
CHSCOM2019
June 9 - 12 * Linköping * Sweden
Abstract book
Fifth International Conference on
Cognitive Hearing Science
for Communication
9–12 June 2019
Linköping, Sweden

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Welcome

It is an honour and a real pleasure for the scientific and organizing committees to welcome you to Linköping and the Fifth International Conference on Cognitive Hearing Science for Communication, CHSCOM2019. The conference series has contributed to establishing the field of Cognitive Hearing Science worldwide. We are delighted that leading scientists within this emerging field readily accepted our invitation to speak and we are overwhelmed by the quality of abstract submissions. We have a preconference programme which targets presentations by PhDs and young researchers in the field, three of whom are awarded sponsored scholarships. We are convinced that this year's conference will be a major success. The field of Cognitive Hearing Science has rapidly gained international recognition and is definitively here to stay.
We hope that you will enjoy CHSCOM2019.

Jerker Rönnberg
Chair of the Scientific Committee

Maria Hugo-Lindén
Chair of the Organizing Committee

Bengt Westerberg
Chair of the Swedish Institute for Disability Research

Scientific committee

Jerker Rönnberg, chair
Mary Rudner, co-chair

Anders Fridberger, Thomas Lunner and Stefan Stenfelt.

Organization committee

Maria Hugo-Lindén and Marie-Louise Mattsson.

Swedish Institute for Disability Research

The Swedish Institute for Disability Research (SIDR) was founded in 2000 in cooperation between the universities of Linköping and Örebro. Since 2012, Jönköping University is formally also a part of SIDR. Disability Research is an interdisciplinary subject and includes medical, technical, behavioural and cultural perspectives. In research and research training SIDR aims to pursue excellence, adopt the perspective of the individual, promote collaboration with user organisations and industry and promote development of the International Classification of Functioning (ICF). The SIDR graduate program is a leading European research program in Disability. 94 doctoral theses have already been successfully defended.
For further information about SIDR, please visit *www.ihv.se.*

Linnaeus Centre HEAD

In 2008, Linköping University received a major 10-year grant from the Swedish Research Council to create Linnaeus Centre HEAD (LCH). HEAD stands for HEaring And Deafness and thus indicates the field of research. Linnaeus Centre HEAD forms part of the Swedish Institute for Disability Research. The backbone of the centre is a multidisciplinary research team, comprising a core group of senior scientists, postdoctoral research fellows and national and international collaborators.
In 2017, the Swedish Research Council approved continued funding for the Linnaeus Centre HEAD, with special emphasis on age-related hearing loss and its relation to cognitive impairment and dementia. The work includes basic research aimed at finding new targets for treatment and define the cortical mechanisms that lead from hearing loss to dementia, clinical trials evaluating novel diagnostic techniques and personalized, targeted treatment of the inner ear, and technical research aimed at developing hearing aids that automatically sense user demands and adjust performance accordingly. For further information about LCH, please visit *www.headcentre.se.*

HEAD Graduate School

HEAD Graduate School is part of the Swedish Institute for Disability Research and affiliated with Linnaeus Centre HEAD. It promotes excellent research training and is open to doctoral students whose projects fall within the broad field of hearing and deafness research. At present, 15 doctoral students are enrolled and a further 34 have graduated and are now alumni members.

SWEDISH INSTITUTE FOR DISABILITY RESEARCH
LINNAEUS CENTRE HEAD GRADUATE SCHOOL

Excellence in Cognitive Hearing Science

HEAD stands for HEaring And Deafness
this is the research focus of
Linnaeus Centre HEAD
and HEAD Graduate School.
Working for excellence in
Cognitive Hearing Science.

Preconference programme

Sunday, June 9

09.00 – 16.00 Registration (Marmorfoajén) and preconference, Linköping Konsert & Kongress.

09.00 – 09.30 Technical/practical information for preconference speakers (Musikalen).

09.55 – 10.00 Welcome to CHSCOM2019 preconference: **Mary Rudner** (Musikalen).

10.00 – 12.00 Preconference session 1. Moderators: **Elisabeth Ingo, Andreea Micula and Erik Marsja**

10.00 – 10.20 The interactions between hearing aids, cognition, and listening effort in adult binaural hearing aid users: a systematic review. **Katrien Kestens**

10.20 – 10.40 How Hard is Too Hard? Determinants of Processing Effort as a Function of Age, Hearing Acuity, and Sentence Complexity. **Nicole D. Ayasse**

10.40 – 11.00 What insights into pupil size during listening do various analysis techniques provide and how sensitive are they to task demands and luminance? **Patrycja Ksiazek**

11.00 – 11.20 COFFEE BREAK (Marmorfoajén)

11.20 – 11.40 Using Semantic and Morpho-Syntactic Context in Word Recognition: Better with age? **Tami Harel**

11.40 – 12.00 Test-retest reliability of audiometric assessment in adults with cognitive impairment. **Kate McClannahan**

12.00 – 13.00 LUNCH (Garden)

13.00 – 16.00 Preconference session 2. Moderators: **Elisabeth Ingo, Andreea Micula and Erik Marsja**

13.00 – 13.20 On phonemic processing and working memory in electric hearing. **Sridhar Srinivasan**

13.20 – 13.40 Cognitive Effects of Stimulation Pulse Rate in Older Cochlear Implant Users. **Cecilia Di Nardi**

13.40 – 14.00 Association of Brain Cortical Thickness with Speech in Noise Test and Attention in Elderly Subjects. **Simón San Martín**

14.00 – 14.20 COFFEE BREAK (Marmorfoajén)

14.20 – 14.40 Cingulate cortex atrophy is associated with cognitive impairment in patients with presbycusis and cochlear dysfunction. **Chama Belkhiria**

14.40 – 15.00 Hearing loss and cortical atrophy in older adults with (or at risk for) dementia: How strong is the relationship? **Nathalie Giroud**

15.00 – 16.00 COFFEE BREAK (Marmorfoajén)

Conference programme

Sunday, June 9

09.00 – 16.00 Registration (Marmorfoajén) and preconference (Musikalen), Linköping Konsert & Kongress.

