strokes and the resulting infarction of the left lateral temporal and precentral gyrus and encephalomalacia of bilateral corona radiata and basal ganglia. SA was diagnosed with Jargon aphasia. PP, a 65-year- old female with symptoms of mild conduction aphasia and stroke induced lesions showed left parietal including supramarginal gyrus and angular gyrus and mesial posterior temporal lobe. JL, a 66-year-old white female with the symptoms of conduction aphasia had left parietal lobe lesion including supramarginal and angular gyrus and posterior temporal lobe. CBH, a 59-year-old, right-handed female with anomic fluent aphasia had a medical history of bilateral parietal lobe lesion. LK, a 45-year-old male, with stroke-induced infarcts involving the left temporal region extending up to a portion of the left frontal lobe and left basal ganglia. SE, a 69-year-old right-handed female had lesions in right frontal lobe under the anterior horn of the lateral ventricle and the head of caudate and putamen due to hemorrhagic cerebrovascular accident. The left hemisphere was spared. Dysgraphia Profiles: Both LK and CBH had features of Phonological/surface dysgraphia. SA's writing was characterized by jargon agraphia. SE's writing had features of phonological agraphia. PP had buffer dysgraphia whereas JL's writing performance was indicative of impaired lexical-semantic and POC mechanisms. The limited data reported in the

current study warrants further research. The left temporo-parietal lobe function underpinning writing to dictation finds some support. However, right hemisphere lesion in SE does not offer support to this position. Recent research supports the view of widely distributed network supporting writing from dictation (Chen et al, 2019). Another factor that could explain the wide-spread lesion sites associated with central agraphia is the gradient nature of laterality for writing.

Topic Area: Writing and Spelling

Poster E7 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Shared Neural Correlates Underpin Theory of Mind and Semantic Cognition: Evidence from a Meta-Analysis of 344 Functional Neuroimaging Studies

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Currently, there is a lack of consensus regarding whether brain regions involved in social processing are specialised for that domain, and to what extent domain-general systems contribute to social cognition. Recently, it has been proposed that the semantic system involved in extracting meaning from language is also crucial for the retrieval of meaning from other types of social cues. However, there is limited direct evidence for a role of semantic processing in social cognition. Therefore, the present study aimed to elucidate the extent to which key nodes of the semantic cognition (SC) network are involved during social mental state inference or theory of mind (ToM) tasks. To overcome the limitations of single studies that often lack power and are prone to effects of idiosyncratic designs and analytic choices, we adopted a meta-analytic approach. We used the activation likelihood estimation algorithm to synthesise the results of a large set of functional neuroimaging data. Our aim was to a) establish the degree of overlap between the ToM network and a wider SC network and b) investigate the influence of methodological and task design factors, such as stimulus domain (verbal/non-verbal) and sensory input modality (visual/auditory) on network overlap. This allowed us to test domain-generality/specificity and whether the pattern of overlap could be explained by the type of tasks/stimuli. To address our main aim, we manually extracted two sets of activation coordinates from 133 ToM, and 211 SC experiments and these were subjected to formal conjunction and contrasts analyses. To address our secondary aim, we repeated these analyses on data subsets that were split according to stimulus domain and input modality. The results revealed extensive overlap between the brain activation reliably associated with ToM and that correlated with SC. The overlap included several key semantic brain areas: the anterior temporal lobes, the angular gyrus (extending to the intraparietal lobule and temporo-parietal junction (TPJ)), the posterior middle temporal gyrus and the inferior frontal gyrus. Further, after the data split, the conjunction pattern remained consistent for the verbal and visual experiments. Although the conjunction between non-verbal ToM and SC experiments was diminished in brain areas that are part of the semantic representational system, we still observed overlap in key nodes of the semantic control network. The right TPJ region consistently activated for ToM but not for SC. To our knowledge, this is the first attempt to formally assess the topological overlap of network activated by ToM and SC across an extensive range of semantic and social studies. The finding that ToM and SC share neural correlates supports the claim that ToM may draw on cognitive processes related to semantic retrieval and speaks against the view that ToM relies solely on domain-specific social neurocognitive systems. Instead, we add to the rising body of evidence supporting a role for the semantic network in social cognition. Key Words: semantic cognition, social cognition, social semantics, ALE meta-analysis

Topic Area: Meaning: Combinatorial Semantics

Poster E8 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The effect of bilingualism on auditory attention in children: A systematic review

and meta-analysis of standardized auditory attention tests

Wenfu Bao[1], Claude Alain[1,2], Michael Thaut[1], Monika Molnar[1]; [1]University of Toronto, [2]Baycrest Health Centre, Toronto

Introduction: A wealth of research has investigated the effect of bilingualism on cognition, specifically on executive function. Developmental studies suggest that different cognitive performance between monolinguals and bilinguals might stem from their differences in attention allocation strategies, which are primarily shown in (audio-)visual attention tasks. Yet, whether such distinction exists in the auditory domain alone is unknown. This study compares differences in auditory attention, measured by standardized tests, between monolingual and bilingual children across typically/atypically developing (TD/AD) populations. Methods: Following the Cochrane Handbook for Systematic Reviews of Interventions as the methodological guidance, we conducted a comprehensive literature search in three electronic databases: OVID Medline, OVID PsycInfo and EBSCO CINAHL. Empirical studies reporting standardized behavioral performance of auditory attention in monolingual and bilingual participants below 18 years were included. Data were synthesized in terms of participants, tests, and key findings. Effect size was analyzed through meta-regression modeling, and publication bias was evaluated. Results: Twenty studies (TD = 19, AD = 1) met the participant and test characteristics. Given the limited number of AD research, the meta-analysis focused on studies with TD children. Results suggest that test measure (accuracy vs. response times or RTs) was a significant predictor of the studies' effect size. Studies reporting accuracy observed a marginal bilingual advantage (g = 0.10), whereas those reporting RTs indicated a small monolingual benefit (g = -0.34). None of other factors (participant age, stimulus type, attention components) affected children's performance. No substantial publication bias was detected. Additionally, further investigation is needed to understand the impact of bilingualism in different groups of AD populations, such as individuals with developmental language disorders, autism, or attention disorders. Conclusion: This meta-analysis suggests very little difference in monolingual vs. bilingual children's performance on standardized auditory attention tests. We also found that studies tend to include a wide variety of bilingual children and report limited language background information of the participants (e.g., age of acquisition, language proficiency, etc.). This, unfortunately, has limited the potential theoretical contributions of the reviewed studies. Recommendations to improve the quality of future research outcomes are presented.

Topic Area: Multilingualism

Poster E9 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Neural correlates of morphosyntactic processing in Spanish-English bilingual children: An fNIRS study

Alisa Baron[1], Neelima Wagley[2], Ioulia Kovelman; [1]The University of Rhode Island, [2]Vanderbilt University, [3]University of Michigan

Introduction. Between the ages of 2 and 10 (Brown, 1973; de Villiers & de Villiers, 1973; Jackson-Maldonado & Maldonado, 2017) children undergo substantial changes in their language development, especially their syntactic competences. The neurodevelopment that underlies these changes remain largely unexplored, especially in linguistically diverse learners who speak more than one language. We used functional Near Infrared Spectroscopy (fNIRS) to examine the neuro-cognitive mechanisms of syntactic processing in children who were bilingual in Spanish and in English. In a pre-registered study (OSF), we assessed the neural correlates of -ing, -ed, and -s grammatical morphemes and how they may vary as a function of age or current language use. Based on prior literature (Friederici, 2009; Friederici et al., 2017; Skeide, 2012; Xiao et al., 2016) we predicted strongest activation in the inferior frontal gyrus (IFG) opercularis and triangularis and posterior half of the left superior temporal gyrus (STG)/medial temporal gyrus (MTG) to primarily be recruited for morphosyntactic processing during sentence comprehension. Methods. Eighty-one participants were included in the final analyses. Participants were grouped based on age into a younger

(6;0-8;11: n=40) and older groups (9;0-11;11: n=41). All participants completed a language background questionnaire, standardized assessments of language and literacy in Spanish and English, and an English sentence judgement task during fNIRS imaging. The focus of the grammatical task was on a developmentally early acquired morphosyntactic structure, the present progressive -ing, and the later acquired structures of regular past -ed and third person singular -s. Analyses were completed using generalized linear models in the NIRS AnalyzIR toolbox in MATLAB. Results. Younger children had significantly greater activation in the left dorsolateral prefrontal cortex (DLPFC; $\beta=-0.51$, $q < .001$) and superior temporal gyrus (STG; $\beta=0.27$, $q=.004$) for -ing than -ed&s. Older children showed greater activation in the left IFG pars opercularis ($\beta=-0.94$, $p=.02$) for -ing when compared to -ed&s. For sentences with an -ing omission, the between-group comparisons revealed that younger children had greater activation in left IFG opercularis ($\beta=1.91$, $q=.01$) and primary auditory cortex (PAC; $\beta=2.27$, $q=.01$). For sentences with -ed&s omissions, the younger children had greater activation in the left IFG opercularis ($\beta=1.63$, $p=.007$) than older children. Analyses of how grammatical morphemes vary as a function of current language use are currently ongoing. Conclusion. Complementary to prior studies, results suggest that the left IFG region is a central processing hub of grammatical morphemes, where complex morphosyntactic features recruit greater activity in this region. The findings confirmed our initial prediction in that Spanish-English bilinguals had strongest left IFG activation for -ing, -ed and -s grammatical morphemes. However, this was mediated by age as younger children showed significantly greater activation than the older children. Our findings contribute to our understanding of the neurodevelopment of syntactic processing in bilingual children.

Topic Area: Multilingualism

Poster E10 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Characterizing speech production impairments in aphasia using delayed auditory feedback

Alexis Basciano[1], Corianne Rogalsky[1], Ayoub Daliri[1], Madilyn Pettijohn[1], Madilyn Majors[1]; [1]Arizona State University

Sensorimotor integration is crucial for intelligible speech and to correct mistakes during speech production. Delayed auditory feedback (DAF), a paradigm used to test sensorimotor integration in speech, delays auditory feedback during speech production in real time to examine online changes in speech fluency. DAF causes disfluencies in neurotypical populations but increases fluencies in individuals who stutter (Daliri et.al, 2018). Because sensorimotor integration is impaired in post-stroke aphasia (Buchsbaum et.al, 2011), DAF can be used to characterize speech production impairments in aphasia. The first DAF study in aphasia found that a delay was related to decreased dysfluencies in conduction aphasia (n=3), while individuals with nonfluent aphasia performed similar to controls, i.e. more dysfluencies under DAF (Boller et. al, 1978). More recent work indicates that perturbing the auditory feedback of speech may be a promising avenue for understanding the mechanisms of speech production impairments in aphasia (Behroozmand et. al, 2018). Thus, the purpose of the current study is to revisit delayed auditory feedback to characterize speech production impairments in individuals with aphasia, using quantitative acoustic measures. To date, we have recruited six individuals with aphasia and nine age-matched controls to complete a sentence-reading task using DAF at 4 different delay intervals (0 ms, 100 ms, 200 ms, and 400 ms). Five target sentences were used, which were each 8 syllables in length and used American-English phonemes. Speech production was characterized using linguistic categories (content errors, morphological errors, phonological errors, and dysfluencies for each utterance) and acoustic features (F1, F2, amplitude, and duration for each type of phoneme – vowels, diphthongs, voiced consonants, unvoiced consonants). ANOVAs and single-case Bayesian statistics were used to characterize the performance of the individuals with aphasia as a function of delay duration. Preliminary analyses indicate that, compared to controls, the aphasia group generated more errors in content word, morphological, and phonological categories across all delay intervals; there was no significant main effect of delay or group by delay interaction. However, the acoustic analyses and single case statistics indicate substantial variability across the individuals with aphasia. For example, under the normal speaking condition with no delay, the participant with conduction aphasia exhibited significantly larger vowel amplitudes and longer vowel durations than controls; however, with increasing delay, vowel durations became not significantly different than controls. In other words, without delay, the conduction aphasia participant's speech was louder and longer compared to controls but became more control-like with increased delays (I.e., DAF improved or normalized the participant's speech). Perhaps longer delay periods allowed the individual with conduction aphasia to engage in compensatory strategies that remedied their abnormal vowel durations, but not their amplitude. Overall, the preliminary results of this study indicate DAF may affect the acoustic, but not linguistic, properties of speech production in individuals with aphasia. Perhaps after more studies are conducted, DAF can be used to characterize speech impairments in aphasia and in the future serve as a tool to improve their speech.

Topic Area: Multisensory or Sensorimotor Integration

Poster E11 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Letter and speech sound association in early blind

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Braille is a tactile writing system derived from the Latin alphabet and used by the blind or visually impaired people. Similarly to the Latin alphabet, in Braille a specific symbol based on a pattern of dots is assigned to each speech sound and "only" the modality of reading is different. In all alphabetic languages, the critical step for reading development is learning letter and speech sound (LS) associations. However, tactile literacy acquisition in the blind lacks preceding pre-literacy symbolic and logographic stages, which might affect the process of forming LS associations. Additionally, changed reading modality could influence the neural basis of this process. In the sighted, LS integration is related to left superior temporal cortex activity. Whether the LS integration takes place in the blind brain and how similar this process is to the sighted population is still unknown. A study on blind adults suggested that they do not integrate audio-tactile syllables due to the mal-development of multisensory mechanisms, but a small sample and lack of sighted controls greatly limit these findings. To better understand LS integration, we tested 42 early blind subjects (9 to 61 years old) and compared their brain activity for implicitly processed letters, speech sounds, and congruent and incongruent LS pairs to a matched population of sighted controls. We focused on examining the supra-additive effect in each group (congruent LS > letters + speech sounds) and the interaction between group and the congruency effect (congruent > incongruent LS pairs). Behaviorally, we tested reading, verbal skills as well as the accuracy and reaction times for judging the congruency of LS associations. Behaviorally, the blind showed enhanced verbal abilities compared to the sighted and similarly accurate but slower reading. The groups did not differ in the performance on LS associations task and presented a similar relation between reaction times in this task and reading efficiency. At the brain level, we found supra-additive effects in both groups bilaterally in the superior temporal cortex and in visual motion sensitive cortex. In sighted subjects supra-additive effects were also present in the ventral occipito-temporal cortex, whereas in the blind in the somatosensory cortex bilaterally. Only in the blind population activation we found subadditivity effect (letters + speech sounds > congruent LS) in the left inferior frontal gyrus. An interaction between the group and the congruency effect was present in the superior temporal cortex, bilaterally. Blind group presented a congruency effect in the right hemisphere, and the sighted group presented an incongruency effect in both hemispheres. Our results, which identify basic sensory aspects (supra- and sub-additivity effect) as well as higher-level associative aspects of audio-visual integration ((in)congruency effect), show that both groups integrated letters and speech sounds, and the areas of integration are similar. The superior temporal cortex is involved in both audiovisual and audiotactile LS integration. Subtle differences in the direction of congruency effect and sub-additivity in the blind might reflect lower decoding efficiency for Braille than print reading or lower exposure to reading in the blind compared to the sighted group.

Topic Area: Reading

Poster E12 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

A systematic investigation of linguistic and non-linguistic processing of time in people with aphasia

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Time impairment is a pervasive phenomenon in aphasia. Many studies (overview in Faroqi-Shah & Friedman, 2015) showed that people with agrammatic aphasia struggle with the production of inflected verbs (e.g., Last night she … went to the movies). Time impairment was also found in agrammatic comprehension (e.g., Wenzlaff & Clahsen, 2004; Clahsen & Ali, 2009; Faroqi-Shah & Dickey, 2009) and in Wernicke's aphasics (e.g., Jonkers & de Bruin, 2009). Interestingly, the source of this impairment does not seem to be related just to morphological complexity or to the production of tense features per se, but to time reference and the ability to access discourse (Bastiaanse et al., 2011; Bos et al., 2014). Discourse represents an interface between syntax and the cognitive system (e.g., Druks, 2017) that operates by rules that go beyond the level of the sentence (Avrutin, 2006). One question is thus whether this time impairment is purely linguistic or affects more general cognitive abilities. Previous studies have offered a fragmentary picture: They focused only on specific aspects of time processing, which was mainly investigated behaviorally by grouping small cohorts of patients based on lesion site or aphasia type. The main aim of this project is to carry out a systematic investigation of time processing in aphasia, across different domains (linguistic, non-linguistic) and, for the first time, involving the use of structural magnetic resonance imaging (MRI) methods, to uncover the neural underpinnings of time processing. Three questions will be addressed: (i) which aspects of time processing are impaired in individuals with aphasia? (ii) Is this impairment purely linguistic? (iii) What is the neurobiological basis of time processing? To address (i), we designed 3 linguistic tasks investigating: the ability to locate the self in the current moment (temporal orientation test, Benton et al., 1994); the ability of locating an event expressed by the verb in the past/present/future (event location, e.g., "The boy peeled the banana"); the ability to verify temporal coherence (temporal concord, e.g., "Tomorrow the boy peeled the banana"). To address (ii), we designed 3 non-linguistic versions of the same tasks, where events are represented visually, through pictures (e.g., Bastiaanse et al., 2011; Borodisky et al., 2011). To address (iii), we will perform Voxel-based Symptom Lesion Mapping (VSLM) analyses using participant scores on these three tasks coupled with structural MRI data. We anticipate involving 50 participants who are English native speakers with left hemisphere lesions, ≥ 6 months post-stroke, and adequate hearing/vision/motor skills to complete the tasks. This 3-year Marie Skłodowska-Curie project began a few months ago and it is currently in the piloting stage. We expect poor performance in the linguistic tasks if time impairment is purely linguistic, but also in the non-linguistic tasks if the impairment is more domain-general. Through VSLM analyses we also expect to identify regions that may be crucial for different aspects of time processing (e.g., pre-frontal regions for temporal concord, temporal/parietal for event location).

Topic Area: Disorders: Acquired

Poster E13 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Speech Motor Adaptation During Synchronous and Metronome-timed Speech

Abigail R. Bradshaw[1,2], Daniel R. Lametti[3], Douglas M. Shiller[4], Kyle Jasmin[5], Carolyn McGettigan[1]; [1]University College London, [2]University of Cambridge, [3]Acadia University, [4]l’Université de Montréal, [5]Royal Holloway, University of London

Research with the altered auditory feedback paradigm has provided evidence for the critical role played by self-generated speech auditory feedback in speech motor control. Specifically, speakers exposed to a predictable

sustained perturbation of real-time auditory feedback (e.g. a change in the first or second formant) gradually start to adapt to this perturbation; for example, by shifting their produced formant frequencies in an opposite direction to the perturbation. Less is known however about the impact of other voices on such speech motor adaptation, and whether adaptation is robust across different speaking contexts. In particular, despite speech typically being a social act, few previous studies have examined speech adaptation in contexts involving a social element. In this study, we tested the effect of synchronous speech (the act of speaking in synchrony with another voice) on the adaptation response. Using the sentence-level adaptation paradigm developed by Lametti, Smith, Watkins, and Shiller, (2018, Current Biology), in Experiment 1 we measured participant's adaptation to a joint F1-F2 perturbation during production of sentences, either while speaking alone (solo reading group, n = 15) or while synchronising their speech with another (pre-recorded) voice ("the accompanist"; synchronous speech group, n = 15). We found that both groups exhibited a significant adaptation response, with no significant difference between the magnitude of the average group responses. There was however a significant difference in the level of between-participant variability in adaptation within the two groups, with more variable adaptation responses in the synchronous speech group. It was further found that participants in the synchronous speech group showed evidence of convergent changes in the F2 and F0 of their speech productions towards those of the accompanist voice prior to introduction of the feedback perturbation. An exploratory analysis suggested that individual variability in adaptation within the synchronous speech group may be partly explained by variability in the extent to which the formant changes required for convergence to the accompanist voice matched those required for adaptation; the greater the match, the greater the adaptation observed. However, Experiment 2 found a similar profile of adaptation responses for a metronome-timed speech condition (n = 15), in which no convergence is possible. This suggests that the act of synchronising speech with an external rhythm in the absence of another voice can also cause increased between-participant variability in adaptation, without affecting the group-level adaptation response. These findings demonstrate that speech motor adaptation can be affected by concurrent performance of a speech task involving exposure to another voice and/or the coordination of speech timing with external stimuli. This suggests that such adaptation is not always an automatic response that remains impervious to the effects of speaking context and style. Further work is planned that will aim to better isolate the potential contribution of vocal convergence mechanisms to the increased individual variability in adaptation observed during synchronous speech. This will involve altering the formant frequencies of the accompanist voice in order to explicitly manipulate the agreement between the direction of formant change required for convergence versus adaptation.

Topic Area: Speech Motor Control

Poster E14 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Neuroscience in the Everyday World: Cortical Activation during Computer-Based Conversation Tasks Using Integrated fNIRS-EEG

Erin Carpenter[1,3], Emily Braun[1], Manuel J. Marte[1,3], Michael Scimeca[1,3], Meryem A. Yücel[2,3], David A. Boas[2,3], Swathi Kiran[1,3]; [1]Department of Speech, Language & Hearing Sciences, Boston University, USA, [2]Biomedical Engineering Department, Boston University, USA, [3]Boston University Neurophotonics Center, Boston University, USA

Introduction: Functional near-infrared spectroscopy (fNIRS) is a neuroimaging modality which uses optical properties of hemoglobin to measure task-related local changes in oxygenated (HbO) and deoxygenated (HbR) hemoglobin. Electroencephalography (EEG) captures neuronal activity via electrical currents. Using combined fNIRS-EEG provides an opportunity to investigate cortical activation in more naturalistic settings, as participants wear a portable cap while engaging in functional tasks (e.g., conversation, walking). Furthermore, using integrated fNIRS-EEG allows for greater specificity of task-based cortical activation than one modality alone, as it provides information on both electrical and hemodynamic activity. Specifically, in conversation tasks, EEG allows for measuring changes in frequency band power to investigate response planning and fNIRS allows for measuring changes in HbO during language production.