16.00 – 16.05 Welcome to CHSCOM2019: **Bengt Westerberg**, Main moderator and chair of the Swedish Institute for Disability Research (Musikalen).

16.05 – 16.20 CHSCOM: A Catalyst for Cognitive Hearing Science Research **Judy R. Dubno**, Professor, Medical University of South Carolina.

16.20 – 16.25 General information CHSCOM2019: **Bengt Westerberg**, Main moderator.

16.25 – 16.45 Introduction to Cognitive Hearing Science: **Jerker Rönnberg**, Chair of the scientific committee and Director of Linnaeus Centre HEAD.

Introductory keynote

16.45 – 17.15 **Anu Sharma**. Cortical neuroplasticity in hearing loss.

17.30 – WELCOME RECEPTION (Marmorfoajén)

Monday, June 10

07.30 – 08.30 Technical/practical information for speakers (Musikalen).

08.30 – 08.35 Welcome and general information: **Bengt Westerberg**, Main moderator (Musikalen).

Theme: Cognition and communication under adverse conditions
Session moderator: **Jerker Rönnberg**

08.35 – 09.00 Keynote: **Barbara Shinn Cunningham.** How subclinical hearing loss can impact communicating in social setting.

09.00 – 09.20 Using Physiological Measures to Assess Distraction and Annoyance from Background Noise. **Alexander L. Francis**

09.20 – 09.40 Rapid time-locked lexical processing of attended but not of unattended continuous spee. **Christian Brodbeck**

09.40 – 10.00 Try harder! The influence of evaluative feedback on the pupil dilation response, saliva-cortisol, and saliva alpha-amylase levels during listening. **Adriana Zekveld**

10.00 – 10.30 COFFEE BREAK (Marmorfoajén)

10.30 – 10.50 The effect of monetary reward on listening effort as reflected by the pupil dilation response. **Thomas Koelewijn**

10.50 – 11.10 Quantifying inattentional deafness: Effects of cognitive load on pure-tone detection and just-noticeable differences. **Sven Mattys**

11.10 – 12.15 Poster session for posters with even numbers (Marmorfoajén).

12.15 – 13.15 LUNCH (Backstage)

13.15 – 13.35 Communication effort as an interactive system between inter-locutors: the effect of hearing loss and amplification. **Gitte Keidser**

13.35 – 13.55 Speech intelligibility in realistic virtual sound environments. **Torsten Dau**

Theme: Brain plasticity and development
Session moderator: **Thomas Lunner**

13.55 – 14.20 Keynote: **Andrej Kral.** Effective Connectivity Between Primary and Secondary Areas Depends on Sensory Experience.

14.20 – 14.50 COFFEE BREAK (Marmorfoajén)

14.50 – 15.10 Short Periods of Perinatal Acoustic Experience Change the Structure and Function of Auditory Cortex. **Stephen Lomber**

15.10 – 15.30 Brain reorganisation measured using functional near infrared spectroscopy can predict cochlear implant outcome. **Douglas Hartley**

15.30 – 15.50 Adaptive neural states and traits in the listening brain. **Jonas Obleser**

15.50 – 17.15 Poster session for posters with even numbers (Marmorfoajén).

18.30 – SWEDISH TRADITIONAL FESTIVITY – DINNER AND ENTERTAINMENT (Marmorfoajén/Backstage).

Tuesday, June 11

07.30 – 08.30 Technical/practical information for speakers (Musikalen).

08.30 – 08.35 Welcome and general information: **Bengt Westerberg**, Main moderator (Musikalen).

Theme: Brain plasticity and development
Session moderator: **Thomas Lunner**

08.35 – 08.55 Cognitive contributions to understanding acoustically challenging speech. **Jonathan Peelle**

08.55 – 09.15 Objectively measuring speech intelligibility: impact of individual participant factors. **Tom Francart**

09.15 – 09.35 Listening and learning difficulties in children. **Dave Moore**

09.35 – 09.55 Over-representation of speech in older adults originates from early and late responses in auditory cortex. **Jonathan Z. Simon**

09.55 – 10.25 COFFEE BREAK (Marmorfoajén)

10.25 – 10.45 Selective and Distributed Attention to Speech: Depth of Processing and Individual Differences. **Elana Zion Golumbic**

10.45 – 11.10 Keynote: **Karen Emmorey.** The plasticity of the reading circuit in deaf adults.

11.10 – 12.15 Poster session for posters with odd numbers (Marmorfoajén).

12.15 – 13.15 LUNCH (Backstage)

Theme: Translational cognitive hearing science
Session moderator: **Mary Rudner**

13.15 – 13.40 Keynote: **Harvey Dillon.** Listening difficulties can be caused by deficits in auditory processing, speech processing, cognition and language.

13.40 – 14.00 Measuring listening effort: pitfalls, pertinence & potential. **Helen Willis**

14.00 – 14.20 A new patient-reported outcome measure of listening effort: Development and preliminary testing of the Listening Effort Questionnaire (LEQ-CI). **Sarah Hughes**

14.20 – 14.50 COFFEE BREAK (Marmorfoajén)

14.50 – 15.10 Exploring the self-regulatory behavior of elementary students with hearing loss in inclusive classrooms: Helping children & teachers. **Sheila Moodie**

15.10 – 15.30 Practice Listening and Understanding Speech (PLUS): Two novel auditory-cognitive training programs for people with hearing loss. **Antje Heinrich**

15.30 – 15.55 Keynote: **Simon Carlile.** Attention switching and multi-talker listening in normally hearing and hearing impaired listeners.

15.55 – 16.20 Keynote: **Frank Lin.** Hearing loss, aging, and dementia – from epidemiologic insights to the ACHIEVE trial.

16.20 – 17.15 Poster session for posters with odd numbers (Marmorfoajén).

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19.00 – CONFERENCE DINNER – ENTERTAINMENT (Garden)

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07.30 – 08.30 Technical/practical information for speakers (Musikalen).

08.30 – 08.35 Welcome and general information: **Bengt Westerberg**, Main moderator (Musikalen).

Theme: Hearing loss, cognition, aging and dementia
Session moderator: **Stefan Stenfelt**

08.35 – 09.00 Keynote: **Natalie Phillips**. Hearing, cognition, and brain structure: Initial findings from the COMPASS-ND study.

09.00 – 09.20 Working memory for signs with poor visual resolution. **Mary Rudner**

09.20 – 09.40 Hearing and vision impairment and mental well-being in older age. **Piers Dawes**

09.40 – 10.00 The relationship between age-related hearing loss, working memory and cognition. **Stephanie Rosemann**

10.00 – 10.30 COFFEE BREAK (Marmorfoajén)

10.30 – 10.50 The Melody and Timing of Speech: How younger and older adults use sentence prosody to balance comprehension and effort. **Art Wingfield**

10.50 – 11.10 Auditory-Cognitive Links and Social Psychological Factors in Aging Well. **Kathy Pichora-Fuller**

11.10 – 11.30 The impact of aging and hearing loss on the production and perception of clear speech adaptations in challenging communicative conditions. **Valerie Hazan**

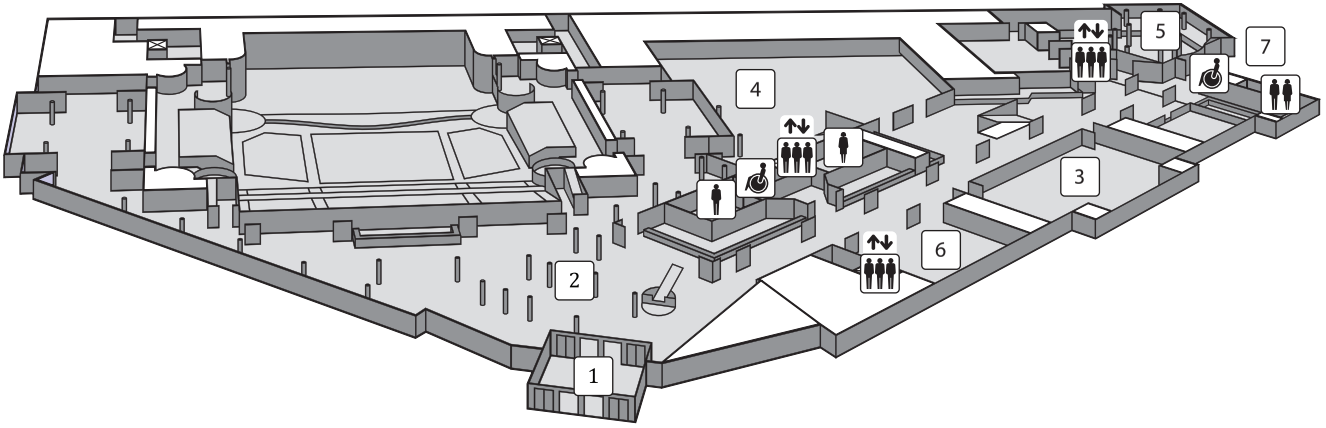
11.30 – 11.50 Thanks and summary: **Bengt Westerberg, Jerker Rönnberg and Anders Fridberger**

11.50 LUNCH-TO-GO (Marmorfoajén)

Welcome back in 2021!

Sixth International Conference on Cognitive Hearing Science for Communication

13–16 June 2021
Linköping, Sweden



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5 Backstage
6 Galleri K
7 Entrance

Abstracts

Preconference

The interactions between hearing aids, cognition, and listening effort in adult binaural hearing aid users: a systematic review

Katrien Kestens[1]
Sofie Degeest[1], Hannah Keppler[1, 2]

[1]Department of Rehabilitation Sciences, Ghent University, Belgium
[2]Department of Oto-rhino-laryngology, Ghent University Hospital, Belgium

Objectives: Hearing aids (HAs) are the primary rehabilitation devices to compensate for presbyacusis, though different results regarding aided performances are documented. Recently, more attention is directed to the contribution of cognition during speech understanding. Therefore, the purpose of this systematic review was to investigate the relationship between hearing aids, cognition, and listening effort.
Methods: Articles were selected through systematic searches in MEDLINE, EMBASE, CENTRAL, and reference lists in March and October 2018. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed.
Results: The initial search resulted in 1092 unique hits, of which 32 were included. Within these studies, the influence of HAs on cognition and listening effort was investigated. Besides, it was examined how cognition may influence the aided speech benefit as well as the amount of listening effort in an aided listening condition. However, a large variation in obtained results were observed.
Conclusion: The existing literature regarding the interactions between HAs, cognition, and listening effort is limited and showed variable results. Hence, it is not possible to define general statements about any of these interactions. Further research regarding aided speech recognition from an auditory-cognitive perspective is essential for optimizing the HA-benefit.