Therefore, this study aims to use an integrated fNIRS-EEG system to measure cortical activation during conversation. Methods: Data will be collected from 15 neurotypical young adults. Participants will complete a computer-based conversation task while wearing an integrated fNIRS-EEG cap. In this paradigm, participants will either respond to conversational questions (experimental condition) or repeat sentences (control condition). To investigate the timing of response planning, the experimental condition will vary when critical information is presented in the question. In the Early-timing condition, participants will be provided with enough information to begin formulating a response halfway through the question (e.g., If you won the lottery, what would you do with the money?). In the Late-timing condition, critical information will be provided at the end of the question (e.g., What would you do with the money if you won the lottery?), and therefore participants are unlikely to begin formulating a response until hearing the entire question. Data will be collected with an integrated fNIRS-EEG cap using a NIRx NIRSport2 continuous-wave NIRS device and a LiveAmp32 EEG system. EEG time-frequency analyses will be performed over the entire question time window to investigate differences in frequency band power between the Early-timing and Late-timing conditions to determine how response planning changes as a function of when information is provided in the question. To investigate response production, differences in HbO between the experimental and control conditions during verbal responses will be evaluated. Data will be preprocessed and averaged to create six epochs (three question and three response epochs) per stimuli block. Repeated measures ANOVAs will be performed to investigate changes in HbO from baseline as the dependent variable with time (in epochs) and condition (experimental vs. control) as within-subjects variables. Anticipated Results: For response planning, we hypothesize greater decreases in alpha band power (via EEG) during the Early-timing condition as compared to the Late-timing condition in left parietal regions, indicative of a shift from attending to the question to planning a response. For response production, we anticipate greater increases in HbO (via fNIRS) from baseline during the experimental vs. control conditions in left temporal and frontal regions. Summary: Overall, the results will provide preliminary evidence on the informativeness of using an integrated fNIRS-EEG system for investigating changes in cortical activation during conversation in neurotypical adults.

Topic Area: Language Production

Poster E15 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Preliminary neural correlates of connected speech in acute post-stroke aphasia using an auditory-perceptual approach

Marianne Casilio[1], Jillian L Entrup[1], Sarah M Schneck[1], Caitlin Onuscheck[1], Deborah F Levy[1], Maysaa Rahman[1], Michael de Riesthal[1], Stephen M Wilson[1]; [1]Vanderbilt University Medical Center

Despite a rich tradition of research investigating the brain-behavior relations of language processing in aphasia, relatively few studies [1–3] have focused on connected speech, although the ability to produce language in naturalistic contexts is a critical functional outcome. The aim of our study in progress is to characterize the neural bases of various connected speech disruptions in aphasia using a novel and validated approach. We extracted audiovisual connected speech samples produced by 51 participants with acute post-stroke aphasia, constituting a subset of participants from a larger study [4]. Each sample was then scored by a speech-language pathologist blinded to all other data using the Auditory-Perceptual Rating of Connected Speech in Aphasia (APROCSA) [5], a 27-item measure with strong psychometric properties that, per a factor analysis, yields scores on four underlying constructs: paraphasia (mis-selection of words and sounds), logopenia (paucity of words), agrammatism (omission of morphosyntactic structures), and motor speech (impaired speech motor programming or execution). We created a new scoring system, where items with >|.4| factor loadings from our original analysis are retained and then summed. Lesions were manually delineated on acute DWI or CT images, following previously described methods [4], and voxel-based lesion-symptom mapping was performed [6]. Lesion coverage spanned the left middle cerebral artery territory, as expected in a stroke cohort, and APROCSA scores were broadly distributed, suggesting there was sufficient variability in both neural and behavioral dimensions. We observed a clear anterior-posterior division among the neural correlates of APROCSA scores that paralleled neoclassical [7] and contemporary [8] views of aphasia. Paraphasia and logopenia, both of which reflect impaired lexical-semantic and phonological processing, had predominantly posterior correlates. Paraphasia was associated with the posterior superior temporal sulcus while logopenia was associated with white matter underlying the middle temporal gyrus, a critical bottleneck for language processing [9]. In contrast, agrammatism and motor speech, which reflect morphosyntactic and motoric processing deficits respectively, had anterior correlates. Both were associated with the ventral precentral gyrus, although agrammatism was additionally associated with the inferior frontal gyrus, and motor speech was associated with the basal ganglia and underlying white matter. Taken together, our preliminary findings suggest that the neural correlates of connected speech in aphasia, as measured using an auditory-perceptual approach, are well-aligned with the extant literature on language processing in the brain. Our next steps will be to score available samples from an additional ~100 participants, to continue to recruit participants, and, when our sample size is larger, to employ multivariate rather than univariate lesion-symptom mapping, correcting for multiple comparisons with permutation testing. [1] Wilson et al., Brain. 2010;133(7):2069-2088. [2] Mirman et al., CABN. 2019;19(5):1286-1298. [3] Ding et al., Brain 2020;143(3):862-876. [4] Wilson et al. Brain. 2022; online. [5] Casilio et al., AJSLP. 2019;28(2):550-568. [6] Bates et al. Nat Neurosci. 2003;6(5):448-450. [7] Geschwind. Brain. 1965;88(2):237-294. [8] Fridriksson et al. Proc Natl Acad Sci USA. 2016;113(52):15108-15113. [9] Turken, Dronkers. Front Syst Neurosci. 2011;5:1-20.

Topic Area: Disorders: Acquired

Poster E16 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Processing difficulty with nonbinary they: ERP evidence

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The pronoun they has been used to refer to a non-specific antecedent or an individual of unknown gender since the 1300s. Recently, they has emerged as a personal pronoun for individuals who identify as gender nonbinary and a coherent subset of English speakers will accept they when referring to a specific, antecedent of known gender. However, online behavioral measures indicate some processing difficulty with the singular use of they. The present study employs ERPs to identify the type of the processing difficulty with nonbinary they when referring to a specific antecedent. Sentences were constructed where binary (he/she) and nonbinary (they) pronouns matched or mismatched the subject in the sentence. For the binary pronoun, we manipulated the gender of the antecedent by using name that were strongly associated with either male or female identifies (Sarah/Robert slept because he was tired.) For the nonbinary pronoun, we manipulated the number of the subject by using one or two names (Sarah/Sarah and Robert slept because they were tired.) Participants were 78 undergraduates attending a school where every student is taught about nonbinary gender identities as part of orientation. They were told they were going to read sentences about named individuals who would be referenced with their preferred pronouns. After the EEG session, participants completed an acceptability survey of they with various antecedents. All analyses and the study design were preregistered. We found that both mismatched binary and nonbinary pronouns elicited a larger posterior positivity compared to their matched controls during the 450-1150 ms time window (i.e., P600 effects). The mismatched binary pronoun, but not the mismatched nonbinary pronoun, also elicited a larger frontal negativity, consistent with an Nref effect. This finding suggests that both types of mismatch triggered processing difficulty, but the mismatching binary pronoun also initiated additional referential work. Intriguingly, offline acceptability judgments did not affect online ERPs. We compared 26 participants who were accepting of they with various singular named antecedents with 44 participants who rejected they in these contexts. These two groups did not show reliable differences in their P600 and Nref effects. To summarize, monbinary they elicits substantial online processing difficulty, but does not lead to referential failure like binary pronouns. This processing difficulty does not decrease even among individuals who are robustly accepting of singular they. We are currently exploring the underlying cause

of the processing difficulty with nonbinary they. One possibility is that they is considered syntactically plural and any use with singular antecedents causes processing difficulty. The other possibility is that they is inherently ambiguous in terms of plural vs. singular use and the difficulty arises in resolving this ambiguity. In the follow-up study, we manipulated the degree of gender bias of the antecedent (i.e., the gender stereotypicality of the name). Preliminary data from 31 participants showed that gender bias of the antecedent did not influence the P600 effect, suggesting that the processing difficulty with nonbinary they may be associated with syntactic violation and they is coded as plural grammatically.

Topic Area: Syntax

Poster E17 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Neural Substrates of Rapid Automatized Naming (RAN) Associated with Character Writing in Children Learning to Read Chinese

Hsin-Chin Chen[1], Zih-Yun Yang[1], Dun-Ya Hu[2]; [1]National Chung Cheng University, [2]Texas A&M University

Studies have documented that performance of rapid automatized naming (RAN) is associated with reading abilities across different writing systems (Norton & Wolf, 2012). Although studies have suggested that reading depends on writing at least in Chinese (e.g., Tan et al., 2005), few studies have examined the neural correlates of RAN associated with spelling/writing, probably due to motion artifacts induced inevitably during naming. Comparing to fMRI, the technique of near infrared spectroscopy (NIRS), which measures blood flow changes in the cortex, are especially suitable for studies of RAN since optical imaging technique is more susceptible to motion artifacts. The present study thus examined the neural basis of RAN associated with Chinese character writing applying fNIRS technique. A group of children (8~10 years old) with normal IQ and without reading disabilities were recruited. All children are native readers and writers of traditional Chinese taught in Taiwan. Participants were tested with serial number RAN and their blood flow changes in the cortex were monitored with the 16x16 NIRScout, NIRx M.T.. Other cognitive and reading tests including nonverbal IQ, working memory, and Chinese dictation were also administered. Blood flow changes of 46 brain channels on bilateral IFG, MFG, STG, MTG, IPL, SPL, and VWFA, which related to language processing, were recorded. Preprocessing of motion artifact and systemic physiology were performed applying nirsLAB and HOMER 3. The changes in the concentration of hemoglobin of all channels associated with RAN speed were calculated with GLM and were then correlated to scores of Chinese dictation. The results revealed that brains areas of IFG, IPL, and VWFA were associated with the speed of serial number RAN. The following analysis indicated that the strengths of such correlation in IPL and VWFA were further correlated to scores of Chinese dictation, suggesting the roles of IPL and VWFA in the relationship between Chinese character writing and RAN. The present report may be among the first to examine neural correlates of serial number RAN, a measure of reading fluency, associated with Chinese character writing, highlighted the role of language fluency in learning to write Chinese characters. The finding that IPL and VWFA correlated to the relationship between RAN and Chinese character dictation may suggest the important and overlapped role of visual-spatial processing in both tests.

Topic Area: Writing and Spelling

Poster E18 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam E session.

The cortical representation of lexical semantics is shared across English and Chinese

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During language comprehension semantic information from spoken and written English is represented in functional networks that are distributed broadly across the human cerebral cortex (Huth et al. 2016, Deniz et al. 2019, Nakai et al. 2021). However, it is unclear whether these cortical representations are similar or different across languages. To address this question, we compared cortical semantic selectivity between English and Chinese language comprehension. In our study we used functional magnetic resonance imaging (fMRI) to record brain activity from fluent Chinese-English bilingual participants. Each participant read over two hours of natural narratives in both English and Chinese. The same narratives were presented in both languages. For each language, the words of each narrative were presented one-by-one using rapid serial visual presentation (RSVP). Each language was presented in its native script. We then used voxelwise modeling (VM) to estimate the semantic selectivity of each voxel in each language. In the VM framework, features of interest are first extracted from the stimuli and then linearized regression is used to determine how each feature is represented in each voxel (Wu et al. 2006, Naselaris et al. 2011). In this study, stimulus features were constructed by projecting each word onto a 300-dimensional embedding space that reflects the lexical semantics of the word (Bojanowski and Grave et al. 2017, Joulin et al. 2018). A separate voxelwise encoding model was estimated for each voxel, participant, and language. Separate datasets were used for model estimation and evaluation in order to estimate prediction accuracy. Prediction accuracy was quantified by computing the Pearson correlation coefficient (r) between predicted and recorded BOLD responses. The estimated voxelwise encoding models reveal the semantic selectivity of voxels located across the entire cerebral cortex. We found that voxels distributed across temporal, prefrontal, and parietal cortices were well predicted by the estimated encoding models in each language. Moreover, models estimated in one language produced highly accurate predictions of brain responses to the other language. These findings show that the same cortical regions are activated for both languages, and furthermore that within these regions semantic selectivity is shared between English and Chinese. We suggest that in higher-level cortical areas lexical semantic information is encoded largely independently from the stimulus language.

Topic Area: Meaning: Lexical Semantics

Poster E19 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Localizing visual mismatch responses in American Sign Language (ASL) using MEG

Qi Cheng[1], Christina Zhao[1]; [1]University of Washington

Auditory mismatch responses (MMR) have been used in spoken language to examine automatic detections of linguistic anomalies/changes at phonetic, phonological, lexical, and morpho-syntactic levels (Pulvermüller & Shtyrov 2006). To date, very few studies have addressed similar questions for sign languages using visual MMR (vMMR). The only existing study on sign language vMMR used static images of Hong Kong Sign Language (HKSL) real-signs and non-signs in an oddball paradigm and found a larger vMMR by deaf signers than for hearing controls, but only for detecting real-signs, suggesting an early automatic lexical processing (Deng, Gu, & Tong 2020). They also noticed a potential topological difference for vMMR. Comparing the localization of lexical MMR effects in spoken and sign languages can provide further insights on cross-modal neural mechanisms during lexical access. In the current study, we aim to replicate the findings from HKSL in ASL and to further localize the vMMR responses using MEG. We identified one pair of highly frequent lexical signs (KID, with handshape=horn and location=nose; BOY, with handshape=flat-B and location=forehead) and switched the handshapes to create two non-signs (ns_BOY_horn, with handshape=horn and location=forehead; ns_KID_flatB, with handshape=flat-B and location=nose). We conducted a behavioral AX task with 5 proficient deaf signers and 5 hearing non-signers and found increased sensitivity to handshape changes (BOY- ns_BOY_horn pairs and KID- ns_KID_flatB pairs) by deaf signers (mean dprime=2.93, sd=0.6)

as compared to hearing non-signers (mean dprime=2.05, sd=0.52). For the MEG study, we plan to include 15 deaf proficient signers and 15 age-matched hearing non-signers. We will examine the same lexical effect by adopting an oddball paradigm where deviants are interspersed within standards about 15% of the time. In each block, the standards and deviants constitute a lexical vs. non-lexical contrast by changing the handshape but not the location (e.g., standard: BOY, deviant: ns_BOY_horn). To ensure that the participants are processing the signs preattentively, the participants will be instructed to focus on the fixation cross at the center of the screen and to detect when the fixation cross has changed shape. The MEG analysis will undergo standard processing steps to minimize noise outside of the dewar, related to head movement as well as physiological artifacts (e.g., heart beat). Then, epochs for standard and deviant trials will be extracted and the vMMR will be calculated by subtracting standards from deviants. The source of the vMMR will be investigated by projecting the vMMR to a cortical surface. Specifically, we will first examine the vMMR in several a prior regions-of-interest (ROI), including occipital, posterior temporal, and inferior frontal regions. We anticipate replicating the effects that the deaf signers will show a larger vMMR for the lexical deviants when compared to the non-signers, and we hypothesize that this effect is most prominent in the language regions (posterior temporal and inferior frontal). Further, we will also conduct whole-brain level analysis to compare vMMR across groups in a more exploratory manner. This analysis will inform us of any other processes that might be contributing to the between-group differences.

Topic Area: Signed Language and Gesture

Poster E21 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Effect of motor demands on sequential learning in adults with developmental language disorder

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Developmental language disorder (DLD) is a common neurodevelopmental disorder characterized by unexplained deficits in expressive and/or receptive components of language. One ongoing question about this language difference is what underlying domains of memory and learning might be affected, and what these differences would imply about expected neural differences. Two prominent theories suggest there are deficits in all procedural learning (Ullman et al., 2020; Ullman & Pierpont, 2005) or just sequence-based procedural learning (Gerken et al., 2021; Hsu & Bishop, 2014) in DLD. Individuals with DLD are also noted to have poorer fine and gross motor skills (Diepeveen et al., 2018; Hill, 2001). Importantly, the tasks used to assess learning commonly rely on motor skills both for acquiring and demonstrating learning, possibly muddying interpretation of the results. In this study, we used two sequence-based implicit learning tasks to explore the influence of manual motor output demands on learning. Participants completed two common sequential learning tasks, a serial reaction time (SRT) task and a visual statistical learning (VSL) task. The SRT task measured participants' ability to implicitly learn a visually-presented, 10-element sequence via manual motor output (i.e., keystrokes on a keyboard). Learning was assessed by the difference in reaction time of correct keypresses in the final block of random presses and the final block of sequence presses. The visual statistical learning task required participants to monitor a stream of shapes that were organized into repeating triplets and then report which triplets seemed more familiar. We hypothesized that adults with DLD would perform worse on the motor-dependent sequential learning task when compared to adults without language difficulties, but would perform similarly on the sequential learning task in which manual motor output was not required. Adults age 18-45 completed language testing to determine language status (Fidler et al., 2011) before completing both tasks. Although online data collection is ongoing, visual inspection of our initial results (comparison group N=19; DLD group N=4) indicates that the DLD group performs worse on the SRT task and equivalently on the VSL task, consistent with our hypotheses. Once our dataset reaches the targeted recruitment based on a priori power analyses (N=21 per group), we will statistically evaluate group differences with t-tests. Results will add to our understanding of DLD regardless of the final statistical results. Significant differences on both SRT and VSL would be consistent with other sequence-based deficit hypotheses (Gerken et al., 2021; Ullman et al., 2020). Differences on only the SRT and not the VSL task would confirm our hypotheses and suggest that manual motor demands mediate (the interpretation of deficits in) implicit learning in adults with DLD. No group differences on both tasks would suggest that differences in sequential learning of these types, if any, were smaller than we were able to detect, and follow-up studies would be needed to explore the interaction of DLD and motor demands more fully. This study contributes to the existing literature by exploring the influence of motor demands on a common concern in DLD, sequential learning.

Topic Area: Disorders: Developmental

Poster E22 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Evaluating effects of phoneme-level and word-level surprisal in continuous speech processing

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Sentential context constraints in speech processing have long been thought to reflect sensitivity to word-level surprisal (i.e., how unlikely a word is in context). This evidence comes from research addressing semantic congruency effects using EEG and MEG, with peaks about 400 ms after word onset (usually referred to as the N400) reflecting this contextual processing. Surprisal effects reflect updating a contextual representation of the input (i.e., if a word is contextually consistent and can be predicted, then it leads to a smaller update of internal representations than a word that is highly surprising). Recent work has shown that brain responses track phoneme-level surprisal, representing a finer grained timescale of sensitivity to sentential and lexical context (Donhauser & Baillet, 2020). It remains a question, however, whether sensitivity to surprisal in continuous speech is completely incremental (occurring only at the phoneme level) or whether there is a separate level of representation that is updated at a slower rate (i.e., word). To answer this question, we used MEG data from Brodbeck et al. (2022) where participants listened to an audiobook (i.e., continuous speech). We used an multivariate temporal response function approach to predict neural responses from different combinations of predictor variables, evaluating model fit to held-out data. In order to get a rich, human-like estimate of contextual word likelihood, we used predictions from GPT-2, a state-of-the-art language model. First, we aimed to replicate N400 effects using continuous speech with a model including only word onset and word surprisal predictors. We observed typical N400 peaks, with surprisal predicting activity in temporal and frontal areas. Next, we modeled both phoneme-level and word-level surprisal jointly. Even when accounting for acoustic- and phoneme-level predictors (including phoneme-by-phoneme entropy and surprisal), a model including word-level surprisal still explained more variation in temporal lobe activity. However, the contribution of phoneme-level surprisal was significantly greater than that of word-level surprisal, suggesting that incremental, phoneme-level representations have greater contribution to the typically studied N400 responses. In other words, accounting for incremental (i.e., phoneme-level) updates of representations captures more variability in neural data than accounting for word-level updates of representations. However, because a model with both incremental and more global (i.e., word-level) updates outperforms a model with either timescale alone, representations are likely updated at different timescales. We then compared the contribution of phoneme predictors derived from GPT-2 and a 5-gram model. We found that phoneme predictors from both models account for more variation in neural activity beyond having either set of predictors alone (i.e., just GPT-2 or just 5-gram). Because GPT-2 predictors represent a more global context and 5-gram predictors represent a more constrained local context, these findings suggest that multiple types of information constrain phoneme-level predictions. Overall, this work suggests incremental phoneme predictors explain patterns of neural responses better than word-level predictors, yet evidence exists for contributions of both types of predictors. This simultaneous contribution to prediction, along with evidence for local and global context influencing phoneme-level predictions, supports the idea that multiple representations of continuous speech are maintained in parallel.