How hard is too hard? Determinants of processing effort as a function of age, hearing acuity, and sentence complexity

Nicole D. Ayasse[1]
Arthur Wingfield[1]

[1]Volen National Center for Complex Systems, Brandeis University, USA

Although much of the psycholinguistic literature has focused on listeners conducting a full syntactic analysis to obtain sentence meaning, a close reading of the ELU model (Rönnberg et al., 2013) raises the possibility that under some circumstances listeners may show a more flexible strategy. One such strategy may be a "gist" approach, in which listeners use key words and plausibility to determine a sentence meaning. We report a study to test the hypothesis that listeners conduct a full syntactic analysis only when the meaning of a sentence is relatively straightforward, and spontaneously shift to a gist algorithm for sentences that have complex linguistic structures. In such cases plausibility will predominate over the literal meaning of a sentence. Young adults and older adults with normal or impaired hearing listened to recorded sentences that varied in both syntactic complexity and plausibility while pupil size was tracked in real time as an index of processing effort. Comprehension was probed after hearing each sentence. A comparison of pupil dilation accompanying correct versus incorrect trials supported the postulate that listeners target an adaptive balance between the accuracy and effort that is sensitive to age, hearing acuity, and the nature of the speech content.

What insights into pupil size during listening do various analysis techniques provide and how sensitive are they to task demands and luminance?

Patrycja Ksiazek[1, 2]
Adriana A. Zekveld[1], Dorothea Wendt[2, 3],
Thomas Lunner[2, 3, 4], Sophia E. Kramer[1]

[1]Amsterdam UMC, Vrije Universiteit Amsterdam, Otolaryngology – Head and Neck surgery, Ear & Hearing, Amsterdam Public Health research institute, the Netherlands
[2]Eriksholm Research Centre, Snekkersten, Denmark
[3]Department of Health Technology, Technical University of Denmark, Denmark
[4]Linnaeus Centre HEAD, Linköping University, Sweden

Listening effort is a specific form of mental effort that occurs when a task involves listening as defined in the Framework for Understanding Effortful Listening (FUEL). The pupil dilation response is sensitive to listening effort during listening to speech in noise, it is sensitive to task demands and monetary reward. Different analysis techniques of pupil data have been proposed in the literature to provide comprehensive indicators of effort.

In this study, we assessed and compared the sensitivity of several proposed analysis techniques to auditory task demands and luminance. The techniques were applied to two independent datasets containing pupil data from normal-hearing participants recorded during Speech Reception Threshold (SRT) tests. The first dataset was recorded during an SRT with stimuli at fixed Signal-to-Noise (SNR) ratios (Ohlenforst et al. 2017). The second dataset was based on an adaptive SRT test that was performed in two luminance levels (Wang et al. 2018). Data were analysed using several techniques, including calculation of the Index of Pupillary Activity measuring pupillary oscillations and Principal Component Analysis revealing independent time components in the signal.

The results indicate that applied analyses techniques provide parameters differentially sensitive to task demand and luminance.

Using semantic and morpho-syntactic context in word recognition: better with age?

Tami Harel[1, 2]
Yuval Palgi[1], Boaz M. Ben David[2]

[1]Department of Gerontology, University of Haifa, Israel
[2]Baruch Ivcher School of Psychology, Interdisciplinary Center (IDC) Herzliya, Israel

Aging has a detrimental effect on speech perception. Sensory degradation and cognitive changes pose challenges as older adults engage in conversations. Fortunately, preserved linguistic knowledge and accumulated experience with language enables prediction of upcoming words in speech, thus facilitating speech perception. Semantic information (carried by the meaning of the words in the sentence) and morpho-syntactic limitations (conveyed for example by verb-noun agreement in gender and number) are two of the main cues available to listeners. The relative contribution of these different types of cues during speech perception in aging is not yet clear. In our study, we use eye tracking to discover the efficiency with which listeners are using context to predict upcoming language input. In an adaptation of the "visual world" eye-tracking paradigm, listeners hear a sentence related to one of four pictograms presented on a visual display. Recording eye movements can indicate the timeline for discriminating target from semantics-sharing or gender-sharing competitors, as the sentence unfolds in time. Preliminary data will be presented. Results shed light on the role of different kinds of lexical information used for prediction of upcoming words in speech across the life span.

Test-retest reliability of audiometric assessment in adults with cognitive impairment

Kate McClannahan[1]
Yi-Fang Chiu[2], Mitchell Sommers[1], Jonathan Peelle[3]

[1]Washington University in St. Louis, Department of Psychological and Brain Sciences, USA
[2]St. Louis University, Department of Communication Sciences and Disorders, USA
[3]Washington University in St. Louis, Department of Otolaryngology, USA

Previous research suggests that hearing loss may be a risk factor for development of dementia in older adults. The majority of studies reporting this relationship have compared peripheral auditory function measures (pure tone thresholds) to clinical diagnoses or scores on cognitive tests (e.g. Mini Mental Status Exam). However, to our knowledge, the reliability of the standard audiometric evaluation process in older adults with cognitive impairment has not been systematically examined. In this study, we determined the test-retest reliability of a typical audiometric evaluation in groups of older adults with and without clinical dementia diagnosis in collaboration with the Knight Alzheimer's Disease Research Center. We prioritized the order of the audiometric assessment to establish hearing abilities across the speech frequencies for each ear. We also included objective measures of auditory function (impedance measures and distortion product otoacoustic emissions) for comparison with behavioral information. Preliminary results indicate good test-retest reliability for all measures. Findings from this study will provide a model for how to modify standard audiologic assessment for older adults with impaired cognitive function.

On phonemic processing and working memory in electric hearing

Sridhar Srinivasan[1]
Piotr Majdak[1]

[1]Acoustics Research Institute, Austrian Academy of Sciences, Austria

Memory for speech sounds is a key component of working-memory models. Current working-memory theories incorporate phonological storage of auditory stimuli in which the content is thought to be maintained via articulatory rehearsal and attentional refreshing. Many studies report that even though encoding of speech sounds is affected by abstracted, categorical representations, continuous acoustic detail is also preserved, depending on other concurrent demands on working memory. While normal-hearing (NH) listeners rely primarily on formant spectral cues of vowel sounds, in cochlear-implant (CI) listeners, these cues are degraded forcing these listeners to more strongly rely on temporal cues. It is, however, not clear how individual-specific representations of speech stimuli account for CI listeners' auditory working memory capacity and precision. We will present data from CI and NH listeners performing perception and working memory tasks using pseudo-continuous vowel-like stimuli. The results will be discussed in the context of current models of auditory working memory, considering differences in stimulus representation arising from differential availability of acoustic features to the two listener populations.