Topic Area: Speech Perception

Poster E23 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Activity in the Subthalamic Nucleus Indexes the Coupling of Articulation and Vocal Intensity

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Introduction: In speech therapy for Parkinson's disease, patients are instructed to speak loudly, which induces improvements in articulation. This powerful therapeutic effect relies on phonetic-intensity encoding, defined as the theoretical process that links articulation and vocal intensity processing. Neurological correlates of phonetic-intensity encoding are unknown, leaving gaps in speech therapy mechanisms and speech production models. Objectives were to 1) Investigate the presence of phonetic-intensity encoding in the basal-ganglia cortical loop and 2) Evaluate the relationship between intensity encoding and established articulatory topography. Methods: 20 patients with Parkinson's disease were tested during the awake portion of deep brain stimulation implantation surgery. Patients spoke three syllable non-words which were constructed from 4 consonants (/g, t, s, v/) and 3 vowels (/i, a, u/). Non-words were produced loudly and softly, via experimental manipulation. Local field potentials (LFPs) were recorded from the subthalamic nucleus (STN) and precentral gyrus (PreCG), as well as acoustic productions. Acoustic analyses were conducted to determine 1) vocal intensity variation between trials and 2) changes in articulatory precision with increasing vocal intensity. Articulatory precision was measured by obtaining the spectral centroid, second formant ratio, vowel duration and fricative duration, which were then correlated to vocal intensity. Neural power in gamma band (70-150 Hz) and theta band (4-8 Hz) were extracted from the LFPs using a Wavelet transformation. To address the first objective, mixed-effects models were fit in each region and frequency band combination. Neural power was predicted from phoneme, vocal intensity, electrode location and all possible interactions. To address the second objective, a functional analysis was completed to determine electrodes that responded to lip, tongue or larynx articulator movements in the PreCG. Data from these articulator electrodes were then included in a mixed-effects model predicting neural power from vocal intensity, phoneme identity, articulator, and all possible interactions. Results: All measures of articulatory precision significantly correlated with vocal intensity (Bonferroni-corrected), confirming behaviorally that phonetic-intensity encoding occurred. Consistent with prior literature, fricative duration negatively correlated with vocal intensity while vowel duration, second formant ratio and spectral centroid positively correlated with vocal intensity. Neurological evidence of phonetic-intensity encoding was found in a significant three-way interaction between vocal intensity, phoneme, and electrode location in STN theta band. A main effect for vocal intensity was found in the STN theta band. No evidence for phonetic-intensity encoding was found in the PreCG, but interaction effects for electrode location by vocal intensity and electrode location by phoneme were found in gamma band. Results from the articulator model in the PreCG showed an interaction effect between vocal intensity and articulator. As vocal intensity increased, gamma band power in lip and tongue electrodes increased while power in larynx electrodes decreased. Conclusions: Phonetic-intensity encoding occurs as vocal intensity-dependent increases in power at phoneme-specific locations in the STN, but not PreCG. Vocal intensity control may be influenced by articulator regions in the PreCG. Interactions between STN and PreCG effects may occur via gamma-theta coupling, requiring future research. Explicit links between articulation and intensity should be incorporated into speech motor control models.

Topic Area: Speech Motor Control

Poster E24 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Components of limb apraxia distinguish patients with different primary progressive aphasia variants

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INTRODUCTION: Primary progressive aphasia (PPA) is a clinical syndrome primarily characterized by a progressive language deficit and relative sparing of other cognitive domains[1,2]. However, limb apraxia-- a disorder of skilled movements not attributable to sensory, motor, or language deficits-- frequently co-occurs[3,4]. Our prior research indicates that limb apraxia after left hemisphere stroke may be characterized by deficits in two components of gesture: (1) hand posture (HP, the shape and movement trajectory of the hand and wrist) and (2) kinematics (KIN, the amplitude and timing of movement[5]). Additionally, following left-hemisphere stroke, HP errors are associated with semantic processing of actions and manipulable objects ("action semantics") and posterior temporal lesions, while KIN errors are associated with meaningless gestures and lesion to pre/postcentral gyri and the inferior parietal lobe[6,7]. However, these gesture components have never been examined in PPA. We examined how each component contributes to limb apraxia in patients across different variants of PPA. METHODS: Participants were 21 adults with PPA (4 semantic [svPPA], 6 nonfluent [nfvPPA], 11 logopenic variants [lvPPA]). Participants were excluded if they had hearing loss, uncorrected visual loss, or history of other neurological disease. Participants completed verb naming[8] and two video-based gesture imitation tasks: (1) meaningless gestures and (2) meaningful transitive gestures (e.g., pantomimed hammering). HP and KIN gesture components each received a 0 or 1 per trial, following established procedures by trained, reliable coders[9]. Generalized logistic mixed-effects models[10] examined a three-way interaction between PPA variant (svPPA, nfvPPA, lvPPA), task condition (meaningful, meaningless gestures), and gesture component (HP, kinematics) on gesture imitation accuracy, controlling for dementia severity (Dementia Rating Scale[11]), with random effects of subject and item. RESULTS: There was a significant three-way interaction between PPA variant, task condition, and component on gesture accuracy (χ^2=24.95, p=0.001). Pairwise comparisons with Tukey corrections[12] revealed that HP was more impaired than kinematics for all PPA variants in the meaningless condition (p's<0.05), but only svPPA patients showed this pattern for meaningful gestures (β=1.98, p=0.007). Although KIN was less impaired than HP at the group level, five participants (4 lvPPA, 1 nfvPPA) showed the opposite pattern, such that KIN was more impaired than HP on meaningful gestures. None of the svPPA showed superiority of HP over KIN. An exploratory follow-up analysis showed that the integrity of verb naming was correlated with a greater HP over KIN advantage (R2=0.60, p<0.001). CONCLUSION: The finding that HP was more impaired than the KIN component for meaningless gesture imitation across all PPA variants is consistent with evidence that HP is the most sensitive measure of limb apraxia in patients with left-hemisphere stroke[5]. However, svPPA was the only variant that also showed relative deficits in HP for meaningful gestures, and no svPPA participants performed better on HP than KIN components. These findings, along with the observed correlation of verb naming and HP advantage, suggest that degraded action semantic representations or retrieval processes in svPPA are tightly linked to HP accuracy. Similar to evidence from stroke[6,7], these findings highlight the important interplay between semantics and gesture deficits in PPA.

Topic Area: Disorders: Acquired

Poster E26 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Your accent is my accent? How accent variants impact listeners' accented speech processing: An electrophysiological study

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In the current globalized world, listeners are exposed to different types of accented speech. Interestingly, behavioral and electrophysiological research has shown that listeners who speak in the same nonnative accent as the talker find

them equally or even more intelligible than a native speaker of that language, known as the Interlanguage Speech Intelligibility (ISI) Benefit (Bent & Bradlow, 2003). ISI behavioral studies have found that nonnative listeners rate other nonnative talkers with a shared first language (L1) as more intelligible (Hayes-Harb et al., 2008; Stibbard & Lee, 2006). Event-Related Potential (ERP) studies testing nonnative-accented speech have found that processing semantically anomalous sentences spoken by a nonnative talker entails a processing cost shown by a delayed N400 effect (Goslin et al., 2012; Grey & van Hell, 2017). These studies typically treat a given nonnative accent as a collective accent shared across all talkers, such as Spanish-accented English in the Spanish speaking community. However, a given language (e.g., Spanish) has accent variants and each variant has distinct and recognizable sound features; for example, over 20 countries have Spanish as their official language, resulting in various distinct Spanish accent variants. Sound features of an L1 impact the production and acoustic-phonetic characteristics of the later-learned second language (L2), and different L1 variants produce distinct L2 nonnative accents (Bent & Frush Holt, 2013). This ERP study examines: 1) How Spanish-English bilingual listeners process Spanish-accented English sentences produced by talkers who speak their own variety of Spanish (i.e., Mexican-Spanish) or a different variety of Spanish (i.e., Chilean-Spanish); and 2) If the ISI benefit effect extends to processing different varieties of Spanish. In this study, 35 highly proficient Mexico Spanish-English bilinguals will listen to semantically anomalous and correct sentences spoken in English by bilingual talkers with a matched accent variant (Mexico Spanish-accented English) and a mismatch variant (Chile Spanish-accented English). Additionally, sentences will be spoken by a control condition of native-accented English (i.e., American-English), and a control condition of nonnative-accented English (i.e., Chinese-accented English) speakers. We hypothesize that if the ISI benefit is restricted to listeners' own variant of Spanish, then semantic anomalies in the accent-variant that matches the listeners' accent are predicted to elicit a canonical N400 response, which is also predicted for the native-accented English control condition. Semantic anomalies in the mismatched Spanish variant are predicted to elicit a delayed N400, as is also predicted for the nonnative-accented English control condition. In contrast, if the ISI benefit extends across all accent variants of a given language (here: Spanish), then semantic anomalies in both Mexican- and Chilean-Spanish accented English sentences will elicit a canonical N400 in Mexican-Spanish-English bilingual listeners, similar to that observed in the English native-accented sentences, but markedly different from the delayed N400 response to the nonnative-accented English control sentences. Critically, the latter result pattern would reflect a theoretically significant broadened scope of the ISI benefit: not only the listeners' own nonnative accent but also a variant of that accent, which has distinctively different sound features, benefit listeners' processing of nonnative accented speech.

Topic Area: Speech Perception

Poster E27 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Neural mechanisms underlying the Time-Flow Illusion

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The Audiovisual Time-Flow Illusion (TFI) is a novel phenomenon in spoken language perception, whereby illusory "pausing" or "skipping" of the visual stimuli is perceived in temporally intact visual speech merged with temporally altered auditory speech. When brief pauses are inserted in or brief portions are excised from an auditory speech stream merged with an intact, congruent visual stream (A-pause/V-norm, A-skip/V-norm), individuals perceive the visual modality as "pausing" or "skipping," respectively. Our previous behavioral study demonstrated that an illusory "pause" in the visual modality was perceived 35.4% of the time in the A-pause/V-norm condition, which is significantly different from the percentage of an illusory "pause" perceived in the unchanged A-norm/V-norm condition (5.3%, $p < 0.001$). Similarly, an illusory "skip" in the visual modality was perceived 48% of the time in the A-skip/V-norm condition, which is significantly different from the percentage of an illusory "skip" perceived in the unchanged A-norm/V-norm condition (2.2%, $p < 0.001$). Interestingly, when the stimulus manipulations were reversed—that is, when brief pauses were inserted in or brief portions were removed from the visual stream, while the auditory stream was kept intact (A-norm/V-pause, A-norm/V-skip)—the illusion was perceived significantly below chance level, < 19%. Taken together, these findings suggested that the auditory modality sets the pace of the visual modality during audiovisual integration of natural speech. To examine the neural mechanisms underlying the TFI, we performed an EEG experiment in which individuals were presented with TFI stimuli (A-pause/V-norm, A-skip/V-norm). Based on data from two subjects, results revealed the presence of alpha power bursts directly following each "pausing" and "skipping" abruption in the auditory speech stream, substantiated by a marked increase in alpha activity (8-12 Hz) approximately 400 to 500 ms following each abruption onset compared to the baseline unchanged condition. Given an n of 2, we cannot firmly conclude whether this alpha is auditory or visual in nature, however, the enhanced alpha power suggests a resetting of ongoing alpha activity to abruption, which may have triggered the illusion. In natural speech, mouth movements typically precede sound production in speech. The visual modality thus has a role in predicting acoustic speech signals as they unfold. The current findings suggest that the visual modality realigns its pace with that of the auditory modality in order to preserve its predictive impact on audiovisual speech processing.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster E28 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

No change in lateralization of language activity or connectivity in older adults

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Language processing in a large majority of adults is functionally dominated by left-hemisphere regions. The hemispheric asymmetry reduction in older adults (HAROLD) model states brain activity tends to be less lateralized in older adults compared to younger adults in a variety of cognitive functions (Cabeza, 2002). Although this model predicts that language lateralization might become reduced in older age, this hasn't been well tested. A confound in comparing fMRI activation across the lifespan is that younger versus older adults may exert disparate effort during the task. Here, we test the HAROLD model with respect to language processing. Because much of HAROLD findings come from task-related fMRI, we begin by examining task-activation in a language task that adapts for difficulty. Because language ability relies on interactions between gray matter regions, we then test for age-related changes in lateralization of both structural and functional connections between the areas activated by the fMRI task. Participants included 61 neurotypical adults (27 male, 34 female; ranged 31-83 years with mean age 61). Each individual completed an adaptive fMRI semantic decision paradigm to elicit language-related activation, a movie-watching resting state scan for functional connectivity, and a diffusion-weighted scan for structural connectivity. We then intersected regions activated in >60% of participants with a structural atlas, and identified contralateral homotopes to each atlas region to generate 23 left-right hemisphere paired nodes from which we generated structural and functional connectomes. For the three imaging metrics, we used Spearman correlations to examine the relationship between participant age and laterality index (LI) at edge-, node-, lobe-, and hemisphere-wise levels. We found no significant age-related changes to activation LI at either node-, lobe-, or hemisphere-wise levels. The functional connectome revealed weakly negative correlations with age throughout the whole network. However, functional connectivity LI showed no statistically significant changes with age. Interrogating our structural connectomes, we saw inter-hemispheric edges whose connectivity significantly declined with age. The nodes whose connections produced statistically significant decline include the left and right temporoparietal junctions, the left dorsomedial prefrontal cortex, the right medial frontal gyrus, and the right angular gyrus. However, we also observed no statistically significant changes to structural connectivity LI with age. Our analyses revealed no age-related changes in lateralization of language across any of our metrics, evaluated at either large- or small-scales. Declines in inter-hemispheric structural connectivity are consistent with previous studies demonstrating white matter structural degeneration with age. Our failure to find changes with LI over age for all of our metrics suggests that the HAROLD hypothesis may not be broadly applicable to all kinds of language processing demands. In prior studies that did not

account for task performance confounds, reduced lateralization with advancing age may have related to increased effort required for fMRI task performance in older adults, rather than a fundamental change in the organization of brain networks with increasing age. Our results add to the body of literature evaluating changes in language processing with increasing age and underscore the importance of further studies to better understand the picture of neurocognitive aging.

Topic Area: Language Production

Poster E30 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

A novel task for measuring prediction abilities in a rat model using a speech-sound discrimination task

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The ability to predict upcoming environmental stimuli and adapt to unexpected events is vital for all animals, including humans. With respect to spoken language, prediction is especially important due to the speed at which speech sounds occur. Prediction of upcoming stimuli facilitates comprehension at rapid speeds. Prediction deficits are often present in several human neurodevelopmental disorders, including autism and dyslexia. It is difficult to determine the biological mechanisms that drive this deficit in humans because of the inability to manipulate individual environmental or genetic risk factors in a controlled laboratory setting. Researchers often use rodent models for this purpose, due to their ability to discriminate between human speech sounds. However, there is no validated task to study speech sound prediction abilities in rat models. In the present study, we developed a novel task to assess the rapid auditory processing (RAP) capabilities of rats in both unpredictable and predictable environments. By introducing a predictive cue to an existing rapid speech sound discrimination paradigm, we were able to assess discrimination in both predictable and unpredictable conditions in a single testing session. Rats were trained to respond to a target sound (/dad/) from within a random stream of distractor sounds (/tad/, /gad/, and /sad/) using an infrared-monitored nose poke in a soundproof chamber. The rats were trained and tested with the sounds presented at 2, 4, 5, 6.7, 10 and 20 syllables per second (sps). In 40% of trials, the sound /bad/ directly preceded the target sound, serving as a reliable predictor. When the predictor was absent, we found that the rats exhibited high accuracy at slow presentation rates, with accuracy decreasing as presentation rate increased, as previously shown. When the predictor was present, we found a similar pattern at the slowest rates, but observed rats responded more frequently to the predictor sound as presentation rate increased, perhaps reflecting anticipation of the upcoming target sound. Overall, these findings suggest that rats are able to use reliable predictive cues about incoming auditory stimuli to more efficiently navigate complex sensory environments. Future studies may utilize this task to assess the genetic, neural, and environmental factors that impact prediction deficits in various human disorders.

Topic Area: Perception: Auditory

Poster E31 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The effect of predictability on the N400 ERP component modeled by transition probabilities in a Bayesian sequential learner model

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Introduction. In the typical N400 paradigms an attenuation of the ERP is recorded when stimuli are congruous with their preceding context e.g., sentences or words. There is an active debate concerning the functional basis of N400 amplitudes. One proposal is that N400 amplitudes might reflect unpredicted semantic information and update of the internal predictive model, which is continuously adjusted based on statistical regularities in the environment (e.g., Bornkessel-Schlesewsky & Schlesewsky, 2019, Front Psychol; Kuperberg, 2016, LCN; Rabovsky et al. 2018, NHB; Rabovsky & McRae, 2014, Cognition). Here, we test this idea using a Bayesian sequential learner model on EEG data obtained during a semantic oddball task with stimuli from different semantic categories and an additional manipulation of transition probabilities between categories. Methods. Specifically, participants will be exposed to a semantic oddball task while their EEG is being recorded. In the task a sequence of nouns from the same semantic category (land formations, clothing, vegetables, tools, or musical instruments) will be presented to the participants one-by-one on a screen. The sequence is followed immediately by a series of nouns from a different category with the categories repeating to create a continuous sequence. We expect a significantly weaker N400 ERP amplitudes for the last word in a stimulus sequence (commonly called standard) than for the first word of the new category (deviant). Crucially, we additionally manipulate the predictability of sematic information via the transition probabilities between categories: a category is followed by one other category with an 85% probability and each of the other categories with a 5% probability. Various statistical learning paradigms have shown that transition probabilities can be (implicitly) learned and influence behavior as well as EEG signals (e.g., in the auditory domain: Koelsch et al, 2016, Sci Rep). Our experimental design allows us to investigate which statistics can be learned in a semantic oddball task and whether this learning modulates N400 amplitudes. To this end, different Bayesian sequential learner models will be compared: (1) The main Bayesian model of interest will infer the transition probabilities of the categories combined with a finite memory. It will be compared to a Bayesian model that (2) learns the (local) occurrence frequency of categories and (3) a null model that captures the category switches only. The change in a model's probability distribution represents its semantic surprise (i.e., the Bayesian surprise; Itti & Baldi, 2009, Vision Res) which can be fitted to the single-trial ERP response for model evaluation. We will also investigate the time windows and electrodes in which the model's surprise readouts best predict ERP activity to compare the hypothesized influence of transition probabilities on the N400 to possible other modulation of later (anterior or posterior) positive ERP components. Discussion. A correspondence of changes in the N400 to Bayesian learning of transition probabilities would not only further support notions that this component indexes surprise from a probabilistic internal semantic model but would also explicitly demonstrate that this probabilistic information can be (implicitly) learned over time from the statistical regularities of the environment.

Topic Area: Computational Approaches

Poster E32 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The temporal distribution of language hierarchy and its neural correlates

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Speech rhythms across languages appear to converge on similar low frequency (LF) modulations of the speech carrier, suggesting a remarkable degree of regularity. It is unclear the extent to which such regularity reflects only low-level speech units, such as syllabic series, or projects to higher-order syntactic chunking. We have mapped variability in unit duration across four speech levels of increasing complexity - phonemes, syllables, words and sentences -, as well as four types of syntactic constituents - Noun phrases, Verb phrases, Adverbial phrases, and Clauses. Twenty-three subjects (5 male, mean age = 23.3, std ± 3.5) took part in a behavioral and EEG study. They were asked to listen to the first chapter of two audiobooks in the Italian language, read by a voice actor. Stimuli were presented through two loudspeakers at a comfortable volume (70 dB). Each chapter was roughly 9 min long, segmented into 10 trials. Linguistic levels in the acoustic signal were annotated manually at the phoneme, syllable, word, syntactic phrase, and sentence time scales using PRAAT software. Syntactic constituency analysis was performed with Stanza, an nlp library in Python. The duration of each temporal unit was extracted, and variance was compared across levels using the coefficient of variation and individual nonlinear fits. Preliminary analyses show significant differences in variance between the phonemic/syllabic levels and the word/sentence levels with larger variance for the latter. While durations

at phonemic and syllabic levels were highly correlated, no other significant correlation was found. Importantly, the larger variance for word/sentence levels was due to a bimodal distribution of duration estimates, relative to the unimodal profile of phonemic/syllabic levels. Similarly, NPs showed the largest variance and a bimodal distribution, while the remaining syntactic units were unimodally distributed. We then tested whether pairwise phase consistency in neural data reflected behavioral variability, displaying one or two peaks of activity, in correspondence to the temporal profiles.

Topic Area: Speech Perception

Poster E33 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

EEG Evidence of Low-Level Speech Processing in Severe Brain Injury

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Assessing cognitive function – especially language processing – in severely brain-injured patients is critical for prognostication, care, and development of communication devices (e.g. brain-computer interfaces). In patients with compromised motor function, EEG measures have been used to probe language processing at the level of comprehension and at the very lowest level – tracking of the natural speech envelope (NSE) – but not at the intermediate level of phoneme processing. Here, we develop and apply methods to identify a differential phoneme-class specific response (DPR) and NSE tracking, and apply them in parallel to severely brain-injured patients. We studied a cohort of 26 severely brain-injured patients (17 traumatic, 5 anoxic, 4 other etiologies; 19 M) and 10 healthy controls. Patients' level of function was assessed via the Coma Recovery Scale – Revised (CRS-R) at bedside, and EEG/fMRI measured of command following via tests of motor imagery. For the present paradigm, EEG was recorded using an augmented 10-20 montage (37 electrodes), during presentation of a 148 s audio clip of Alice in Wonderland. EEG responses to phoneme classes (approximants, fricatives, nasals, plosives, and vowels) were extracted by averaging the EEG (2-15 Hz band-pass filtered) with respect to time markers placed at phoneme onset. Tracking of NSE was assessed from the same recordings, and was measured by cross-correlating 2 s segments of EEG response with the speech envelope. For the phonemic analysis, healthy controls had DPRs for multiple phoneme pairs, which agrees with previous phoneme processing studies done in healthy controls (Khalighinejad et. al., 2017). The response was observed during the entire 500 ms analysis interval, most often at 200-300 ms after phoneme onset. Most differences localized to left frontal, central parieto-occipital, right temporal, and right frontal regions. DPRs were found in all patients, but patients with evidence of command following had an early bilateral response in the first 50 ms. In comparison, patients without any evidence of command following lacked the early response but had a late response around 250 ms. For NSE tracking, responses in the first 100 ms distinguished patients without any evidence of language processing. Specifically, patients without any evidence of language processing had a frontopolar response in the first 100 ms and a late fronto-central response around 200 ms. Patients with evidence of language processing had a more global response in the first 100 ms. Finally, we noted that the overall dynamics of the DPR and NSE tracking in healthy controls was largely similar but there was a critical difference in the spatial pattern: the central parieto-occipital response observed in DPRs was absent in NSE tracking response. In conclusion, we developed an EEG-based method to probe low-level speech processing in severely brain-injured patients. When applied to assess NSE tracking and phoneme processing, our results suggest that patients with evidence of command following have an early bilateral response component, which is absent or weak for patients without any evidence of command following.

Topic Area: Perception: Speech Perception and Audiovisual Integration

Poster E34 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam E session.

Auditory cortex morphology is related to overlaps between phonological inventories of multilinguals' languages

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Heschl's gyrus (HG), the cortical structure housing early auditory cortex, exhibits large individual variation in shape and size. Although formed in-utero, HG's volume has been previously associated both with putatively genetically driven factors (speech sounds learning abilities and musical aptitude), and environmental variables including bilingual language experience. One possibility is that distinct influences (environmental versus genetic) are reflected by different measures describing the structure of HG. Indeed, a recent large-scale genome-wide association meta-analysis suggested that cortical surface area is influenced by genetics and cortical thickness reflects environmentally driven neuroplasticity (Grasby et al., 2020). In this study, we leveraged a unique sample of 136 participants exposed to between 1 to 6 languages (2.65 languages on average) and asked whether the variability in morphology of their HG (cortical thickness in particular) reflected the variability in their language experience. We further explored whether typological distances between multilinguals' languages were associated with the neural signatures of multilingualism in the auditory cortex. Specifically, we investigated whether neuroanatomical indices describing HG were related to cross-linguistic phonological information: segmental, feature-level, or counts of phonological classes. To describe the language background of our participants, we expressed Age of Onset(s) of Acquisition (AoA) of different languages in a continuous quantitative measure using Shannon’s entropy equation. Subsequently, the PHOIBLE database and open-source software (Dediu & Moisik, 2016) were used to construct three measures of typological distance between the languages spoken by our participants: (1) overlaps in sets of segments belonging to each language; (2) overlaps in distinctive articulatory features describing the segments of each language (e.g., "short", "long"); and (3) similarity in counts of phonological classes that share certain features (e.g., "front rounded vowels", "clicks"). Next, the summed phonological distances between all language pairs for each participant were weighted by the AoA information for each of the participants' languages, resulting in three different indices of language experience accounting for typological relations between languages. We processed the T1 structural MRI data with FreeSurfer’s brain structural pipeline, and segmented HG using an automated toolbox (TASH, Dalboni da Rocha et al., 2020). Our dependent variables were TASH-derived measures (volume, surface area and thickness) for the extracted HG labels. For each gyrus and each measure, we first fit linear models assessing the relationships with multilingual language experience but ignoring typological relations between languages, controlling for age, gender and total brain volume or mean thickness. Out of all investigated cortical measures, only average thickness of the second HG (bilaterally) proved to be related to participants' language experience. Next, based on this result, we performed a model comparison procedure which showed that the language experience index including cross-linguistic segmental-level information explained the most variance in average thickness values of the second HG (both left and right). The direction of this effect was negative, showing that the more extensive and varied one's language experience, the thinner the cortex of their second HG. We hypothesize that this finding might reflect experience-driven pruning and neural efficiency, which would need to be tested in further longitudinal studies of language acquisition.

Topic Area: Multilingualism

Poster E35 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam E session.

Brain Directed Connectivity Analysis Shows Evidence of Auditory Corollary

Discharge

Amirhossein Khalilian-Gourtani[1], Ran Wang[1], Xupeng Chen[1], Leyao Yu[1], Werner Doyle[1], Orrin Devinsky[1], Yao Wang[1], Adeen Flinker[1]; [1]New York University

Introduction: A direct consequence of any motor action is the activation of the relevant sensory system. It is critical for the brain to dissociate self-generated action from external sensation. A hallmark neural circuit addresses this issue by a blueprint of motor signals informing the sensory cortex of the impending action; known as corollary discharge (CD). While there is ample evidence of CD signals across the animal kingdom and sensory modalities, the source and dynamics of CD in the human auditory system are not known. Methods: We leveraged the excellent spatiotemporal resolution of electrocorticography (ECoG) and acquired re-cordings from 8 neurosurgical patients while they performed an auditory repetition task (subjects were instructed to listen and then repeat single words). We used the high-gamma broadband (70-150 Hz) signal which is a common marker for underlying neural activity. In order to study the information flow between brain regions, we developed a directed connectivity analysis framework based on autoregressive Granger causality measures and applied unsupervised clustering techniques. Our approach elucidates dominant information flow (source and target) as well as prototypical temporal connectivity patterns (tested against permutation at $p<0.05$ for statistical significance) with their corresponding directed connections. Results: To understand the dynamics of information flow we applied our directed connectivity analysis framework to the neural recordings. Our results show three distinct phases during the auditory repetition task likely related to comprehension, pre-articulatory preparation, and speech production. Locked to word articulation we find a distinct component peaking at -100 msec relative to articulation onset with directed influence from speech motor cortex onto auditory cortex (STG). Unlike high-gamma analysis alone, which revealed pre-articulatory neural activity in multiple cortical regions and subsequent STG suppression, only the connectivity approach was able to extract the directed information flow which originated in ventral precentral gyrus targeting STG. The corollary discharge component replicated within patients and the degree of directed influence on auditory electrodes significantly predicted speech-induced suppression in STG (Pearson Correlation, $R=0.504$, $p=5.3e-4$). Conclusions: In humans, an auditory CD is hypothesized to increase sensitivity to our own speech and its impairment can lead to auditory hallucinations. Our results provide the first evidence for the source and timing of a corollary discharge signal in the human auditory system and has great implication for speech motor control as well as the study of psychotic symptoms in humans.

Topic Area: Speech Motor Control

Poster E36 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam E session.

Brain Age Predicts Long-Term Recovery in Post-Stroke Aphasia

Sigfus Kristinsson[1], Natalie Busby[1], Chris Rorden[1], Roger Newman-Norlund[1], Dirk B. den Ouden[1], Sigridur Magnusdottir[2], Helga Thors[2], Argye E. Hillis[3], Leonardo Bonilha[4], Julius Fridriksson[1]; [1]University of South Carolina, [2]University of Iceland, [3]Johns Hopkins University, [4]Medical University of South Carolina

Introduction Neuroplastic properties of the brain decrease with age.1 Nonetheless, the association between age and language recovery in stroke remains unclear.2 Here, we examined the association between brain age, a neuroimaging-derived measure of brain atrophy, at stroke onset and: (1) cross-sectional language function, and (2) long-term recovery of language function, beyond chronological age. Method A total of 49 consecutive cases (age: 65.2+/-12.2 years, 25 female) of acute left-hemisphere strokes underwent routine clinical neuroimaging and a language assessment (BEST-2)3 upon hospital admission. A subsample of 30 participants returned for follow-up language assessments >2-years after stroke. Each individual's lesion brain scan was 'healed' to enable automated brain age estimation. First, FLAIR/lesion maps were co-registered to participants' own T1 scan. Next, T1s and lesion maps were used to create an enantiomorphically healed version of their T1.4 This process exploits the symmetrical nature of the brain and the fact that lesions in our sample were unilateral. Briefly, damaged tissue in the ipsilesional hemisphere was replaced with healthy tissue from homologous areas of the healthy hemisphere. We used the BrainAgeR analysis pipeline (github.com/james-cole/brainageR)5 to estimate brain age using default settings. The pretrained model was created based on images from healthy individuals (N>4,000) between 18-90 years old,5 thus serving as inherent control data here. Multiple regression models were constructed to test the effects of brain age on language outcomes. Lesion volume and chronological age were included as covariates in all models. Results Estimated brain age was on average decelerated by 3.7+/-7.5 years (range: -24.1 to 10.1 years) relative to chronological age. Accelerated brain age was associated with poorer overall language performance ($F(1,48)=5.65$, $p=.022$), naming ($F(1,48)=5.13$, $p=.028$), and speech repetition ($F(1,48)=8.49$, $p=.006$) at stroke onset. All participants who returned for a follow-up assessment >2 years after onset showed a significant improvement across all language tasks (all $p<.001$). At follow-up, brain age was found to be inversely associated with change in language function ($F(1,26)=8.66$, $p=.007$) and speech repetition ($F(1,26)=7.10$, $p=.013$), but its correlation with change in naming ($F(1,26)=3.4$, $p=.078$) and auditory comprehension ($F(1,26)=3.3$, $p=.081$) marginally failed to reach statistical significance. Across timepoints and assessments, chronological age was only associated with naming performance at stroke onset ($F(1,48)=4.18$, $p=.047$). Conclusion Our findings reveal for the first time that a neuroimaging-derived measure of biological brain age, as a measure of structural integrity at stroke onset, is associated with longitudinal recovery of language function. Importantly, brain age explained more variability in language function than chronological age. These findings hold substantial promise to improve clinical management of stroke as brain age was estimated based on routine clinical brain scans as opposed to the more time-consuming research-grade scans. Future research will need to investigate the extent to which brain age supplements other measures of brain health in the context of stroke recovery.

Topic Area: Disorders: Acquired

Poster E37 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Predicting negative features of words in context: The role of negative bias in younger adults

Li-Chuan Ku[1], Vicky Tzuyin Lai[1]; [1]University of Arizona

Language prediction studies typically examined the activation of concrete semantic features, e.g., animacy, rather than abstract features, e.g., emotional valence. Do people pre-activate affective features of a word in sentences? One recent study found that emotionally unexpected yet plausible (vs. emotionally expected) target words in sentence-final positions require more neural resources to override anticipated affective representations (Chou et al., 2020). However, they combined positively and negatively valenced stimuli in the analysis, and did not consider readers' cognitive/affective tendency. Younger readers often showed a negativity bias, i.e., the tendency to attend to negative information (Ku et al., 2020). Here we investigated if and how readers pre-activate positive or negative features of a word in emotionally ambiguous sentences. We hypothesized that undergraduates will show a negativity bias proactively, i.e., in pre-activating more negative features of an upcoming word in sentences. Twenty-seven undergraduates participated (Mage=18.9, 15 females). We assessed participants' depression, anxiety, and stress levels (DASS), as these variables may bias emotional expectation, and verbal cognitive control (Letter and Category Verbal Fluency Test), as it was associated with language prediction ability. Stimuli included 120 sentence primes with emotionally ambiguous interpretations (e.g., Joan was stunned by her final exam result.), each paired with positive and negative target words (success/distress). The sentence-word pairs were equally semantically related between conditions based on norming (N=46. On a 0-3 scale, M(positive words)=1.99 and M(negative words)=1.93). Target words were matched on length, frequency, part-of-speech, concreteness, and emotional intensity. During EEG recording, in each trial, participants first read an emotionally ambiguous sentence that has either a positive or negative continuation, while actively predicting a continuation. They then saw a positive or negative target word, and judged whether their predicted continuation was similar to the target word on the screen on a 0 (not similar at all) to 3 (very similar) scale. Behaviorally, negative target words (M=1.44, SD=0.26) on average received higher similarity ratings than positive ones (M=1.31, SD=0.3; p=.044), indicating a better match between participants' predictions and the presented words in the negative condition. For ERPs, positive target words elicited a larger N400 (350-550 ms) than negative words (p=.006), suggesting retrieval difficulty due to incongruency between the predicted negative information and the presented positive word. This N400 was driven by 18 (out of 27) participants who showed negativity bias, evidenced by their higher similarity ratings for negative target words than positive ones. Additionally, positive target words elicited a reduced late positivity (or a sustained negativity; 550-800 ms) than negative ones (p=.012), indicating less meaning elaboration (or continued feature retrieval) due to fewer activated features in positive words. Moreover, participants' verbal cognitive control predicted both the anterior N400 (β=.626, p=.021) and late positivity (β=.85, p=.002) effects, whereas DASS predicted neither. This suggests that cognitive abilities, rather than speaker affect, modulates affective feature pre-activation. In conclusion, younger adults pre-activate negative features more than positive features during language processing, consistent with "negativity bias". Such negativity bias is driven by cognitive control, which highlights the importance of individual differences, e.g., age, in affective prediction.

Topic Area: Meaning: Lexical Semantics

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Poster E39 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The role of animacy in computing thematic relations during online sentence comprehension

Chia-Hsuan Liao[1], Hsiang-Ching Chiu[1]; [1]National Tsing Hua University

INTRODUCTION: Although unpredicted words usually elicit a larger N400 response relative to predicted ones (Kutas & Federmeier, 2011), results from “role-reversed” sentences (“The millionaire that the servant fired…”) are controversial. While the absence of N400 responses to role reversal situations have been replicated in many languages (Kolk et al. 2003; Kuperberg et al., 2007), some studies do observe an N400 effect (Bornkessel-Schlesewsky et al. 2011). The current study tested whether animacy of the noun phrases could modulate the N400 responses in role-reversal anomalies. We hypothesized that when the noun phrases have different animacy features, it would be easier to evaluate their thematic relations to update predictions. In particular, (at least in Mandarin) sentences with an inanimate subject and an animate object would be more marked compared with the other way around, and we expected their processing profiles to be different. EXPERIMENT: 28 native speakers of Mandarin read sentences word by word during EEG recording. 120 stimuli were presented. We used the SOV ba construction in Mandarin, with the morpheme ba providing reliable cues about the thematic roles of the noun phrases before the presence of the verb. A two (Thematic role assignment: Canonical vs. Reversal) by two (Animacy feature: Animate-Inanimate vs. Inanimate-Animate) experiment was set up to approach the question. We’ve kept the semantic relatedness between the subject and object identical between the two types of Animacy features. The predictability of the target verb in Canonical conditions, regardless of the Animacy features, was 52% (Animate-Inanimate: The pitcher ba the ball threw out, meaning “the pitcher threw out the ball”, Inanimate-Animate: The alarm clock ba the roommate woke up, meaning “the alarm clock woke up the roommate”). Sentences in Reversal conditions were created by reversing the subject and the object in Canonical conditions, and the predictability of the verb was 0%. None of the target verbs were repeated throughout the experiment. Participants performed a plausibility judgement task at the end of each sentence. ERP analyses were time-locked to the onset of the verb for each condition. RESULTS: ERP results showed a significant interaction between Thematic role assignment and Animacy feature at the N400 time window. Follow-up analyses showed a reduced N400 response in Canonical Inanimate-Animate condition relative to the other three conditions. By contrast, at the P600 time window, we only observed a significant Thematic role assignment main effect, with Reversal conditions being more positive than Canonical conditions. Taken together, the P600 main effect suggests that role reversal anomalies are difficult to recover. More importantly, animacy of the noun phrases could modulate the computation of thematic relations online. Participants were sensitive to the marked animacy features of the noun phrases, and they could make advantage of such features to update predictions rapidly. The findings add to the literature by showing that animacy features could be one of the factors that contribute to the inconsistent role reversal findings. It also provides insights into how event relations are represented in the mind.

Topic Area: Meaning: Combinatorial Semantics

Poster E40 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Prolonged pauses in spoken sentences reveal ERP responses in children similar to adult brain responses to constituent interruptions in visual narrative structure

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Inspired by early "click" studies investigating the online processing of constituency boundaries in language (e.g., Fodor & Bever, 1965), Cohn et al. (2014) used ERPs to probe the structure and processing of visual narratives. Sequentially presented images (panels of comics without text) were interrupted (or not) by blank panels occurring either within or between putative narrative constituents. ERP responses obtained with this paradigm included anterior negativities and posterior positivities which could be argued to resemble previously observed effects related to the processing of linguistic constituency. In our ongoing developmental ERP studies of the processing of abstract hierarchical structure across cognitive domains, we developed and tested an auditory paradigm with analogous between/within constituent interruptions of naturalistic speech which accompanied short animated movies. Auditory analogues of the blank panel interruptions from the Cohn et al. comics study here took the form of prolonged pauses (1600 ms) inserted into spoken sentences (versus pauses with natural duration, 400 ms). Pauses were inserted within a first clause (WC1), within a second clause (WC2), or between clauses (BC). ERP data from eight children (10-12 yrs) are presented here. The previously reported visual narrative ERP responses in Cohn et al.'s study with adult participants appear to replicate in our auditory sentence paradigm. The comparison of prolonged pauses at WC1 with prolonged pauses at BC indicated a late negativity over centro-parietal sites. This was consistent with the late negativity for the comparison of visual interruptions at corresponding positions (though less frontal on the scalp). Similarly, we found a late biphasic response (anterior negativity and parietal positivity) to prolonged pauses at WC2 compared to prolonged pauses at BC, and a parietal positivity to prolonged pauses at WC2 compared to prolonged pauses at WC1. Statistical analyses showed a main effect of omission position ($F(2,14) = 3.81$, $p < .05$, $\eta p2 = .35$) between 700-900 ms after pause onset which represents the time window 400-600 ms relative to the natural pause offset (i.e., the disambiguating point). Follow-up analyses corroborated this pattern , particularly over medial sites (WC1-BC: position x laterality, $F(1,7) = 18.25$, $p = .004$, $\eta p2 = .72$; WC2-WC1: position x laterality, $F(1,7) = 10.89$, $p = .013$, $\eta p2 = .61$). However, the biphasic response for WC2-BC was not significant (p's > .325). Thus, our preliminary child ERP data appear to show responses contrasting within- versus between-constituent interruptions of speech that are strikingly similar to previously reported effects in adults for analogous interruptions targeting visual narrative constituency. Though this similarity of patterns across modalities and age groups needs to be handled with caution, it does at least suggest that the present auditory paradigm may succeed in targeting dimensions of processing relevant for informing our study of abstract hierarchical structure across domains in child development.

Topic Area: Syntax

Poster E41 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Neural activation and connectivity differences among semantic association, categorization and synonym judgement: an fMRI study

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The human capacity to understand the world depends on manipulating various concepts through language. To make sense of the complexities of a possibly infinite number of concepts, they must be linked and organised into a comprehensible structure. Semantic association and categorization are two of the various means for assigning relations between concepts. Semantic association refers to the temporal or spatial co-occurrence of concepts that are usually united by a theme, event or scene, while semantic categorization indicates the hierarchical organization of meaning. Despite the well-documented brain network of general semantic processing, less is known about how the semantic network is engaged to support association and categorization. This study compares the neural correlates

and connectivity patterns of these two processes to synonym judgement, which measures general semantic processing, with a within-subject fMRI study. Twenty-three native Mandarin speakers were recruited in Beijing and scanned with a Siemens Prisma 3T scanner at Peking University. Association, categorization and synonym judgements tasks on Chinese characters pairs were devised to probe into the three processes respectively in different runs. A font-size judgement task was used as the baseline task. Activation maps of each semantic process were obtained by contrasting the semantic blocks with the baseline blocks. To compare the relative contributions of each region in the semantic network to the three processes, a region-of-interest (ROI) analysis was conducted at 7 locations according to published meta-analyses of the semantic network (Jackson, Hoffman, Pobric, & Lambon Ralph, 2015; Wu, Ho, & Chen, 2012). To further examine the directed information flow within the semantic network during Chinese reading, a Granger causality (GC) analysis among the chosen ROIs was conducted with the MVGC toolbox in Matlab (Barnett & Seth, 2014). The whole brain analysis results showed that the three tasks commonly recruited the left dorsal and ventral lateral prefrontal cortices, including the middle frontal gyrus, pars opercularis, pars triangularis and pars orbitalis, bilateral medial frontal gyrus; the left superior parietal lobule (BA 7), left fusiform gyrus (BA 37) and the right cerebellum, but not the anterior temporal lobe or the angular gyrus. ROI analysis revealed stronger activation in the posterior middle temporal gyrus (pMTG) and the inferior frontal gyrus during association, but weaker activation in the pMTG during categorization. Granger causality analysis revealed similar connectivity patterns for association and categorization versus synonym judgement on the left hemisphere, but only categorization exhibited significant connections between the right insula and the left hemisphere. We discuss how the results suggest that demands on semantic retrieval, degree of accurate semantic representation, perceptual experiences and world knowledge lead to observable differences in the three kinds of semantic processing. In particular, synonym judgement is the relatively simple task that requires basic semantic retrieval but also more top-down modulation for accurate semantic representation; semantic association requires the connection of lexical meaning to perceptual experiences and hence more embodied semantic representations, while semantic categorization needs the integration of word meaning and world knowledge about hierarchical or taxonomic relationships.

Topic Area: Meaning: Lexical Semantics

Poster E42 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Are All Reading Disabled Brains the Same? Gray and White Matter Structure in Specific Reading Comprehension Deficit, Developmental Dyslexia, and Typically Developing Children

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Research on the neurobiology of reading has been instrumental for furthering our understanding of the component processes in reading and reading disability. The bulk of this work has focused on word-level reading and proximal sub-skills (e.g., phonological awareness) and has revealed robust differences between good and poor readers in brain structure and function. Relatively less work has explored the neurobiology of reading comprehension and relevant sub-skills, despite importance of reading comprehension for academic success and the substantial number of children who struggle with reading comprehension despite adequate word reading skills. Better understanding of the neurobiology that supports reading comprehension, and where/how it differs from that which supports word-level reading, should advance our understanding of the processes that contribute to comprehension difficulties. While some work has compared groups of children with specific reading comprehension deficits (SRCD) to those with word-level reading difficulties (i.e., developmental dyslexia, DD) to identify unique neural signatures of these profiles, this work has been done in relatively small, homogenous samples. Further, the two extant studies of brain structure in SRCD included only gray matter analyses, leaving white matter pathways unexplored. In our ongoing study, we are analyzing a large, open-source dataset (Child Mind Institute Healthy Brain Network) to explore brain structure in those with SRCD, DD, and typical development (TD). Gray and white matter measures, including measures of neurite orientation and dispersion (NODDI), which may be more sensitive to individual differences, will be explored. This project features a larger, more diverse sample than previous research and will contribute new information about white matter structure to the SRCD literature. MRI data are pre-processed for quality control and grey matter and white matter metrics (cortical and sub-cortical morphometries, fractional anisotropy, mean diffusivity and neurite indices) are computed using open-source toolboxes - FreeSurfer and FSL. Metrics will be compared across groups and to behavioral measures of word reading and reading comprehension. While our hypotheses are speculative, given the small extant body of literature, two previous investigations of gray matter structure in SRCD, (Bailey et al., 2016; Patael et al., 2018), lead us to hypothesize that SRCD participants will have decreased gray matter volume relative to DD and TD peers in bilateral regions that have been shown to be important for comprehension, including the inferior and superior temporal gyri and anterior cingulate, right-hemisphere frontal regions including the middle frontal gyrus and dorsolateral prefrontal cortex, and the cerebellum. Work on reading comprehension more broadly, not in SRCD (e.g., Horowitz-Kraus et al., 2014b & 2015b), guides us to expect white matter differences predominantly in the right hemisphere, including lower FA and higher MD in right superior longitudinal fasciculi. These findings, particularly those on white matter structure, will complement existing data and to help elucidate the neural architecture underlying good and poor reading comprehension.