Cognitive effects of stimulation pulse rate in older cochlear implant users

Cecilia Di Nardi[1, 2]
Cristina Simoes-Franklin[2], Jaclyn Smith[2], Niall Pender[3], Renata Filippini[2], Piumi Chathurika Kosgallana[2], Laura Viani[2, 4]

[1]School of Postgraduates Studies & Research, RCSI, Ireland
[2]The National Hearing Implant & Viani Research Centre, Beaumont Hospital, Ireland
[3]Department of Psychology, Beaumont Hospital, Ireland
[4]Royal College of Surgeons in Ireland, Ireland

Hearing loss is recognised as a major contributor of cognitive decline in the elderly. Cochlear implants (CIs) suboptimal settings can result in increased listening effort (LE) and reduced cognitive function. Given the slower processing speed of the ageing brain, we hypothesize that older CI users may benefit from slower stimulation rates (SRs).
The aim of our study is to investigate electrophysiological correlates of LE in older CI users by means of an n-back bimodal task.
Thirteen older adults with CochlearTM devices with a SR of 900 pulses per second (pps) are enrolled in this study. Over a 3-months period, participants are asked to try two new MAPs (high-SR and low-SR; order counterbalanced across participants). For each SR setting, participants complete an electroencephalographic recording while performing a bimodal task that evaluates cross modal effects of LE and a battery of cognitive and speech discrimination tests.
Preliminary results indicated that low-SR participants show decreased perceived LE and improved short-term memory. Cross-modal effects of LE were also observed for P200 thought to be involved higher-order perceptual processing.
This study combining functional outcomes, subjective and objective measures is one of the most comprehensive at evaluating the effects of SR in older CI users.

Association of brain cortical thickness with speech in noise test and attention in elderly subjects

Simón San Martín[1]
Chama Belkhiria[1], Mariela Torrente[2], Alexis Leiva[1],
Carolina Delgado[1, 3], Paul H. Delano[1, 2, 4, 5]

[1]Neuroscience Department, Faculty of Medicine, University of Chile, Chile
[2]Otolaryngology Department, University of Chile Clinical Hospital, Chile
[3]Neurology and Neurosurgery Department, University of Chile Clinical Hospital, Chile
[4]Biomedical Neuroscience Institute, BNI. Faculty of Medicine, University of Chile, Chile
[5]Advanced Center for Electrical and Electronic Engineering, AC3E,
Federico Santa María Technical University, Chile

Introduction: Challenging auditory tasks may lead to cognitive effort and mental fatigue. During aging, preserved cortical brain structures like attentional and cingulo-opercular network areas could be important for successful accomplishment of both auditory and cognitive tasks. Our objective was to explore the relationship between brain cortical thickness, speech in noise processing and attentional performance in a group of elders. Materials and methods: Eighty subjects between 65-85 years old with normal hearing or symmetrical unaided hearing loss and no history of neurological or psychiatric disease, went all through 3-Tesla MRI, neuropsychological tests and a spanish version of Speech-in-Noise test. Freesurfer (surface-based morphometry) and SPSS statistical software were used. This project was approved by the institutional ethics committee. Results: We found a positive correlation between right ear speech-in-noise and left superior temporal gyrus thickness (rho=0.419, $p<0.001$), right superior temporal gyrus thickness (rho=0.406, $p<0.001$), right pars orbitalis thickness (rho=0.381, $p<0.001$), and right insula thickness (rho=0.363, $p<0.001$). Among other findings, attentional cognitive tests had positive correlations with nearly the same brain structures as Speech-in-Noise test. Conclusion: These data suggest that several brain areas need to be preserved to adequately understand speech under noise conditions during aging.

Cingulate cortex atrophy is associated with cognitive impairment in patients with presbycusis and cochlear dysfunction

Chama Belkhiria[1, 2]
Rodrigo C. Vergara[1, 2], Simón San Martín[1, 2], Aexis Leiva[1, 2], Bruno Marcenaro[1, 2], Melissa Martínez[3], Carolina Delgado[1, 3], Paul H. Delano[1, 2, 4]

[1]Neuroscience Department, Facultad de Medicina, Universidad de Chile, Chile
[2]Biomedical Neuroscience Institute, Facultad de Medicina, Universidad de Chile, Chile
[3]Neurology and Neurosurgery Department, Hospital Clínico de la Universidad de Chile, Chile
[4]Otolaryngology Department, Hospital Clínico de la Universidad de Chile, Chile

Age-related hearing loss is associated with cognitive decline and has been proposed as a risk factor for dementia. However, the mechanisms that relate hearing loss to cognitive decline remain elusive. Here, we propose that the impairment of the cochlear amplifier mechanism is associated with structural brain changes and cognitive impairment. Ninety-six subjects aged over 65 years old (63 female and 33 male) were evaluated using brain magnetic resonance imaging and neuropsychological and audiological assessments, including distortion product otoacoustic emissions as a measure of the cochlear amplifier function. The group with cochlear amplifier dysfunction showed greater brain atrophy in the cingulate cortex and in the parahippocampus. In addition, the atrophy of the cingulate cortex was associated with cognitive impairment in episodic and working memories and in language and visuoconstructive abilities. We conclude that the neural abnormalities observed in presbycusis subjects with cochlear amplifier dysfunction extend beyond core auditory network and are associated with cognitive decline in multiple domains. These results suggest that a cochlear amplifier dysfunction in presbycusis is an important mechanism relating hearing impairments to brain atrophy in the extended network of effortful hearing.