Topic Area: Reading

Poster E43 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Do grammatical gender cues facilitate processing?: Evidence from monolingual and bilingual speakers

Gabrielle Manning[1], Laura Sabourin[1]; [1]University of Ottawa

Grammatical gender is often referred to as one of the most difficult grammatical categories to master, making it an ideal tool to investigate how grammatical concepts are processed. Previous studies have focused on anticipatory processing of grammatical gender cues in native speakers and have found a facilitation effect to upcoming nouns (e.g., Dussias et al., 2013; Lew-Williams & Fernald, 2010). However, these studies primarily focus on languages consisting of a highly transparent gender system (e.g., Spanish; Beatty-Martínez, et al., 2020) and findings are typically collapsed across grammatical genders, as opposed to disentangling them. The current study tested, 61 functional monolingual French speakers and 27 simultaneous French-English bilinguals from Ontario and Québec, Canada via an online study. At the time of testing, participants resided in the Ottawa-Gatineau region, a largely bilingual community. Participants completed a lexical decision task using a masked priming paradigm to examine how a gender-marked determiner (e.g., la) facilitates access to its corresponding noun (e.g., maison). Trials consisted of congruent (e.g., la maison) and incongruent (e.g., le maison*) determiner-noun pairs. Results show that simultaneous bilinguals are slower to respond than monolinguals (p=.03*). This result is thought to be reflective of the presence of more than one lexicon in the bilingual speaker. Due to the potential integration and activation of both lexicons, simultaneous speakers take longer to access and process the relevant information. Further, neither language group demonstrated facilitative processing from grammatical gender cues for either the feminine or masculine congruent conditions (p>.05). Interestingly, the monolingual group was quicker to respond in the incongruent masculine condition (e.g., la bateau*) in relation to the congruent masculine condition (e.g,. le bateau) (p=.018*). Feminine gender cues on the determiner in French may be strong enough to use with any noun regardless of the noun gender. The same pattern is not present in the congruent masculine condition, potentially due to French's 'default masculine' notion, resulting in the masculine determiner being used flexibly. The remaining results do not coincide with previous literature on anticipatory processing, as no gender congruency effect is seen. These findings may be reflective of the bilingual language environment speakers currently reside in, resulting in more flexible use of gender cues and/or less importance placed on utilizing gender cues. Additionally, the implemented behavioural methodology may not

accurately tap into the potential use of gender cues. Therefore, more sensitive measures, (e.g., Event-Related Potentials), are likely to provide further insight into the implicit processing involved in grammatical gender cuing in real-time.

Topic Area: Multilingualism

Poster E44 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Functional partitioning of sentence processing and emotional prosody in the right perisylvian cortex of perinatal stroke participants

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In most adults, ‘core’ language functions, such as sentence processing, are strongly lateralized to the left hemisphere (LH), while other language functions, such as vocal emotion detection (emotional prosody), are oppositely lateralized to the right hemisphere (RH). Indeed, a stroke impacting LH perisylvian regions in adulthood generally produces aphasia but not aprosodia, while a stroke to RH perisylvian regions produces aprosodia but not aphasia. In contrast, a stroke to LH perisylvian regions around the time of birth does not result in chronic aphasia in most cases: studies have shown that language abilities develop in the normal range and language functions that are typically left-lateralized instead recruit homotopic RH perisylvian regions. These findings raise an important question: How does the functional map of right perisylvian regions change to support both emotional prosody and typically left-lateralized language functions after a LH stroke early in development? In the current work we used task fMRI to examine how two processes that lateralize to parallel regions in opposite hemispheres of the healthy brain (sentence processing and emotional prosody processing) are organized in the intact RH of individuals who suffered a large LH stroke around the time of birth. In our recent work we have shown that that sentence processing becomes organized in precisely homotopic RH regions of individual left hemisphere perinatal stroke participants (LHPSPs) without apparent detriment to language or emotional prosody outcomes, and that these two functions appear to claim separate cortical territories in right perisylvian cortex. Here we investigated this finding further by asking about these outcomes in more precise quantitative detail. After a LH perinatal stroke, does sentence processing simply become reflected into RH frontotemporal regions and overlap with emotional prosody processing as one would expect with simple mirroring? Or do these functions overlap less than would be expected if that was the case? Thirteen perinatal stroke participants were included, all of whom suffered a large cortical stroke to the left middle cerebral artery. Eleven healthy controls were also included, who are siblings from the same families and roughly age-matched to the stroke participants. Participants completed an auditory description decision task and an emotional prosody decision task in the scanner. We employed a ‘top voxel’ analysis approach which allows us to compare the same number of the most active voxels between participants and between hemispheres to evaluate similarity in the spatial arrangements of activity. Independent samples t-tests revealed that the frontal and temporal areas recruited for these functions overlapped significantly less in the intact RH of LHPSPs compared to the overlap when LH sentence processing areas in controls were transposed into the RH and spatially compared (using a Dice Coefficient) with their emotional prosody areas. This result indicates that in the intact hemisphere of perinatal stroke participants, separation between the areas that perform sentence processing and the areas that perform emotional prosody processing may be important for these two functions to develop successfully. Our findings have important implications for how the cortical layouts for sentence processing and emotional prosody form during development.

Topic Area: Development

Poster E45 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam E session.

Intracranial neural dynamics of cognitive control in rapid word recognition.

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The ability to select important information from the environment and flexibly adapt this process based on behavioral goals is an essential feature of human cognition. Within human visual processing, flexible cognitive control enables rapid directed attention to salient stimuli. In a visually crowded environment, in a matter of milliseconds, humans are able to recognize a familiar face in a crowd of people or the words on a street sign. This process is hypothesized to involve a distributed top-down cognitive control network that modulates earlier bottom-up visual processing within the ventral visual stream. fMRI work has revealed that task-based attentional conditions can modulate category selective regions of ventral occipitotemporal cortex (vOTC), such as the visual word form area. In this study, we utilize the robust spatial and temporal resolution of intracranial EEG recordings to characterize the modulation of visual word regions in vOTC by changing task demands. Data was collected from 21 patients undergoing electrode implantation for seizure localization of intractable epilepsy. We utilized a rapid visual recognition task, with visual stimuli of different categories (Words, Faces, Scenes, Animals). For the same stimulus set, patients performed multiple tasks with varying cognitive demands: for example, tracking color changes of a fixation point, performing a one back task, or making semantic decisions (e.g., finding names of fruits).We used broadband gamma activity (BGA; 70-150 Hz) as an index of local neural activity. Within the vOTC, we isolated regions selective for words relative to other stimulus categories. Consistent with previous intracranial findings, this region extended much more anteriorly than the fMRI-derived visual word form area. Word selective regions of vOTC showed distinct scaling of BGA responses with selectivity increasing as attentional task demand increased, suggesting a task-driven recruitment of distinct cortical substrates. We quantified inter-areal dynamics within patients with concurrent vOTC and inferior frontal gyrus (IFG) coverage. The onset of peak BGA was earliest for vOTC relative to IFG across attentional conditions. Within IFG, we found a greater and more sustained increase in BGA in IFG for semantic trials in which words were selectively attended to. This suggests that distinct changes in local neural activity within word-selective regions of the vOTC are scaled by attentional task conditions. These findings point to a complex interplay beyond a bottom-up feedforward model of visual word form recognition, illustrating that attentional task demands and behavioral state play a critical modulatory top-down role in this process.

Topic Area: Reading

Poster E46 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Cerebellar role in lexical processing during continuous speech perception

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INTRODUCTION In the last few decades, research into the role of the cerebellum has expanded beyond motor functions, with specific subregions of the cerebellum—namely lobule VI and Crus I—implicated in higher cognitive functions that include language processing. One proposed function of the cerebellum in spoken language processing is in generating predictions about upcoming words from contextual cues (e.g., semantic and/or sentence context; Lesage et al., 2016; Moberget & Ivry, 2019). Generating accurate lexical predictions during spoken word recognition depends on word properties, such as lexical frequency and phonological neighborhood density, that affect both lexical access and selection. While words with higher lexical frequency have been shown to facilitate lexical access

(due to increased activation compared to low frequency words), lexical selection is thought to be impaired for words with higher phonological neighborhood densities, due to increased competition from words that are similar in sound properties. Although the cerebellum has been implicated in lexical processing more generally (e.g., Guediche et al., 2014; Lesage et al., 2016; Pleger & Timmann, 2018), remarkably little research to date has explored its sensitivities to these lexical properties while listening to natural, continuous speech. The current fMRI study is the first, to our knowledge, to independently examine the effects of lexical frequency and phonological neighborhood density on cerebellar activity during continuous speech perception. METHODS Seventy-nine participants passively listened to a 10-minute sample of an unaltered podcast during fMRI. We extracted the lexical frequency (SUBTLWFUS, Balota et al., 2007) and phonological neighborhood density (IPhOD, Vaden et al., 2009) for each content word. After implementing a standard preprocessing pipeline, subject-level analyses used an amplitude-modulated regressor, time-locked to the onset of each word, to model the lexical properties (i.e., lexical frequency and phonological neighborhood density) of the unfolding speech signal. The output allowed us to examine cerebellar activation scaled to our lexical regressors of interest. RESULTS and DISCUSSION At the group level, sensitivity to lexical frequency and phonological neighborhood density was localized to cerebellar regions Crus I and Crus II. We then used Diedrichsen et al.'s (2009) probabilistic atlas of the cerebellum to plot each participant's activation map. Overall, cerebellar sensitivity to lexical frequency and phonological neighborhood patterned in opposite directions. Across participants, we observed a positive correlation with lexical frequency that patterned with an extensive lexical-semantic cortical network (Binder et al., 2009) including the anterior temporal lobe, inferior frontal gyrus, and the tempo-parietal junction. Conversely, there was a negative correlation with phonological neighborhood density, which tracked with cortical regions sensitive to acoustic-phonetic information (i.e., superior temporal gyrus). These findings contribute to accumulating evidence that the cerebellum, specifically Crus I, is sensitive to factors that affect word recognition. The cerebellum has been implicated in prediction error learning, across multiple perceptual domains. Given that lexical information can be used to generate predictions about the incoming speech signal, the findings of the current study are consistent with a similar role for the cerebellum in spoken language processing.

Topic Area: Speech Perception

Poster E47 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*
This poster is also being presenting in the Poster Slam E session.

Development of the language network in the brain

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Adult language processing relies on a functionally-specialized left-lateralized fronto-temporal network (e.g., Fedorenko et al., 2011). How this network emerges over the course of development remains poorly understood. Although many prior studies have examined language processing in children (e.g., Blumenfeld et al., 2006; Wood et al., 2004; Friederici et al., 2011), most have relied on traditional group-averaging analyses (cf. Olulade et al., 2020), which assume voxel-wise correspondence across brains. Because the precise locations of functional areas differ across individuals, such analyses suffer from low sensitivity and functional resolution (Nieto-Castañón & Fedorenko, 2012) and may be especially problematic when comparing between age groups due to developmental changes in inter-individual variability. We use individual-subject fMRI analyses to investigate developmental differences in selectivity and lateralization of the language network. All participants (Children: N=171, 4-14 years, mean=10.9, SD=3.3; Adults: N=91, 19-45 years, mean=27.4, SD=5.5) were presented with a robust and extensively validated functional 'localizer' task (Fedorenko et al., 2010; Scott et al., 2017). During the task, participants listened to a language

condition (engaging passages) and an incomprehensible auditory control condition (acoustically degraded or backward speech). We defined functional regions of interest (fROIs) in each individual based on the language>control contrast. Using pre-existing 'masks' (six per hemisphere, covering lateral frontal and temporal cortex) derived from a large independent sample of adults performing a similar task, we defined individual fROIs as the top 10% of most localizer-responsive voxels within each mask based on half of the data. Response magnitudes for the two conditions were extracted from these fROIs using the other half of the data. Two primary findings emerged. First, a reliable language>control effect was observed in each left-hemisphere language region in adults and children, including the youngest children, in the 4-5 age range. This result suggests that by age 4, both temporal and frontal language areas support language comprehension. However, the size of the language>control effect in the frontal, but not temporal areas, showed a developmental increase, consistent with slower functional maturation of the frontal cortex (Fuster, 2002). Secondly, across all ages, the magnitude of the language>control effect was larger in the left hemisphere than the right hemisphere, and unlike Olulade et al. (2020) and others (Holland et al., 2007), the degree of lateralization was not modulated by age. This result suggests that by age 4, the language network is strongly left-lateralized, as in adult brains. These findings suggest that some aspects of the language network's architecture—including reliable responses to language in both temporal and frontal areas and left-hemisphere lateralization—are already in place by age 4, whereas other aspects—like the language-selective response in the frontal areas—continue to mature into mid/late childhood. Understanding whether/how these slower-maturing aspects affect linguistic and cognitive processing remains an important question for future work. Methodologically, this work establishes that functional localization is effective for identifying language-selective areas in children, and will likely confer similar benefits, relative to the traditional group-averaging approach, as it has in adult language processing research (e.g., Nieto-Castañón & Fedorenko, 2012; Gratton & Braga, 2021).

Topic Area: Development

Poster E48 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Experimental L2 Semantics/Pragmatics of Scalar Implicature: An ERP Study

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There have been a few studies investigating the processing of scalar implicature using ERPs. Noveck and Posada (2003) found a reduced N400 at the critical word such as 'ears' in underinformative sentences such as "Some cats have ears". Niewland et al. (2010) reported a greater N400 for the underinformative relative to the informative critical word. The present study examined Nineteen Korean English L2ers' comprehension of scalar implicature of English 'some' and 'no' to investigate whether they make a distinction between semantic and pragmatic interpretations. In our experiment we adopted a picture-sentence verification design (modelled after Politzer-Ahles et al. (2012)) to compare the neural responses to scalar quantifiers such as some and no. In the experiment 1, Some-type pictures with the four types of picture, (i) some apples in the basket, (ii) no apple in the basket, (iii) all apples in the basket, and (iv) some pineapples in the basket. The quantifier some was used in the experimental condition such as In the picture, being thrown into the basket by the boy was some candies. In the experiment 2, No-type pictures with the four types of picture, (i) no apple in the basket, (ii) some apples in the basket, (iii) all apples in the basket, or (iv) no banana in the basket. The quantifier no was used in the sentence such as In the picture, being thrown into the basket by the boy was no candy. ERPs were measured at the critical phrase (e.g., some candies or no candy). EXP 1 showed (i) a significant anterior P600 in No (semantic violation: SV) condition, (ii) a significant P200 in All (pragmatic violation: PV) condition, and (iii) a significant N400 in lexical violation (like 'some pineapples' in the picture) condition, relative to Some condition, respectively. EXP 2 showed (i) a significant N400 in Some (SV) condition, (ii) a marginal P700 in All (PV) condition, and (iii) a significant N400 in lexical violation (like 'no banana' in the picture) condition, relative to correct No condition, respectively. These findings suggest that semantic/pragmatic aspects of meaning are processed using different mechanisms, and that different quantifiers may make a distinct contribution in semantics/pragmatics.

Topic Area: Meaning: Lexical Semantics

Poster E49 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Dissociations in statistical word learning in aphasia

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Introduction: Statistical learning (SL) is a cognitive mechanism that supports the ability to parse unknown words from running speech and to acquire novel word-referent mappings in referentially ambiguous contexts by computing statistical patterns in the learning context. Here we assessed the functionality of these mechanisms in aphasia with SL tasks tapping phonological and lexical-semantic word acquisition by using a Bayesian method for the examination of dissociations in single-case studies. Methods: Participants were 24 healthy older adults (10 male, age: 60±11.63 years) and 3 participants with chronic post-stroke aphasia (PWA): P1 (male, 78 years, global aphasia), P2 (male, 42 years, mixed non-fluent aphasia), and P3 (male, 73 years, fluent aphasia). The PWA underwent language assessments including the BDAE III (Goodglass, Kaplan, & Barresi, 2005) to determine the presence of aphasia and aphasia severity and subtests of the TALSA battery (Martin et al., 2018) to evaluate verbal short-term memory. All participants completed a speech segmentation (SS) task (Peñaloza et al. 2015) tapping phonological learning, and a cross-situational learning (CSL) task (Peñaloza et al., 2017) examining lexical-semantic learning. In the SS task, participants were exposed to a spoken artificial language composed of four trisyllabic pseudowords and needed to learn the words by identifying word boundaries (i.e., computing transitional probabilities between adjacent syllables, higher between syllables within words and lower between syllables spanning word boundaries). They also completed a test that required discriminating words from nonwords. In the CSL task, participants needed to learn 9 pseudoword-novel referent pairs across 4 training blocks. In each trial, two objects of the training set were presented together with two spoken pseudowords, and the participants needed to figure out the correct associations between words and objects. The referential ambiguity of each learning trial (i.e., 4 possible word-referent associations) could be resolved by tracking the co-occurrence between words and objects across learning trials. Each training block was followed by a recognition test that required identifying the correct object associated to each trained word among four objects of the training set. Dissociations in word learning were assessed using the Bayesian Standardized Difference Test (Crawford & Garthwhite, 2007) by comparing the difference between each PWA's performance on task X and task Y relative to the differences of the control group performance on these tasks. Results: All PWA showed a putative classical dissociation between phonological and semantic word learning (all p values ≤.035), presenting deficits in CSL but not in SS relative to the control group average performance (task X: SS=.66±.14; task Y: CSL=.81±.20). Conclusion: All 3 PWA met criteria for a putative classical dissociation in novel word learning suggesting that relatively more automatic, phonologically based statistical word learning appears to be better preserved in PWA than the ability to discover word-referent associations in referentially complex contexts.

Topic Area: Disorders: Acquired

Poster E50 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

This poster is also being presenting in the Poster Slam E session.

Hemispheric asymmetries in the cortical myeloarchitecture parallel the functional lateralization of language

Tyler Perrachione[1], Ja Young Choi[2]; [1]Boston University, [2]Harvard University

Left-hemisphere dominance for language is the oldest and best-established example of functional specificity in the human brain. Even 150 years after the foundational discoveries of Broca and Wernicke, exactly why language

occupies primarily the left frontal and temporal lobes remains an enduring question. Asymmetries in gross morphological features like gray matter volume or cortical surface area remain distantly removed from the neuronal-level tissue properties that could explain hemispheric asymmetries in neural computations. Advances in structural MRI now allow better analysis of signals related to local tissue cytoarchitecture (Glasser & Van Essen, 2011), providing more proximal resolution on the microstructural differences that could inform this question. Here, we used structural and functional MRI scans from the Human Connectome Project (HCP) Young Adult 1200 Subjects dataset to measure (1) intracortical myelination, (2) cortical thickness, and (3) functional selectivity for language within each anatomical region of the Desikan-Killiany Atlas from FreeSurfer. Using T1- and T2-weighted anatomical volumes, we obtained the T1w/T2w ratio—a measure of tissue microstructure sensitive to local differences in intracortical myelination (Glasser & Van Essen, 2011). We measured cortical thickness from the T1-weighted volume. We used the HCP Language Processing fMRI task (Binder et al., 2011), which contrasts neural responses to auditory stories (Story condition) vs. auditory arithmetic problems (Math condition) to measure language selectivity, which we operationalized as the proportion of voxels within a region having greater Story vs. Math response among those with positive response to the Story condition. For each dependent measure, we computed its regional lateralization index (λ) as the difference between left and right hemisphere values divided by their sum: $\lambda=(L-R)/(L+R)$. Cortical myeloarchitecture asymmetries: We observed a striking anterior-posterior gradient in intracortical myelination. Frontal and temporal regions exhibited significant leftward lateralization, while parietal and occipital regions exhibited significant rightward lateralization. The most left-lateralized regions were IFG pars triangularis ($\lambda=0.041$), rostral MFG ($\lambda=0.039$), and IFG pars opercularis ($\lambda=0.038$) (all $p<<0.0001$). Temporal areas were also significantly left-lateralized: STG ($\lambda=0.022$); MTG ($\lambda=0.016$). The most right-lateralized regions included lingual ($\lambda=-0.033$), pericalcarine ($\lambda=-0.030$), and inferior parietal cortices ($\lambda=-0.030$). Language selectivity asymmetries: We found strong leftward asymmetries in language-selective responses, with the strongest in IFG pars opercularis ($\lambda=0.433$), caudal MFG ($\lambda=0.419$), and IFG pars triangularis ($\lambda=0.315$). Lateralization was significant but weaker in MTG ($\lambda=0.173$) and STG ($\lambda=0.042$), reflecting more bilateral organization of speech processing. Relationships between cortical myeloarchitecture and language selectivity: Five core language regions exhibited significant correspondences between individual subjects' language and myeloarchitectural asymmetries (controlling for age and sex; Holm-Bonferroni correction for multiple comparisons): STG ($\beta=0.173$, $p<0.0001$); IFG pars orbitalis ($\beta=0.121$, $p<0.0025$); IFG pars triangularis ($\beta=0.098$, $p<0.05$); IFG pars opercularis ($\beta=0.092$, $p<0.05$) and MTG ($\beta=0.088$, $p<0.05$). No such relationships for cortical thickness: Cortical thickness exhibited a subtle but significant pattern of predominantly rightward lateralization across the brain. However, there were no relationships between cortical thickness and language lateralization. Together, these results suggest that left-hemisphere dominance for language may be related to hemispheric asymmetries in the cytoarchitecture of core language regions—especially IFG and STG—favoring faster, intracortical myelin-dependent computational circuitry.

Topic Area: History of the Neurobiology of Language

Poster E51 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Functional flexibility in language networks

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Assessing the synchrony and interplay between distributed neural regions is critical to understanding how language is processed. Here, we investigated the architectural configuration of the language system using a novel multivariate network-based approach, which involved generalized psychophysiological interactions (gPPI toolbox; http://www.nitrc.org/projects/gppi, McLaren and others 2012) and graph-theory measures (i.e., (i.e., strength, clustering, node degree, hubness, betweeness centrality, and modularity). We implemented a sentence comprehension task with native Spanish language speakers, stressing the distinction between syntactic and semantic combinatorial processes. This paradigm manipulates formal – whether the noun-adjective gender relationship was congruent or incongruent – and semantic information – whether the noun refers to an animate (i.e., grammatical gender) or inanimate entity (i.e., conceptual gender) –. Specifically, we explored whether pre-defined ROIs show differential coupling with other brain regions depending on the critical experimental manipulations. Here a multiregional approach previously used by Cocchi and others (2013) was performed. This approach included 24 spherical seed regions that were built in MNI space. Each ROI was defined for each participant as the first eigenvariate of the time series of all active voxels within six mm radius spheres centered on the maximum peak of activation resulting from the group-level effect of the F-test contrast All conditions vs. Null ($p<0.05$ FWER corrected at the peak level). Given the 24 ROIs included in these analyses, 276 possible connections per subject and condition were generated. Our results demonstrate how the interface between form-based and conceptual features depends on the synergic articulation of brain areas divided into three subnetworks that extend beyond the classical left-lateralized perisylvian fronto-temporal language circuit. Subnetworks 1 and 2 comprised regions previously related with language functions (e.g., IFG, MTG, inferior parietal, supramarginal and angular gyri, and fusiform gyrus). However, subnetwork 3 included areas previously linked with general attentional control mechanisms (e.g., orbitofrontal, superior frontal gyrus, precuneus, and middle and anterior cingulate cortex). Despite this functional segregation, we found clear evidence for interactions between them. We isolated a left parietal cluster showing a significant interaction between gender congruency and gender type. The functional interplay between this cluster and the left perisylvian language-specific circuit proves crucial for constructing coherent and meaningful messages. Importantly, we show that this complex system is functionally malleable: graph features change depending on whether the linguistic input drives access to meaning through form-based or conceptual cues.

Topic Area: Meaning: Lexical Semantics

Poster E52 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Mechanisms underlying the interaction between language experience and cognition: A behavioral, electrophysiological, and neuroimaging approach

Somayya Saleemi[1], Shanna Kousaie[1]; [1]University of Ottawa

Bilingualism is increasingly studied in the context of health and development. Learning a second language is believed to strengthen executive function (EF), contribute to cognitive reserve and neural reserve, and serve as a protective factor against neurodegenerative disease. Bilingualism has been found to be related to neural activation in several brain regions associated with language processing and control (e.g., dorsolateral prefrontal cortex, inferior frontal gyrus), regions which are also involved in EF, including working memory (WM) and cognitive flexibility. However, the exact mechanisms underlying the interaction between language experience and cognition are unknown. In study 1 (behavioral pilot study), monolingual (ML) and bilingual (BL) young adults (YA) completed several executive function tasks, namely, the Stroop task (conflict monitoring and inhibition), the Simon task (stimulus-response conflict), and verbal and non-verbal versions of the n-back task (WM monitoring and updating). Participants also completed a comprehensive language questionnaire. Differences in the influence of language experience on verbal and non-verbal tasks were noted. Importantly, the behavioral data collected in this pilot study provided information about the suitability and feasibility of the tasks for use during electrophysiological recording and functional magnetic resonance imaging (fMRI), as well as identified appropriate language measures to include in a subsequent study. Study 2 is in the final stages of development, and based on recent recommendations in the literature, the sample will include 100 healthy YAs who vary in terms of language experience. In this study, a comprehensive language questionnaire will be administered to obtain detailed self-report information, including the timing and mode (e.g., informal vs. formal) of language learning, current patterns of language use, and language mixing/code-switching. The electroencephalography (EEG) and fMRI data collection will consist of resting-state and task-based recordings, using modified versions of the same task paradigms as study 1 that are optimized for each testing modality (e.g., a greater number of stimuli for EEG paradigms, additional baseline conditions and modified timing for fMRI paradigms). Event-related potentials (ERPs), with emphasis on the N2 and P3 ERP components, which have previously been investigated in relation to EF in BLs, will be examined in this study. (f)MRI data will also be examined to identify the underlying brain areas/networks that are related to language experience and EF. Each task will be investigated individually, and it is predicted that individual differences in language experience will be related to EF performance on non-verbal conditions that have higher EF demands or conflict. Furthermore, we expect to observe modulatory effects of language experience on the timing of EF processes, as measured by ERPs, and on neural recruitment in brain areas related to language and EF processing (e.g., dorsolateral prefrontal cortex, inferior frontal gyrus), as measured by fMRI. The ultimate goal is to identify the brain mechanisms underlying the interaction between language experience and cognition, and language experience related neuroplasticity.

Topic Area: Control, Selection, and Executive Processes

Poster E53 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Sentence predictability modulates the auditory N1 event-related potential component

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As spoken language unfolds over time, listeners must analyze a rapidly changing auditory signal, which varies in how predictable subsequent segments are. To accomplish this, multiple levels of linguistic analysis must be carried out simultaneously: Listeners accumulate predictions for upcoming segments based on higher-level information—such as sentence context—as they concurrently parse incoming acoustic information. The event-related potential (ERP) technique has been useful in elucidating some of the mechanisms supporting these processes. In particular, the auditory N1 is sensitive to differences in acoustic cues that signal phonetic differences, such as Voice Onset Time (VOT). Short VOTs (voiced sounds; e.g., /b,d,g/) yield a more negative N1, whereas long VOTs (voiceless sounds; e.g., /p,t,k/) yield a less negative N1. Prior work has shown that ambiguous acoustic cues (e.g., between /b/ and /p/) are susceptible to feedback from higher-level linguistic influences. An ambiguous cue occurring in a /b/-biasing context will yield a more negative N1, whereas that same cue in a /p/-biasing context will yield a less negative N1 (consistent with how these sounds are encoded). The present study seeks to better characterize the nature of this process during auditory sentence processing. To do this, we manipulated how well sentences predicted a sentence-final target word along two dimensions—cloze probability (how strongly a word is predicted) and entropy (how many other possible words could reasonably be expected)—and measured N1 responses to an acoustically ambiguous target word. Participants identified which phoneme the target word started with in a six-alternative forced-choice task (/b,d,g,p,t,k/). EEG data were collected using a 32-channel BrainVision actiCHamp, with electrodes placed according to the International 10-20 system. Data were recorded continuously, referenced online to the left mastoid and re-referenced offline to the average mastoid, and digitized at 500 Hz. Then, data were filtered from 0.1 to 30 Hz and epoched to the start of the sentence-final target word with a 200 ms baseline. If the influence of higher-level information on acoustic encoding is driven in part by the activation of specific lexical items, then cloze probability and entropy should modulate the strength and specificity of that activation, which in turn should affect the strength of feedback that influences the N1. Thus, we hypothesize that higher cloze probability or lower entropy would show a larger shift in mean N1 amplitude, according to the bias of the preceding sentence (i.e. whether a voiced or voiceless sound was expected). Preliminary results (N=22) show that sentence bias significantly shifts listeners' categorization of an ambiguous target word; this effect is significantly stronger for higher cloze probabilities. Moreover, sentence bias and entropy modulate listeners' reaction times when making this phoneme decision. Finally, ERP analyses indicate a significant main effect of cloze probability on N1 amplitude, but no effects of sentence bias or entropy. However, further data collection may be needed to detect such effects and their interactions. This work will help disentangle the influences of cloze probability, entropy, and sentence bias on acoustic encoding, and will give insight into the neural mechanisms supporting these dynamic interactions during speech perception.

Topic Area: Speech Perception

Poster E54 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Cortical (re-) organization of the language system through high intensity language training in chronic aphasia – what we can learn from intracranial recordings with single-neuron resolution

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We will present an early-stage project investigating cortical (re-) organization and potential behavioral rehabilitation of language in a post-stroke aphasic patient. Language training will be complemented by chronic multi-site intracortical recordings of electrophysiological neural signals (single unit activity and local field potentials) using the Utah multielectrode array. In particular, we will be probing the interactive two step model of speech production [1] by investigating neural correlates of phonological and phonetic encoding with regard to the precise time course of lexical selection, phoneme integration and control processes. We are planning to implant a total of four electrode arrays in distributed cortical regions of an individual patient's right frontoparietal language homologues to gain insights into the role of single neurons, their local circuits and long-range connections during language processing. The neuronal recordings will be carried out in multiple sessions per week while the patient is undergoing computerized and automated language training that includes productive and receptive tasks. This will allow us to correlate neurophysiological signals and behavioral performance with high spatiotemporal resolution. Following implantation, we plan to collect data for at least one year. The study will be conducted as a single-case, multiple baseline study. The recruited participant is a 51-year-old, right-handed, native German speaker who has suffered infarction of large parts of the left frontal, temporal and parietal lobe following a middle cerebral artery stroke in 2016. While the stroke acutely resulted in a global aphasia and severe apraxia of speech, the patient is now presenting with main symptoms of word-retrieval and -production deficits together with severe agrammatism. The patient's language comprehension abilities remain largely intact. Results of the study may inform the implementation of language processes on the cellular and microcircuit level. Beyond potential rehabilitative effects of the high-intensity language training that might be mirrored by a change in the response profiles and functional recruitment of different cell ensembles throughout the study, we are interested in the underlying neuronal mechanisms of successful and unsuccessful word production as well as word and sentence comprehension. Recent advances in intracranial multi-electrode technology for recording large-scale brain activity have mostly been applied in the fields of sensory-motor rehabilitation or substitution [2]– including speech [3] – while language or other cognitive functions remain under-researched. New innovative approaches are needed in the field of the neurobiology of language that allow for an investigation of language functions with higher temporal and spatial resolution than can be achieved by conventional, non-invasive methods such as EEG or fMRI. The described study is highly interdisciplinary and combines contributions from fields as diverse as systems and computational neuroscience, artificial intelligence, computational linguistics, ethics, and social sciences. [1] Foygel, D., & Dell, G. S., Journal of Memory and Language, 2000, 43(2), 182–216. [2] Hochberg, L. R. et al., Nature, 2006, 442(7099), 164–171. [3] Moses, D. A. et al., The New England Journal of Medicine, 2021, 385(3), 217–227.

Topic Area: Methods

Poster E55 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The more languages the merrier? Plurilinguals are distinct from bilinguals when it comes to cognitive control abilities

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In psycholinguistics, a thorny debate concerns the impact of individuals' language background on their cognitive abilities. Many studies (e.g., Bialystok et al., 2012) suggest that bilingualism could confer certain advantages for the brain's executive functions—particularly those related to 'cognitive control', the general ability to focus on goal-relevant information and filter out irrelevant details (Morton et al., 2011). The contested hypothesis is that these 'bilingual advantages' result from the regular shifting of language modes: according to context, bilinguals must alternately activate their appropriate language and suppress their irrelevant language. Under this perspective, it may be asked whether plurilinguals (i.e., speakers of two or more languages) display additional or enhanced cognitive advantages compared to bilinguals, as they must inhibit two or more languages simultaneously when activating another. Unfortunately, in studies investigating language-related cognitive advantages, plurilinguals are usually collapsed with bilinguals or outright excluded from the sample. As such, the current pilot project explored the data of participants rejected from an online experiment studying cognitive control among French-English bilinguals (Gosselin & Sabourin, in prep) as they possessed various third (or more) languages. We compared these 22 plurilinguals with 22 randomly selected bilinguals retained for the larger study. The groups were matched for age, education, video-gaming habits, age of exposure to English/French, current proficiency in English/French, percentage of time spent in unilingual-mode, and code-switching habits (all ps>.11). Participants completed two inhibitory control tasks: a non-linguistic Flanker task and a French-English bilingual adaptation of the linguistic Stroop task (see Sabourin & Vīnerte, 2015). Participants' cognitive control skills were operationalized by computing facilitation effects (i.e., difference between non-conflict and baseline trials), inhibition effects (i.e., difference between conflict and baseline trials) and global effects (i.e., overall reaction times for all trials) for both tasks. Between-group ANOVAs were conducted on each of these dependent variables. Plurilinguals had faster global reaction times on the Flanker task ($F(1, 41)=3.94$, $p=.054$), an advantage of a magnitude of 40.9ms. Descriptively, plurilinguals also displayed smaller inhibition effects than bilinguals (by a magnitude of 11.7ms), but this difference did not reach statistical significance ($F(1, 41)=2.12$, $p=.153$). In the Stroop task, there was a trend for plurilinguals to demonstrate larger facilitation effects ($F(1, 40)=2.75$, $p=.105$; magnitude of 27.4ms) and smaller inhibition effects ($F(1, 40)=2.67$, $p=.110$; magnitude of 39.4ms) for English items, but no such advantages for French items (facilitation: bilinguals=39.7ms, plurilinguals=-5.7ms; inhibition: bilinguals=-26.1ms, plurilinguals=-53.8ms). These preliminary results suggest that plurilinguals may possess domain-general monitoring advantages (i.e., a cognitive 'readiness' for all types of trials) relative to their bilingual counterparts; the findings also suggest that plurilinguals may experience better language-specific inhibitory control than bilinguals in at least one of their shared languages. Even though the plurilinguals in the current project possessed diverse language backgrounds, they differed sufficiently from bilinguals for the group to merit closer inspection in future research. A study is currently being initiated to recruit and further examine a more uniform set of plurilinguals. This will allow us to better establish how plurilinguals' performance compares to that of bilinguals in inhibitory control tasks.

Topic Area: Multilingualism

Poster E56 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Functional connectivity across the human subcortical auditory system using a Gaussian copula graphical model approach with partial correlations

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The central auditory system is comprised of multiple subcortical brain structures that sequentially process and refine incoming acoustic signals along the primary auditory pathway. Due to the technical limitations of imaging small structures deep inside the brain, most of our knowledge of the subcortical auditory system is based on research in animal models using invasive methodologies. While recent advances in ultra-high field functional magnetic resonance imaging (fMRI) have enabled novel investigations of the human subcortex non-invasively, optimal approaches to assessing functional activation and connectivity are still being developed. Traditionally, functional connectivity using fMRI data is estimated with simple correlation matrices. Partial correlations however reveal the connectivity between two regions after removing the effects of all other regions and hence are often more meaningful. Partial correlation analysis is particularly promising in the subcortical auditory system, where sensory information is passed serially from nucleus to nucleus up the primary auditory pathway, providing redundant but also increasingly abstract representations of auditory stimuli. In this project, we developed and implemented a Gaussian copula graphical model (GCGM) approach to estimate the partial correlations and thereby infer the functional connectivity patterns within the auditory system. Given the paucity of non-invasive methods for human subcortical investigations, we aim to unveil novel information about the hierarchy and direct connections throughout the human subcortical auditory system. Our results show strong positive partial correlations between contralateral structures throughout the auditory system, particularly in the auditory midbrain and thalamus. We also found positive partial correlations between successive structures in the auditory pathway on each side (left and right), including between auditory midbrain and thalamus, and between primary and associative auditory cortex. Further, we confirmed that these connectivity estimates were unique to the auditory system, as non-auditory regions included as controls—namely, visual cortex and superior frontal cortex—were strongly connected to their contralateral homologues but only minimally connected with auditory brain regions. Additionally, these results were highly stable when splitting the data in half and computing partial correlations separately for each half of the data. Overall, these results demonstrate that unique functional connectivity patterns along the auditory pathway are recoverable using novel connectivity approaches and that our connectivity methods are reliable across multiple acquisitions.

Topic Area: Perception: Auditory

Poster E57 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

A connectivity constrained analysis of the white matter correlates of taxonomic and thematic based naming errors

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Successful word production relies on retrieval of semantic concepts[1–3].which is supported by neurobiological networks of language[4,5] and semantic memory[6–9]. Damage to these overlapping networks results in semantic naming (word retrieval) deficits, e.g., ‘cat’ for ‘dog’. Semantic naming impairments following stroke-induced aphasia are associated with lesions in anterior temporal lobe (ATL), prefrontal cortex, and temporo-parietal junction[10,11] (TPJ). Schwartz and colleagues[12] examined lesion correlates of taxonomic (feature-based: ‘cat’ for ‘dog’) and thematic naming errors (association-based: ‘leash’ for ‘dog’) in a large left-hemisphere stroke sample (n=88) and found all participants made more taxonomic than thematic errors and that these errors were uniquely associated with the ATL and TPJ, respectively. The current study investigated the neural substrates of taxonomic and thematic errors, expanding on previous work in two novel ways. First, it used connectometry[13] to investigate the white-matter correlates of these error types, rather than their cortical substrates[12]. Second, it used Resnik scores[14] and Point Wise Mutual Information (PMI) methods to objectively and reproducibly classify taxonomic and thematic errors, rather than using human classification of these error types [12]. Methods: Data from twenty-nine out of a larger sample of 60 people with aphasia and unilateral left-hemisphere lesion have been analyzed to date (mean months post onset: 81.0; sd: 70.5). Participants’ aphasia severity ranged from severe to mild[15]. Naming responses were collected using the Philadelphia Naming Test[16]. Resnik[14] scores and PMI were estimated with the Natural Language Processing Toolkit[17] implemented in python with text corpora exceeding 1-million unique lemmas[18,19]. These scores were used to classify semantic naming errors as taxonomic vs. thematic: high Resnik and low PMI reflect taxonomic relations between target and naming error, whereas the opposite pattern is consistent with thematic relation between target and error. Deterministic connectometry[13] was used to derive nonparametric Spearman correlations between Quantitative Anisotropy (QA; the amount of anisotropic spins diffusing along fiber orientations[20]) and logit-transformed number of taxonomic and thematic errors. Results: A ratio of 2.4 to 1 taxonomic to thematic errors was observed across participants, with a significant difference between the mean number of taxonomic and thematic errors. Three participants produced more thematic than taxonomic errors. Connectometry analyses Taxonomic errors were associated with dorsal tracts including the L-Arcuate Fasciculus (AF), L-Fronto-Parietal cingulum (FPC) and ventral tracts including the L-Inferior (ILF) and L-Middle Longitudinal (MdLF) fasciculi, and the L/R-Inferior Frontal Occipital (IFOF) Thematic errors were associated with dorsal (L-AF, L/R-FPC) and ventral (L-ILF, L-MdLF, L-IFOF, and L-Extreme Capsule) tracts. Discussion: The present findings are partially consistent with those of Schwartz and colleagues[12]. First, we did not observe a one-way dissociation between taxonomic and thematic errors, with more taxonomic than thematic errors across all participants. Second, we found dorsal pathways (L-AF) terminating in the TPJ and ventral pathways terminating in the ATL (IFOF and ILF) that were associated with both taxonomic and thematic errors. We attribute these differences to the objective measurements utilized to identify taxonomic and thematic relations within this study. Additional analyses will determine whether these associations hold in the full sample of 60 participants.

Topic Area: Meaning: Lexical Semantics

Poster E58 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Morphology of the posterior superior temporal plane and language abilities in autism

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The posterior superior temporal plane exhibits remarkable structural variability across individuals. Morphological variability, particularly of Heschl's gyrus (HG) and planum temporale (PT), have been implicated in language and communication impairments. Such impairments often occur in autism spectrum disorder (ASD), as do structural differences in the superior temporal plane. However, the aspects of morphological variability in autism that are related to language skills in particular remain poorly understood. We investigated differences in superior temporal morphology between neurotypical and autistic children and their relationship to language skills in autism. Methods: We obtained T1-weighted whole-brain structural MRI scans from neurotypical (NT: N=69; age 5-18, mean=10.2 years; 34 female, 35 male) and autistic children (ASD: N=39, age 5-18, mean=11.3 years, 7 female, 32 male), which underwent the standard cortical reconstruction and parcellation pipeline in FreeSurfer. Cortical segmentations were automatically and manually inspected, then corrected for white- and pial-surface boundary errors. Patterns of HG duplication were identified based on virtual dissections revealing the 3D-reconstructed gray matter surface of the superior temporal plane and confirmed in the volume. Two independent labelers manually demarcated HG, HG2 (when present), and PT on the cortical surface following standard gyral and sulcal landmarks. Surface labels were transformed into the volume and masked by the cortical ribbon; boundary disagreements were resolved by consensus. Using these labels, we measured the gray matter volume, cortical surface area, and cortical thickness of each structure. We analyzed these for differences between groups and hemispheres, controlling for age, sex, nonverbal IQ (KBIT), and total cerebral volume. In the ASD group, we investigated relationships between these morphological measurements and communication skills based on CELF core language, digit span, SCQ communication, and ADOS calibrated severity scores. Results: The probability of HG duplication did not differ between groups, whether in both hemispheres or each separately (all $p>0.46$). There were no relationships between HG duplication and language ability or symptom severity in ASD. Both HG and PT were larger in ASD than NT, including gray matter volume (HG: 2.22cc/1.94cc, $p<0.006$; PT: 1.56cc/1.34cc, $p<0.025$) and cortical surface area (HG: 743mm^2/646mm^2, $p<0.0013$; PT: 598mm^2/499mm^2, $p<0.008$), but not cortical thickness (HG: 2.82mm/2.83mm, $p=0.89$; PT: 2.74mm/2.76mm, $p<0.60$). However, PT cortical thickness was significantly related to core language scores in ASD (p<0.002) (but not NT; p=0.69). PT cortical thickness in ASD was also related to digit span (p<0.006), SCQ communication (p<0.012), and ADOS calibrated severity (p<0.008). These relationships were not significant in HG. Discussion: HG duplication was unrelated to either ASD diagnosis or language ability. The sizes of both HG and PT were larger in ASD than NT (controlling for age, sex, IQ, and total cerebral volume), but the sizes of these structures were not related to language abilities in ASD. Instead, PT cortical thickness was related to several measures of language and communication abilities in ASD. These results suggest that, while exaggeration of primary and association auditory areas may occur in ASD, language abilities in this group are specifically related to differences in PT morphology that may reflect microstructural tissue differences in this area.