Hearing loss and cortical atrophy in older adults with (or at risk for) dementia: how strong is the relationship?

Nathalie Giroud[1, 2]
Kathy Pichora-Fuller[3], Paul Mick[4], Walter Wittich[5], Faisal Al-Yawer[1], Sana Rehan[1], Natalie Phillips[1, 2, 6]

[1]Department of Psychology, Centre for Research in Human Development, Concordia University, Canada
[2]Centre for Research on Brain, Language, and Music, Canada
[3]Department of Psychology, University of Toronto, Canada
[4]Department of Surgery, Faculty of Medicine, University of British Columbia, Canada
[5]School of Optometry, University of Montréal, Canada
[6]Lady Davis Institute for Medical Research, Jewish General Hospital, Canada

Hearing loss (HL) in older adults has been associated with cognitive decline and higher risk for dementia. However, the underlying link with brain structure remains largely unknown. Using data from the COMPASS-ND dataset, we investigated the relationships a) between HL (HL category based on pure-tone thresholds at 2kHz and speech-in-noise thresholds) and working memory (WM, sentence repetition) and b) HL and cortical volume (controlling for education, age, sex, and intracortical volume) in older adults with different degrees of cognitive impairment, namely subjective cognitive impairment (SCI, N=24), mild cognitive impairment (MCI, N=59), and Alzheimer's dementia (AD, N=19).
SCI: There was no evidence for a relationship between HL and WM, but greater HL (i.e., higher HL category) was associated with lower gray matter volume in temporal and frontal regions (R2≥.23). MCI: HL was not significantly associated with WM or cortical volume. AD: Higher speech-in-noise thresholds were related to lower WM performance (R2=.25) and to lower right hippocampal volume (R2=.28). Our data provide evidence for a link between HL and working memory in AD only. Furthermore, our results reveal a moderate relationship between HL and brain atrophy in SCI and AD. This research contributes to better understanding the association between HL and neurodegeneration.

Scholarship sponsored by Linnaeus Centre HEAD to:

Nathalie Giroud

After having completed my PhD at the University of Zurich in Switzerland, I had the opportunity to extend my previous research on the influence of age-related hearing loss and hearing aids on neural speech processing in older adults. Using a variety of EEG and structural MRI approaches, I am currently investigating different strategies which may help older adults to process speech (i.e., lip reading). Supported by the Swiss National Science Foundation mobility program and as part of Team 17 of the Canadian Consortium on Neurodegeneration in Aging (CCNA: http://ccna-ccnv.ca/), my postdoctoral research in the Cognition, Aging, and Psychophysiology lab further focuses on the relation between age-related peripheral and central hearing loss and cognitive decline in older adults. By using novel structural and functional neuroimaging techniques and data from the COMPASS-ND study of the CCNA (http://ccna-ccnv.ca/compass-nd-study/), I follow my long-term goal to evaluate and develop rehabilitation strategies for age-related sensory decline to maintain sensory and cognitive functioning in healthy older adults as well as older adults with MCI and dementia to improve their quality of life in the long-term.

Scholarship sponsored by Linnaeus Centre HEAD to:

Patrycja Ksiazek

My name is Patrycja Ksiazek, and I'm a PhD student at Amsterdam UMC, location VU medical center, affiliated with the section Ear & Hearing, Department of Otolaryngology – Head and Neck Surgery led by Professor Sophia E. Kramer and with the research group Cognitive Hearing Science in Eriksholm Research Centre led by Professor Thomas Lunner.

I've received my Masters in Engineering Acoustics from the Technical University of Denmark (DTU) in August 2017. Before starting my PhD in July 2018, I worked as a Research Engineer at Eriksholm Research Centre supporting research involving pupillometry. My research interest is in enhancing health care with use of advanced analytics and engineering solutions.

My PhD is part of the Horizon 2020 project HEAR-ECO. My focus in the project is to develop an ambulatory and ecologically valid method of evaluating listening effort reflected in the pupil response. The project is supervised by Professor Sophia E. Kramer and Dr. Adriana A. Zekveld from Amsterdam UMC, location VUmc as well as Professor Thomas Lunner and Dr. Dorothea Wendt from Eriksholm Research Centre.

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Scholarship sponsored by Linnaeus Centre HEAD to:

Simon San Martín

Simon San Martín is Speech and Language Therapist in Santiago de Chile. Currently developing his master thesis on brain morphology and its relationship with cognitive functioning and hearing in noise abilities in elderly population at the University of Chile. Member of the Auditory and Cognition Center, funded by the National Commission for Scientific and Technological Research CONICYT (ACT-1403).

Abstracts

Sunday

Introductory keynote: Sunday June 9, 16.45–17.15

Cortical neuroplasticity in hearing loss

Anu Sharma[1]

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A basic tenet of neuroplasticity is that the brain will re-organize following sensory deprivation. A better understanding of cortical neuroplasticity accompanying hearing loss may allow us to improve the design of hearing devices, allowing accommodation of altered cortical processing. Compensation for the deleterious effects of hearing loss include recruitment of alternative brain networks during cortical processing. Our experiments suggest that hearing loss ranging from mild-moderate to severe-profound, results in significant changes in neural resource allocation, reflecting patterns of cross-modal compensation from the visual and somatosensory modalities, increased listening effort, and decreased cognitive spare capacity. Furthermore, cortical changes are related to cognitive decline and decreased speech perception in noise. Interestingly, many cognitive and cortical changes may be reversed after use of appropriately fitted interventions (such as hearing aids and cochlear implants). Our results suggest that compensatory plasticity influences outcomes for patients with hearing loss.

Abstracts

Monday

Keynote: Monday June 10, 8.35–9.00

How subclinical hearing loss can impact communicating in social settings

Barbara Shinn-Cunningham[1]

[1]Carnegie Mellon Neuroscience Institute, USA

Many listeners with normal hearing thresholds nonetheless have trouble understanding speech in noisy settings – especially if they are middle-aged or older. Recent advances, driven by studies in noise-exposed and aging animals, suggests that such difficulties can come about when cochlear function is healthy, but there is a loss of auditory nerve fibers conveying information to the brain. Yet, there is no broad consensus in the field about the degree to which such affects influence human communication. This talk will explore how such hearing loss may interfere with communication, especially in noisy, social settings, and will discuss how such loss might interfere with "cognitive" abilities, such as directing selective auditory attention to understand one listener in a complex auditory scene.

Monday June 10, 9.00–9.20

Using physiological measures to assess distraction and annoyance from background noise

Alexander L. Francis[1]

[1]Purdue University, Department of Speech, Language and Hearing Sciences, USA

Noise is a significant source of annoyance and distress and is increasingly recognized as a major public health issue in Europe and around the world. Workplace noise impairs cognitive performance and increases fatigue and susceptibility to chronic disease. Background noise may be particularly troublesome for individuals with tinnitus, hyperacusis, or misophonia, all of which appear to involve atypical attentional and emotional responses to auditory stimuli. Even in non-clinical populations, sensitivity to noise varies considerably, with 20-40% of individuals reporting some sensitivity and 12% reporting high sensitivity. We hypothesize that background noise causes annoyance when irrelevant sounds interfere with task performance, e.g. through distraction and/or increased listening effort. Chronic annoyance, in turn, may induce physiological stress responses that damage long-term health. This implies that the short- and long-term effects of noise on job performance and health may vary depending on individual differences in information processing (cognitive capacity), susceptibility to distraction (selective attention), and emotional response (affective psychophysiology). In this talk I will outline a new research program to investigate individual differences in cognitive and affective responses to noise, and to develop objectively quantifiable psychophysiological measurements that could eventually be obtained through inexpensive wearable devices.

Monday June 10, 9.20–9.40
Poster no 1

Rapid time-locked lexical processing of attended but not of unattended continuous speech

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During speech perception, a central task of the brain is to segment the continuous acoustic speech signal into discrete words and identify those words. When listening to multiple speakers, each individual speech stream might be analyzed this way. Using source-localized magnetoencephalography responses to continuous narrative speech, we show that the transition, from speech-processing based on acoustics, to speech-processing based on its lexical units, occurs in auditory cortex. Analysis of the responses employs both acoustically-based continuous variables, and phoneme-by-phoneme variables, related to the information content of each phoneme for the word being heard, to allow isolation of time-locked brain responses related to lexical processing. Results for clean speech suggest that phonemes are processed using their informational content for lexical perception within ~110-130 ms. For a mix of two talkers, the attended speech generates similar neural responses, both acoustic and lexical, though delayed by ~15 ms, suggesting an additional processing load. However, no equivalent lexical responses were present for the unattended speech (only acoustic responses), suggesting that unattended speech is not processed lexically in the same strictly time-locked fashion as attended speech.

Monday June 10, 9.40–10.00
Poster no 2

Try harder! The influence of evaluative feedback on the pupil dilation response, saliva-cortisol, and saliva alpha-amylase levels during listening

Adriana Zekveld[1]
Hannah van Scheepen[1], Niek Versfeld[1], Sophia Kramer[1]

[1]Amsterdam UMC, Vrije Universiteit Amsterdam, Otolaryngology – Head and Neck surgery, Ear & Hearing, Amsterdam Public Health research institute, the Netherlands

The pupil dilation response is sensitive to listening effort, but also to the social significance of a task. We assessed the effect of evaluative feedback on the pupil dilation response, subjective ratings, and two biomarkers sensitive to stress: cortisol and alpha-amylase levels as determined in saliva samples.
We included 34 participants with normal hearing (mean age = 52 years) and 29 age-matched participants with mild-to-moderate hearing loss (mean age = 52 years). Half of the participants performed a standard SRT test, and the other half performed an SRT test in which 1) written feedback was provided, 2) a performance indicator was shown, and 3) the experimenter provided evaluative feedback. The SRT conditions targeted 50% and 71% sentence reception. Pupil size was recorded during listening and saliva samples were obtained before, during and after the test. As expected, hearing loss was associated with poorer SRTs, and better SRTs were obtained for the 50% as compared to the 71% intelligibility condition. Receiving feedback improved the SRTs in the 71% intelligibility and increased the peak pupil dilation in both intelligibility conditions. No effect of hearing status on the pupil dilation response was observed. We will furthermore present the subjective, cortisol, and alpha-amylase data.

The effect of monetary reward on listening effort as reflected by the pupil dilation response

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Adriana Zekveld[1, 2], Thomas Lunner[2, 3, 4, 5,6], Sophia Kramer[1]

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This study examined the effect of monetary reward on speech processing in noise and the related listening effort. Twenty-four normally hearing participants (median age 21 yrs.) performed speech reception threshold (SRT) tasks, tracking at 50% correct, 85% correct, or in quiet. For each task, participants were told that they could earn a high (5 euros) or low (0.20 euro) reward when repeating 70% or more of the sentences correctly. The six conditions were presented in a blocked fashion and during each trial, pupil diameter was recorded. At the end of each block, participants rated the effort they had experienced, their performance, and their tendency to quit listening. Additionally, participants filled in a need-for-recovery (NFR) questionnaire. Their peak pupil dilation (PPD), relative to baseline, was significantly larger for the high than for low reward conditions, and for the easy as compared to the harder conditions. Higher NFR was associated with a higher subjective tendency to quit listening. Interestingly, the results showed no effect of reward on speech perception performance as reflected by the SRT, which is now further investigated in an additional study. Consistent with the Framework for Understanding Effortful Listening, we conclude that listening effort is sensitive to monetary reward.