Topic Area: Disorders: Developmental

Poster E59 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Dissociation between structural and functional longitudinal changes in Primary Progressive Aphasia

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Introduction Primary Progressive Aphasia (PPA) is a neurodegenerative disease with prominent progressive left-lateralized gray matter atrophy. However, changes in functional and white-matter structural connectivity have been less investigated. Previously in a cross-sectional study, we reported that lower structural connectivity (SC) between homotopic regions was associated with elevated homotopic functional connectivity (FC) (Tao et al., 2022). Here with longitudinal data, we examined how white-matter structural and functional connectivity are affected by tDCS-augmented behavioral language treatment that occurred in the context of continuing gray matter degeneration. Methods Thirty-seven PPA participants (17 non-fluent, 14 logopenic, 6 semantic) were recruited for a clinical trial (NCT02606422) and received the same multi-week treatment protocol. They underwent MRI scanning at least 6 months apart, prior to and after treatment. For each participant and time-point, we calculated functional and structural connectivity measured by resting-state fMRI and DTI, as well as gray matter volumes with VBM analysis. Using the AAL atlas (Rolls et al., 2020), we calculated the functional and structural connectivity strength between 43 pairs of cortical homologous regions (i.e., homotopic FC and SC). Longitudinal changes between the two time-points were evaluated with paired t-tests. Results Consistent with our previous findings, at baseline, homotopic FC values were elevated while SC values were depressed relative to healthy controls in frontal regions. With regard to structural changes, we found evidence of continuing degeneration with significant decreases in gray matter volume in areas typically atrophic in PPA, as well as significantly decreased homotopic SC volumes concentrated in the medial frontal regions (FDR alpha<0.1). In contrast, homotopic FC showed evidence of normalization from baseline to follow-up (t=0.24, p=0.0233). Furthermore, the longitudinal FC and SC changes were not correlated (r=0.04, p=0.42). Conclusions Subsequent to tDCS-augment behavioral language intervention, we found normalization of homotopic functional connectivity that occurred along with behavioral improvement. The fact that the structural and functional homotopic connectivity changes were uncorrelated suggests that the functional changes reflect dynamic reorganization despite continuing structural decline. Factors underlying the functional connectivity changes (e.g., disease stage, treatment effect) in PPA will be discussed.

Topic Area: Disorders: Acquired

Poster E60 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The Effect of HD-tDCS and Phonological Component Analysis on Functional Connectivity and Behavior in People with Aphasia

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Introduction: Damage to the phonological system is common after left hemisphere stroke, resulting in difficulty retrieving correct sounds for speech production. Given prior evidence that left angular gyrus (AG) activation is associated with better oral reading performance in people with this deficit (Pillay et al., J Cogn Neurosci, 2018), we hypothesized that stimulation of the AG with transcranial direct current (tDCS) may promote reorganization of networks relevant to phonological retrieval. We coupled high-definition tDCS (HD-tDCS) with phonological component analysis (PCA) therapy, in which patients explicitly identify phonological features of a target word. We used resting state functional MRI (rs-fMRI) to test whether these treatments induce persisting changes in functional connectivity. Methods: Three patients with chronic left hemisphere stroke and phonological impairment received PCA therapy during either active anodal HD-tDCS to the left AG or sham/control tDCS for 10 days of therapy, then crossed over to the opposite stimulation arm. Patients were trained on reading and picture naming tasks using items they were reliably unable to name at baseline, then tested on trained and untrained items after therapy. RS-fMRI and language assessments were acquired pre-treatment, 10 weeks post-treatment cycle 1, and 10 weeks post-treatment cycle 2. The 20 minutes of rs-fMRI data from each session were denoised using ICA-AROMA. Pairwise connectivity was computed between Brainnetome atlas parcels comprising the left semantic (Lsem) and phonological (Lphon) networks and their right hemisphere homologs (Rsem and Rphon). Results: After AG HD-tDCS, patient 004 showed significant connectivity increases within the Lsem, Lphon, and Rphon networks. Connectivity within the Rsem network did not change, and connections between sem and phon networks became negative (inhibitory) in both hemispheres. Inter-hemisphere connectivity increased between Lsem and Rsem, and between Lphon and Rphon. After sham-tDCS, there were small connectivity increases in Lsem, Rsem, and Rphon networks, while connectivity reverted to baseline in Lphon, and sem-phon connectivity became less inhibitory. Inter-hemisphere connectivity decreased between left and right phon networks. The patient improved approximately 40% on untrained items. After AG HD-tDCS, patient 008 showed significantly decreased connectivity within Lphon and Rphon networks, and between sem and phon networks in both hemispheres. Inter-hemispheric connections, which were strongly inhibitory at baseline, became less inhibitory. After control-tDCS, most intra-hemisphere connectivity continued to decrease, while Lphon connectivity returned to baseline levels, and inter-hemispheric connections became even less inhibitory. The patient showed modest improvements to roughly 20% correct on untrained items after both treatment cycles. After AG HD-tDCS, patient 052 showed significant intra-hemisphere connectivity increases in all networks except Rphon. Inter-hemisphere connectivity increased between Lsem and Rsem. The patient showed modest improvements to roughly 10% correct on untrained items, but dropped out of the study prior to cross-over with control-tDCS. Conclusion: In these preliminary studies, fMRI connectivity showed long-lasting changes after PCA therapy combined with HD-tDCS. Inter-hemisphere connectivity increased in all patients, and all showed improved performance on untrained reading and picture naming items. A larger dataset is needed to identify correlations between behavioral and functional connectivity changes.

Topic Area: Disorders: Acquired

Poster E61 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

A Shared Representational Code for Object and Event Concepts

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Introduction: Functional neuroimaging studies have provided evidence that certain regions of the cerebral cortex are differentially activated by object and event concepts, but the mechanisms underlying these differences are still unknown. We hypothesized that these findings reflect systematic differences in the experiential content of these two categories of concepts. We tested this claim using representational similarity encoding of fMRI data, based on a 65-dimensional experiential model of conceptual content. We asked whether an encoding model trained to predict the similarity structure of the neural activation patterns elicited by object concepts would also predict the similarity structure of event concepts, and vice versa. Such a finding would provide strong evidence that both categories are represented by the same underlying experiential dimensions. Methods: Thirty-nine right-handed English speakers were shown 320 English words consisting of 40 items in each of 4 event subcategories (negative, social, verbal, nonverbal sound) and 40 items in each of 4 object subcategories (animal, food, tool, vehicle) using a fast event-related design during 3T fMRI. Each stimulus was presented 6 times across 3 sessions on separate days. Participants rated the familiarity of each word on a 1 to 3 scale. MRI data were preprocessed with the HCP pipeline. As a first step, a univariate contrast was performed between event and object conditions, incorporating numerous lexical variables as nuisance regressors, to identify distinct event and object networks of interest (NOI). A second general linear model with each word as a regressor was built to generate t-maps for each word. A neural representational dissimilarity matrix (RDM) for each category was computed for each NOI. We then trained an encoding model for each NOI to fit the 65-dimensional experiential model RDMs (one RDM per dimension) to either the object or event neural RDM, then tested whether the trained model predicted the neural RDM of the other category. Finally, in a separate vertex-wise encoding analysis, we used ridge regression to find the linear combination of experiential dimensions that best predicted the activation amplitude for event trials (160 words per dimension). The weighted model was then used to predict the average object activation amplitude for each vertex. The predicted object activation maps and event activation maps were then contrasted at the group level, using a one-sample t-test at each vertex, to generate a predicted event-object contrast map. The resulting t-map was visually compared with the observed t-map from the event-object univariate contrast. Results: Both encoding models significantly predicted the neural similarity structures across categories in both networks ($p <.0001$). The predicted t-map from the vertex-wise encoding analysis closely resembles the pattern observed in the original univariate contrast between event and object conditions. Discussion: These results indicate that object and event concepts rely on a shared representational code based on experiential information, suggesting that differences in neural activation between object and event concepts arise from quantitative differences in the experiential content of these concept categories.

Topic Area: Meaning: Lexical Semantics

Poster E62 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

In the Prime of Life: ERP Evidence for Syntactic Comprehension Priming in Older Adults

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Background : Syntactic priming is a sensitive tool to examine implicit sensitivity to syntax and syntactic adaptation without taxing declarative memory ability. Priming therefore has great potential to uncover age–related changes in syntactic processing. However, most syntactic priming studies with older adults have focused solely on priming in production, and none have included an electrophysiological component. This study explored the behavioural as well as the neural correlates of syntactic priming in older adults' comprehension, aiming to examine whether priming — and therefore, sensitivty to implicit syntactic adaptation — remains intact with age. Additionally, we aimed to contribute to the ongoing theoretical discussion surrounding the cognitive underpinnings of syntactic priming. Method : We used a self–paced reading and event-related potential paradigm with groups of older (n = 18, M Age = 69.6, SD Age = 4.01, range = [64,79]) and younger adults (n = 20, M Age = 21.4, SD Age = 2.28, range = [19,27]). Participants read reduced relative (RR) Targets (e.g. "The teenager criticised by the parents threw up a fit"). Targets could be Primed with a preceding RR structure, lexically Boosted by a preceding RR with a matching verb, or Unprimed by a grammatically unrelated structure, while reading times and EEG recordings were obtained. We additionally tested lexis–only overlap using a Lexical Control Condition (LCC) in which verbs from Primes were either repeated or unrepeated in Second Filler items. We expected to find facilitated reading times and attentuated P6 waveforms to the disambiguating “by” in Primed compared to Unprimed, and Boosted compared to Primed trials, as well as attentuated N4s to verbs in Boosted and repeated LCC trials. Results: Older and younger adults showed intact syntactic priming and lexical boost on reading times. However, older adults did not experience facilitation when only verbs were repeated in LCC items. P6 waveforms to “by” in RRs took a wide frontal distribution in older adults but were front–left centered in the younger group. P6 waveforms on “by” were more sensitive to priming conditions in younger compared to older adults. Additionally, a verbal P6 was evident in our data, and both groups showed attenuated verbal P6 waveforms in response to Primed and Boosted trials. No age differences were apparent on verbal P6 or N4 amplitudes in any time window. Conclusions: Our findings of intact behavioural priming in the presence of some by–group ERP differences suggest older adults’ syntax processing remains intact in part due to their recruitment of wider neural resources. Furthermore, while older adults showed intact lexical effects in when syntactic overlap was also present, there were no lexis–only overlap effects. This further aligns with past compensation–focused accounts of language processing in older age. Finally, our discovery of a frontal and verbal P6 suggests syntactic priming in comprehension may depend on different mechanisms compared to production, including recognition of verbs in the lexical boost, making a concrete contribution to literature on the cognitive basis of syntactic priming.

Topic Area: Development

Poster E63 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Neural pathways of phonological and semantic processing and its relations to children’s reading skills

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Reading is facilitated by three main interconnected systems: orthography, phonology, and semantics. Children’s phonological abilities are strongly associated with successful word reading skills whereas semantic knowledge is strongly related to reading comprehension. Neuroimaging research on the development of this triad typically focuses on connectivity analyses between the occipito-temporal cortex and regions in the temporo-parietal or inferior frontal cortex. Correlations between network connectivity and reading ability are commonly used to characterize differences in children with and without reading difficulties. Yet, little is known about skill differences in functional connectivity between the temporo-parietal and frontal cortex, areas often associated with representational versus control aspects of the network. This study examines if engagement of the dorsal pathway (i.e., dIFG to pSTG) during phonological processing is related to word reading skill, whereas engagement of the ventral pathway (i.e., vIFG to pMTG) during semantic processing is related to reading comprehension skill. We used functional magnetic resonance imaging (fMRI) and behavioral data from a publicly accessible dataset on OpenNeuro.org. The research questions, hypotheses, and analytical plan were pre-registered on the Open Science Framework. Forty-six children ages 8-15 years old were included in the final analyses. Participants completed two in-scanner reading tasks (word rhyming and word meaning) and two subtests of the WJ-III standardized assessment (letter-word identification and passage comprehension). In a series of registered and exploratory analyses, we correlated connectivity coefficients from generalized psychophysiological interactions (gPPI) with behavioral measures and used z-score to test the equality of two correlation coefficients. We observed small correlations of connectivity in the dIFG-pSTG pathway during phonological processing with word reading skill ($r = 0.04 - 0.22$) and with accuracy on the in-scanner word rhyming task (¬r = 0.16 - 0.19). There was little to no correlation of connectivity in the vIFG-pMTG pathway during semantic processing with reading comprehension skill ($r = -0.05 - -0.14$) or with accuracy on the in-scanner word meaning task ($r = 0.03 - 0.04$). In conclusion, results suggest that the engagement of the dorsal IFG to STG pathway for phonological processing is related to children’s word reading skills. There was no clear evidence to support the differentiation between the dorsal pathway’s relation to word reading and the ventral pathway’s relation to reading comprehension skills. We are

extending this research to children who are deaf or hard of hearing (DHH). We expect that predominantly oral DHH children may rely more on the dorsal phonological pathway, but bimodal children may rely more on the ventral semantic pathway for skilled reading.

Topic Area: Reading

Poster E64 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

A Simple Scale for Measuring the Lexical-Sublexical Speech Impairment Dissociation in Individuals with Aphasia

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The Walker et al. (2018) cognitive psychometric model of picture naming suggests that independent cognitive processes can be disproportionately challenged by different target words, opening the possibility to detect disproportionate impairments based on targeted assessments. Specifically, selection among lexical representations based on meaning can be challenged separately from the formulation and production of the sublexical speech segments that comprise words. Using response type data from 365 participants with left hemisphere stroke and aphasia who named 175 unique items, we created two 20-item lists that predominately challenged lexical or sublexical production processes, respectively. In a new group of 91 participants with left hemisphere stroke, we examined differences in accuracy between these lists to determine how much information can be gained about the neurocognitive locus of impairment, over and above what can be learned from overall naming accuracy. We examined four predictions: 1) There should exist participants who perform better on one test than the other and participants who exhibit the reverse pattern. 2) The difference between lexical and sublexical naming test scores should be directly related to the difference between the Word Finding and Repetition subscores of the Western Aphasia Battery. 3) Disproportionately sublexical naming impairment should indicate damage to dorsal speech motor regions of the brain; disproportionately lexical naming impairment should indicate sparing of dorsal speech motor regions. 4) Disproportionately sublexical naming impairment should indicate increased effort and associated increased fMRI activation of speech motor regions of the brain during naming; disproportionately lexical naming impairment should indicate increased effort and associated increased fMRI activation in ventral temporal lobe regions during naming. All predictions were confirmed to some extent, along with some novel findings. A Barnard's exact test ($p < .2$) identified 13 participants who performed significantly better on the lexical than the sublexical naming test and 10 participants with the reverse pattern. An interaction with overall severity was observed, with predominately sublexical impairment being associated with more severe overall impairment and predominately lexical impairment being associated with less severe overall impairment. The difference between naming test scores was correlated with the difference between WAB Word Finding and Repetition subscores ($r = .47$, $p = .0000026$). Participants with better Repetition subscores (>10%) performed better on sublexical naming ($p = .031$); participants with better Word Finding subscores (>10%) performed better on lexical naming ($p = .014$). Partial correlations predicting lesion load within each region of the AICHA atlas from the difference in naming test scores while controlling for external lesion volume revealed significant associations in left perisylvian and speech motor regions for predominately sublexical impairment and in left cingulate cortex for predominately lexical impairment. Partial correlations predicting fMRI activation during naming within each region of the AICHA atlas from the difference in naming test scores while controlling for overall naming accuracy revealed significant associations in bilateral speech motor regions for predominately sublexical impairment and in bilateral middle and inferior temporal cortex and the temporal poles for predominately lexical impairment. Implications for clinical assessment and neurobiological theories of language will be discussed.

Topic Area: Disorders: Acquired

Poster E65 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

‘Language regions’ are artifacts of averaging

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Neo-localizationist (e.g., ‘dual-stream’) models of the neurobiology of language suggest that a small number of anatomically fixed brain regions are responsible for language functioning. This observation derives from centuries of analyzing brain lesions causing aphasia and is supported by decades of neuroimaging studies. The latter rely on thresholded measures of central tendency applied to activity patterns resulting from heterogeneous stimuli and participants. We hypothesize that these methods obscure the whole brain distribution of regions supporting language processing. Specifically, we suggest that ‘language regions’ are input regions and connectivity hubs. The latter primarily coordinate other peripheral regions whose activity is highly variable, making them likely to be spatially averaged out when thresholding is applied. We conducted three analyses to provide support for this model. First, we did a ‘meta-meta-analysis’ to demonstrate that ‘language’ activates the same regions in neuroimaging studies. This consisted of 85 individual meta-analyses of language representations (e.g., phonemes, words, sentences) and associated processes (e.g., speech, semantics, syntax), derived from the brainmap.org (N=28) and neurosynth.org (N=57) databases. Each meta-analysis was thresholded at $p < .01$ FDR corrected for multiple comparisons using a minimum cluster size of 50 voxels and combined by count. Second, we developed a meta-analytic network connectivity hub metric. Specifically, degree centrality was calculated via 165,953 voxel-wise co-activation meta-analyses across 14,371 studies, thresholded at $p < .01$ FDR corrected and combined by count. The resulting map was converted to z-scores to identify hubs, using 3.5 standard deviations from the mean as a cutoff ($p < 0.0005$). Third, the neuroquery.org database was used to conduct meta-analyses of ‘verbs’ (N=662) and ‘nouns’ (N=889) to demonstrate that language is distributed across the whole when specific linguistic categories are not indiscriminately averaged over. The 45 meta-analyses that survived thresholding all roughly activated the same regions regardless of language representation or associated linguistic process, including the bilateral superior temporal gyrus (STG), posterior middle temporal gyrus (pMTG), and posterior inferior frontal gyrus (pIFG). There was surprising overlap between these same regions and those constituting highly central regions or hubs. Finally, verbs and nouns activated a whole brain distribution of activity, with verbs producing greater activity in pre- and primary motor, somatosensory, and visual motion regions whereas nouns produced greater visual and fusiform activity (among other regions; using z-scores greater than 3.72 or $p < .0001$). These results suggest that ‘language regions’ and ‘the language network’ are an artifact resulting from the indiscriminate averaging of heterogeneous word categories are linguistic processes. This is not to say these regions do not perform functions. Indeed, given that we have demonstrated that they are primarily highly central connectivity hubs (explaining why they are left over after averaging), one such role would be to coordinate the whole-brain distributions of regions necessary for processing the complexities of language in the real world. That ‘language regions’ are connectivity hubs also explains why they likely result in gross disorders like aphasia that also affect ‘nonverbal’ functioning.

Topic Area: History of the Neurobiology of Language

Poster E66 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Second Language Learning Related Structural White Matter Plasticity

Xuehu Wei[1], Helyne Adamson[1], Matthias Schwendemann[1], Tomás Goucha[1], Angela D. Friederici[1], Alfred Anwander; [1]Max Planck Institute for Human Cognitive and Brain Sciences

Introduction: Several studies have suggested that learning a second language (L2) in adulthood causes dynamic changes in the gray and white matter of the brain (e.g. Li et al., 2014, Cortex, 58, 301–324, Pliatsikas, C, 2020, Bilingualism, 23(2), 459–471). Changes related to lexical-semantic, phonological and syntactic L2-acquisition were found beyond the regions associated with native language processing with additional right-hemispheric involvement and changes in the interhemispheric communication. In this longitudinal study, we aimed to understand experience-dependent white matter plasticity during intensive second language learning in relation to the second language performance. Methods: 60 young healthy right-handed Arabic native speakers (mean age, 25.9 years; range, 19-34) were recruited for an intensive German course (5h/day, 5days/week) over a six-month period. After three and six months of language learning, we acquired high-resolution diffusion MRI. At the same time, each participant performed a standardized holistic second language proficiency test. Using probabilistic tractography, the structural connectivity between all language-related areas in both hemispheres were computed. We scaled language test scores from the two time-points to a common scale following the scaling method proposed by the Cambridge Test of English. We then assessed L2 proficiency using a Linear Mixed Effects (LME) model with language test scores at each time point as fixed effects. To localize the learning-induced connectivity change for specific subnetworks, we used Network-Based R-statistic LME models to test the relationship between brain network plasticity and L2-proficiency across the learning period (p-threshold = 0.01, K = 3000 permutations, Gracia-Tabuenca et al., 2020, bioRxiv, 11.07.373019). Results: We observed that L2 language proficiency showed significant improvement from three to six months. And the changes in L2 proficiency from three to six months were related to increased intra-hemispheric connectivity in several sub-networks known to be associated with lexical-semantic and phonological processing. These sub-networks include the bilateral parietal-temporal system and the right dorsal pathway between the inferior frontal gyrus and temporal regions. Additionally, we found a negative correlation between L2-proficiency and changes in interhemispheric connectivity via the anterior and posterior corpus callosum. Conclusions: The present study demonstrated that multiple white matter sub-networks show significant change during second language learning. The main effects were found in the lexical-semantic system in temporo-parietal regions of both hemispheres. This highlights a crucial role of the right hemisphere in second language learning. Additionally, we found a reduction in transcallosal connectivity, which might relate to a stronger specialization of both hemispheres for efficiently processing the newly acquired language. These findings demonstrate the experience-dependent structural plasticity in the human brain during second language learning, which is essential to better understand the interaction of environment, behavior, and language on shaping the human brain.

Topic Area: Multilingualism

Poster E67 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The role of the mirror mechanism in the perception of signing avatars' movements

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Recent research shows that deaf signers with early exposure to a signed language (SL) show increased behavioral and neural sensitivity to certain types of movement, such as biological motion, human actions, and signing avatars. Their early exposure to SL experience also interacts with the experience of being deaf, which may itself lead to improved understanding and perception of human movements. However, the neural mechanism behind these within- and cross-domain enhancements to human movement perception and understanding in deaf signers remain unclear. One possibility is that deaf signers' lifelong experience with an SL leads to changes in their ongoing and automatic predictive processing of movements during perception. The perception and understanding of human movement have been found to be mediated in part by the mirror mechanism, a neural function that recruits the sensorimotor cortices to understand others' actions. Research has shown that the experience of being deaf along with and early SL exposure lead to more negative behavioral responses toward uncanny signing avatars' movements. However, we do not yet known which neural mechanism leads to this increased sensitivity to uncanny signing movements. One possibility is the mirror mechanism, a sensorimotor mechanism that has been previously implied in the uncanny valley, perception, and understanding of human movement. We hypothesize that in deaf signers who had early exposure to SL, their perception of uncanny signing avatar's movement will lead to weaker automatic predictive processing by their mirror mechanism. To understand the effect of age of ASL exposure on deaf signers' perception of signed word movement, we created stimuli that vary in two ways. Four signers differ in their movements (familiar/unfamiliar signing movements) and form (human/avatar). Those four signers are ASL (American Sign Language) Human, German Sign Language Human, Motion Capture (Mocap) Avatar, and Computer Synthesized (CS) Avatar. Mocap Avatar and CS Avatar both are signing ASL words, but the familiarity of their signed word movement differs. Mocap Avatar is animated with familiar movement of a human signing, while the CS avatar produces unfamiliar signing movements through synthetic language production. Both Humans provide with a control for the appearance of human/ avatar form on the perception of familiar and unfamiliar movement, along with any possible non-signed differences such as body movements during signing. We plan to collect behavioral and EEG data from signers with an early exposure (N = ~25) and late exposure to ASL (N = ~25) as they watch individual signed words. To measure participants' familiarity with the signing movements, we will collect their rating of each signers' familiarity, comprehension, naturalness, and appearance before and after the EEG experiment. Prior research has shown that mu rhythm desynchronization is modulated by the sensorimotor activity and also familiarity during perception. We will conduct time-frequency analysis on theta (4 - 7 Hz), alpha (8 - 12 Hz), and beta (13 - 30 Hz) EEG oscillations within the first 2500 ms of stimuli. This pre-registered EEG study will examine whether early exposure to SL lead to delayed sensorimotor EEG rhythms during perception of uncanny signing avatars.

Topic Area: Signed Language and Gesture

Poster E68 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

When music is language: electroencephalography of a musical speech surrogate

Samantha Wray[1], Laura McPherson[1], Joseph Fausey[1], Mamadou Diabate[1], Yong Hoon Chung[1], Kevin Ortego[1], Viola Störmer[1]; [1]Dartmouth College

A speech surrogate encodes language into a non-speech modality for transmission. The most widely used globally and cross-linguistically is writing, but others, including musical surrogates utilizing instruments exist as well. These feature flutes, "talking drums", and many others (see Winter and McPherson (2022) for an overview). Experts in a speech surrogacy system can encode and decode messages using this unconventional modality. Despite the relatively well-understood relationship between literacy and language processing areas of cortex, the neural correlates of processing other speech surrogates are entirely unstudied due to the rarity of their practice. An exception is the Carreiras et al. (2005) fMRI study which found that fluent speakers of Silbo Gomero, a whistled speech surrogate from the Canary Islands which is non-musical and utilizes no instrument, recruited left hemisphere temporal lobe regions associated with language processing while listening to clips of whistled speech. The current study aims to start the research program investigating the processing of a musical surrogate of the Seenku language in Burkina Faso. Seenku can be encoded and played on a balafon: a West African xylophone constructed of resonator gourds beneath wooden keys struck by a mallet. This pilot experiment focused on a single subject who is an expert player of the balafon for speech surrogacy (N=1, male aged 49, right-handed). Four types of audio stimuli were included: (1) Seenku speech (2) balafon speech surrogacy (3) balafon "singing" (playing a melody with lyrics) (4) balafon playing devoid of any linguistic content. The Seenku speech condition was the most acoustically distinct to the naïve ear as it contained human speech, whereas the other three conditions contained sounds produced by the balafon. During EEG recording, the participant was positioned in front of a blank screen while auditory stimuli were randomly presented with a varying jitter for the interstimulus interval to prevent neural entrainment to the audio signal. The experiment duration totaled approximately 20 minutes. Data were recorded on a 32-channel BrainProducts system. Eye blink and other identifiable motor artefacts were removed manually. Epochs were selected from 200ms pre-stimulus to 800ms post-stimulus., and data were baseline corrected relative to the −200ms to 0ms pre-stimulus interval. Preliminary results comparing event-related potentials (ERP) associated with each stimulus type revealed that balafon playing music devoid of any linguistic content elicited strong frontal positivity, whereas the other three conditions elicited strong frontal negativity. Despite the Seenku speech condition being produced by a human speaker, these results suggest that for an expert, balafon speech is processed like human speech and not like balafon music. This effect held for multiple time windows analyzed: 100-200ms, 200-300ms and 300-400ms after stimulus onset. Additionally, single trial permutation analyses (threshold=0.01, FDR-corrected) of Fz underscored this frontal effect and showed between-condition results are significant in the 200-400ms time windows. Future work is planned to recruit additional expert balafon players in addition to two other participant types: expert musicians (without a speech surrogacy component), and those with no musical experience whatsoever.

Topic Area: Perception: Auditory

Poster E70 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Does Producing Language Induce More Prediction During Comprehension?

Yaqi Xu[1], Melissa Troyer[2], Rupali Limachya[3], Suzanne R. Jongman, Katrien Segaert[3], Kara D. Federmeier[2]; [1]UC Santa Cruz, [2]University of Illinois, Urbana-Champaign, [3]University of Birmingham

A growing body of literature shows that people engage in predictive behavior during ongoing language comprehension processes. Previous studies have shown facilitated word processing for predictable compared to unpredictable words as evidenced from online measures including reaction times, eye-tracking, and event-related brain potentials (ERPs). The current study aims to understand the effect of language production on prediction observed during sentence processing. Although there is an abundance of evidence supporting prediction while reading sentences, only a few studies have looked at production and comprehension together. In our blocked design study, we recorded EEG/ERPs while participants read sentences in one block (the comprehension block) and read sentences with a production task in another (the production block). In the production block, the critical last word was replaced with a line drawing and participants were required to name the picture out loud. In both blocks, the critical word/picture was one of three types: the expected ending (i.e., best completion), a within-category (i.e., related) anomaly, or a between-category anomaly. An example sentence would be: “They wanted to make the hotel look more like a tropical resort. So, along the driveway, they planted rows of …” For the example sentence, an expected word would be “palms,” which is the best fit given the sentence context. A related anomaly would be “pines,” which is considered to be in the same general category of “trees” and shares many similar features. A between-category anomaly would be “roses,” which is not a type of tree. These stimuli have previously been shown to elicit related-anomaly effects suggestive of predictive processing (Federmeier & Kutas, 1999; Federmeier & Kutas, 2001). Half of the participants completed the comprehension block first and the other half did the production block first. Our analysis focused on differences in the amplitude of the N400 component to critical words in the comprehension block. The N400 is a negative going waveform feature peaking around 400 ms after stimulus onset that has been associated with semantic processing. We compared the comprehension-first group to the production-first to investigate the possible influence of prior production on later comprehension trials. We hypothesized that if prediction and production mechanisms are linked, then we should observe relatively larger N400 prediction effects when participants had recently been producing language—i.e., a greater reduction in N400 amplitude to within-category words compared to between-category words in the production-first group compared to the comprehension-first group. Our preliminary results suggest that this is the case. Such a finding would support claims that neurobiological pathways involved in production are also active during prediction.

Topic Area: Meaning: Combinatorial Semantics

Poster E71 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

Subcortical Volume is Related to Early Learning of a Second Language

Yinan Xu[1], My V.H. Nguyen[1], Arturo E. Hernandez[1]; [1]University of Houston

The multilingual brain implements mechanisms that serve to select the appropriate language depending on the situational communicative environment. Engaging these mechanisms on a regular basis has been shown to have effects on structural adaptations of subcortical brain regions that are key for language control. Existing literature on bilingual-induced brain structural adaptations has found that volume in a variety of areas including the caudate nuclei, putamen, thalami, accumbens, as well as the cerebellum is linked to bilingual language experience. The current study used MRI data combined from 8 previous studies, consisting of 215 Spanish-English bilinguals and 145 English monolinguals. Language skills were assessed using several measures, including the Boston Naming Test (BNT; Goodglass et al., 1983) and/or the Woodcock-Muñoz Language Survey – Revised (WLS-R) picture vocabulary subtest along with either the passage comprehension subtest or listening comprehension subtest (Woodcock et al., 2010). A total measure of language skill was calculated as an average of proportion correct across different tests. Subcortical volume was compared between bilinguals and monolinguals, as well as correlated with language proficiency in all participants. Across the whole sample, English proficiency was positively related to subcortical volume in the right thalamus and the left nucleus accumbens after controlling for socioeconomic status (FDR corrected at $p < .05$). There was no difference between bilinguals and monolinguals in subcortical volume. Additional analyses were run within each group of participants. Notably, English proficiency, but not Spanish proficiency, and English age of acquisition positively correlated with the volume of the right thalamus and left nucleus accumbens in bilinguals; however, English proficiency was uncorrelated with subcortical volume in monolinguals. The results showed a combined effect of age of acquisition and English proficiency in volume adaptation in right thalamus and left nucleus accumbens in bilinguals. These findings are in line with existing literature on the dynamic volume adaptation of these brain regions on bilingual experiences. Studies have shown that the nucleus accumbens has been implicated in active language selection and processing (Deluca et al., 2019). In addition, the thalamus, connected with the Basal Ganglia via the dopaminergic system, was shown to be involved in language selection (Abutalebi & Green, 2016). It must be noted that the current study was unable to look at the separate effects of age of acquisition and English proficiency within our bilingual sample, as the two are highly correlated with each other and there was insufficient power to look at each effect separately. While the findings are intriguing, future studies are needed to better understand the unique contributions of AoA and proficiency on structure in these brain areas.

Topic Area: Multilingualism

Poster E72 *Saturday, October 8, 3:15 - 5:00 pm EDT, Millennium Hall*

The neurobiology of processing multiple emotional cues during language comprehension

Yi Jou (Winnie) Yeh[1], Mathilde Muraz, Natividad Beltran, Jeremy I Skipper; [1]Experimental Psychology, University College London, London, UK

Introduction How does the brain allow us to understand emotional language in the real world? We have some neurobiological understanding of how emotions portrayed through emotional prosody, facial emotional displays, and emotions conveyed through word meaning work in isolation, but we do not know how the brain uses these sources of information together. From a predictive processing framework, having multiple informative emotional cues should result in a reduction in activity in 'language regions' as the intended acoustic input can be more accurately predicted. Thus, we hypothesised the sensorimotor (e.g., auditory regions for emotional prosody) and 'theory of mind' related regions would be relatively engaged when processing individual emotional cues and that processing two or more cues (e.g., emotional faces, prosody, and semantics) would result in a reduction in activity in 'language regions'. Methods Thirty-eight healthy adult participants watched '500 Days of Summer' or 'Citizenfour' during fMRI. A separate set of participants rated sentences from these movies on arousal and valence for the video with the audio track removed (i.e., 'face'), an audio-only version of the sentences with flat prosody (i.e., 'semantics'), and a low-pass filtered incomprehensible version of the sentences (i.e., 'prosody'). Based on the ratings, sentences were grouped into eight categories for arousal and valence independently, where each cue was considered either emotionally informative or neutral (e.g., 'high-prosody, neutral-face, neutral-semantics' compared to 'high-prosody, high-face, high-semantics'). We used a general linear model, where each sentence category was convolved with a hemodynamic response function modulated by duration. A linear mixed-effects model was used to examine group-level effects. Results Results show that valence and arousal load more heavily on different systems, e.g., with valence activating more sensorimotor and precuneus regions and arousal more visual and auditory cortices. Individual valence cues also activated different brain regions, e.g., with more informative prosody loading more on auditory, faces on visual and motor regions, and semantics on somatosensory and superior temporal regions. Finally, there was an increase in activity in right lateral visual and premotor and bilateral precuneus regions for two or three compared to one informative emotional cue, with a large bilateral reduction in visual and superior and middle temporal regions. Conclusions Our results are consistent with a model of emotional language processing in which a distributed set of brain regions are dynamically engaged to process different emotional cues. The more informative emotional cues that are available, the more acoustic and linguistic input is predictable, resulting in a reduction of activity in what is often called 'language regions'. This seems to come at the cost of activating more sensorimotor regions, perhaps to simulate emotional displays in the voice and on the face, and 'theory of mind' related regions, perhaps needed to make more inferences about emotional states. These results provide the first neurobiological framework for understanding the processing of emotional language as it naturally occurs, i.e., in situations where multiple contextual cues can aid in interpretation.

Topic Area: Perception: Speech Perception and Audiovisual Integration

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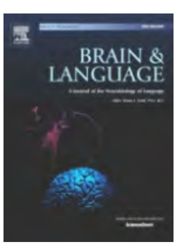

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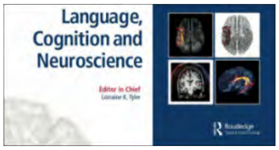

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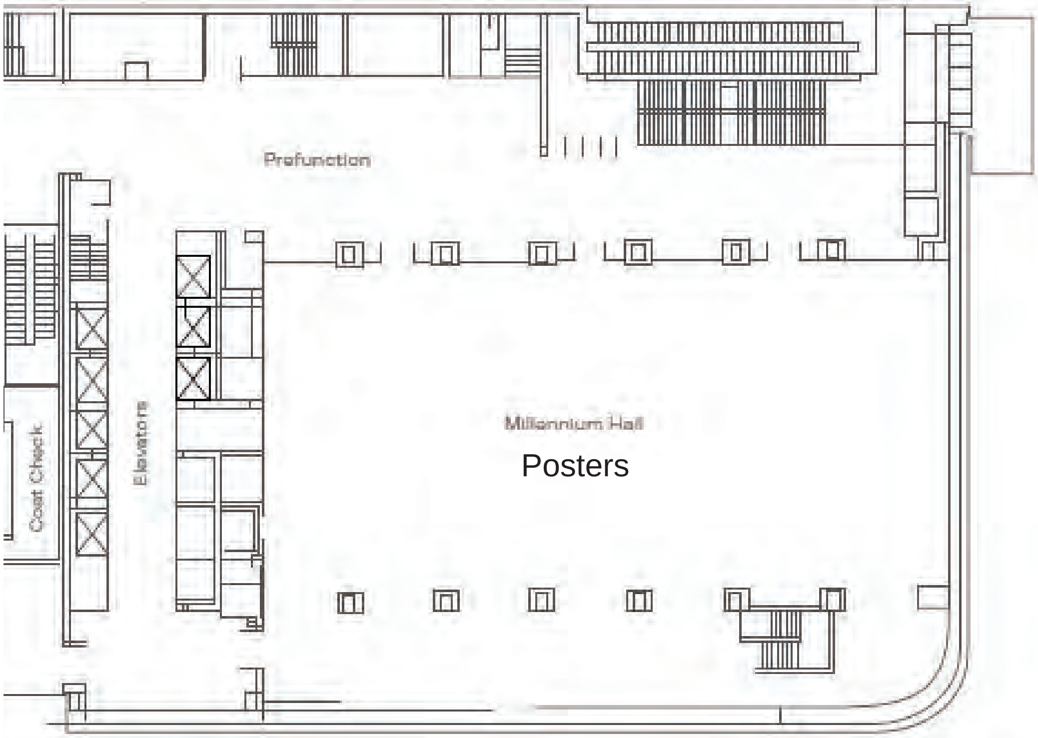

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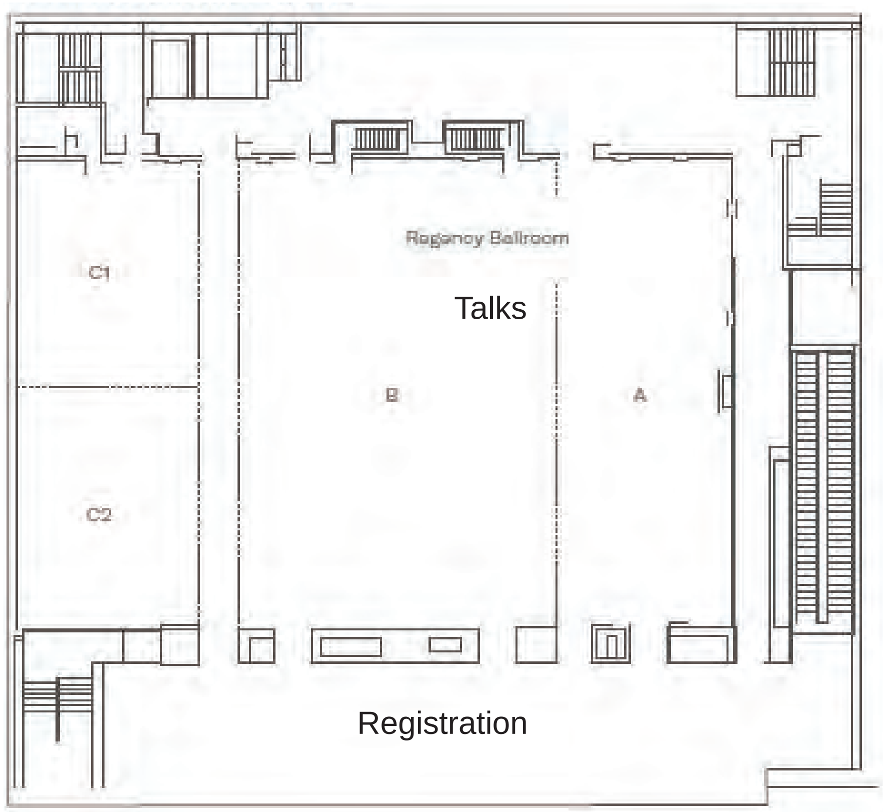

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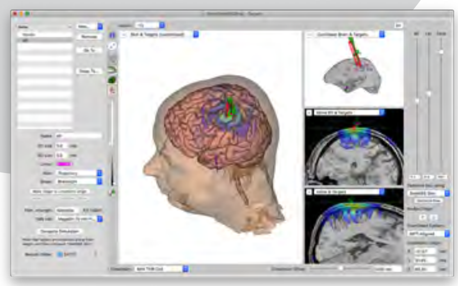

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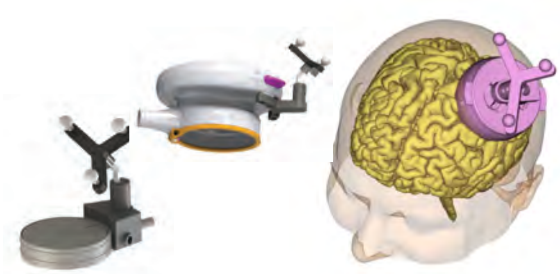

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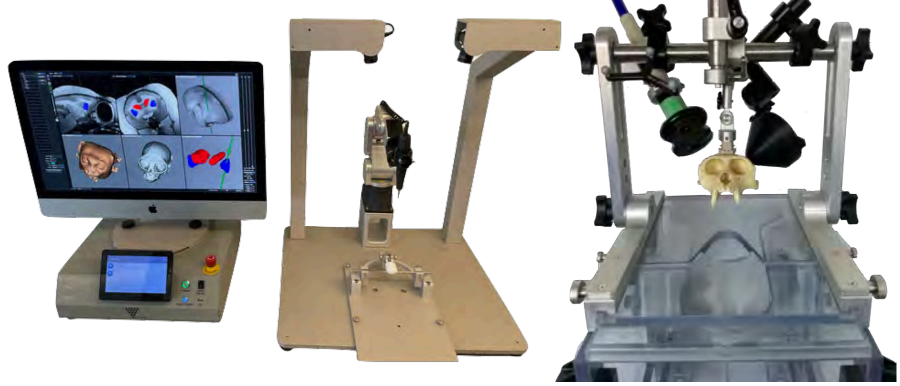

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