Quantifying inattentional deafness: effects of cognitive load on pure-tone detection and just-noticeable differences

Sven Mattys[1]

[1]University of York, UK

Cognitive load (CL), e.g., a concurrent memory task, reduces speech perception accuracy. Here, we ask whether the effect of CL on hearing can be detected through pure-tone audiometry (PTA), a behavioral measure of basic auditory processes that is often seen as encapsulated from cognition. Young and older adults performed a PTA test on .5, 1, 2, and 4 kHz pure tones under CL and no CL. CL consisted of a visual 2-back task running throughout the PTA test. The stimuli in the 2-back task involved either sub-vocal encoding or purely visual encoding. Young adults showed a significant 2 dB elevation of detection thresholds, but only when CL involved sub-vocal encoding. CL had no effect when it involved purely visual encoding. In contrast, older adults showed elevated detection thresholds under both types of CL. The results indicate that CL disrupts basic auditory processes and that this disruption can be quantified in terms of hearing loss. The age difference in the CL condition involving purely visual encoding suggests important lifespan changes in the attentional regulatory system and sensory representations.

Monday June 10, 13.15–13.35

Communication effort as an interactive system between interlocutors: the effect of hearing loss and amplification

Gitte Keidser[1, 2]
Tim Beechey[3, 4, 5], Jorg Buchholz[4, 5]

[1]Eriksholm Research Centre, Snekkersten, Denmark
[2]University of Queensland, Brisbane, Australia
[3]National Acoustic Laboratories, Sydney, Australia
[4]Macquarie University, Sydney, Australia
[5]Hearing Cooperative Research Centre, Melbourne, Australia

A significant consequence of hearing impairment is reduced functioning in communication situations. To maintain successful communication, especially in adverse conditions, interlocutors engage in a dynamic feedback system in which talkers accommodate their conversation partners, who signal difficulty understanding, by modifying their speech and language. In the dynamic feedback system, it appears people employ embodied cognition during verbal communication - a concept that treats individuals and their cognition as inseparable from their environment (including other people). In this talk we present an approach that enables dynamic feedback and takes the interaction between interlocutors into account when examining communication. The approach addresses ecological validity in terms of acoustic environment, stimuli, and task to obtain a novel measure of communication effort. We present data to demonstrate how communication effort increases within conversations in increasingly more adverse environments, how communication effort further increases within conversation as a function of the degree of hearing impairment of an interlocutor, and how communication effort is alleviated when providing amplification to the hearing-impaired interlocutor. Findings suggest the approach may provide a valuable means for understanding hearing loss as well as amplification in the context of interactive conversations and their effects on both communication partners.

Monday June 10, 13.35–13.55

Speech intelligibility in realistic virtual sound environments

Naim Mansour[1]
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Employing realistic, yet controlled sound scenarios for the evaluation of hearing aid (HA) algorithms in a virtual sound environment (VSE) has the potential to improve HA users' real- world listening experience and performance. In the present study, so-called critical sound scenarios (CSS) were defined as acoustic scenes that HA users experience as important, difficult and common, and selected through ecological momentary assessment (EMA), inspired by results from recent studies. One such scenario was acquired in a real scene using a spherical microphone array, and reproduced in an acoustically valid way inside the VSE. A speech intelligibility task using the Danish Hearing In Noise Test (HINT) was implemented in the scene to measure speech reception thresholds (SRT) for normal- hearing and hearing-impaired subjects. SRTs obtained for the realistic VSE background noise were found to be higher than corresponding ones reported in headphone-based studies, potentially as a result of the increased listening effort required to separate target speech from the more realistic interfering speech background.

Keynote: Monday June 10, 13.55–14.20

Effective connectivity between primary and secondary areas depends on sensory experience

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[3]School of Medicine and Health Sciences, Macquarie University, Australia

Cortical responses are embedded into ongoing cortical processing through corticocortical interactions, also providing information on the context and the mental model of the outside world. Stimulus related activity is reflected in local field potentials (LFPs) in the form of evoked responses (phase-locked to the stimulus, reflecting the thalamic input) and induced responses (non-phased-locked activity, representing corticocortical processing). The effect of auditory experience on evoked and induced responses in the primary auditory cortex (A1) and a higher-order auditory field (posterior auditory field, PAF) was evaluated using time-frequency representations (TFR) of auditory responses in adult hearing controls (HCs) and congenitally deaf cats (CDCs) with wavelet analysis (Yusuf et al., 2017, Brain). Coupling strength between A1 and PAF was quantified using weighted phase-lag index, pairwise phase consistency and Granger causality. Cochlear-implant-elicited responses showed no significant effect of deafness on A1 evoked responses, but a near loss induced responses in both A1 and PAF in CDCs. Also the coupling between A1 and PAF was significantly smaller in CDCs. Hearing experience thus shapes effective connectivity between auditory areas. Developmental hearing experience is essential for integration of different features of sensory input and corticocortical ongoing processing in the cortex.

Monday June 10, 14.50–15.10
Poster no 3

Short periods of perinatal acoustic experience change the structure and function of auditory cortex

Stephen Lomber[1]
Alex Meredith[2]

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Compared to hearing subjects, psychophysical studies have revealed specific superior visual abilities in the deaf. The neural substrate for these superior sensory abilities has been identified to reside in the deprived cerebral cortices that have been reorganized through crossmodal plasticity. Furthermore, the cartography of auditory cortex is altered following the loss of auditory input early in life. This study examined how perinatal exposure to brief periods of acoustic stimulation alters the developmental trajectory of auditory cortex. Compared to hearing animals, movement detection, localization in the visual periphery, and face discrimination learning are superior in congenitally deaf cats. To examine the role of acoustic experience in mediating these enhanced functions, hearing animals were chemically deafened at increasing ages postnatal. The animals had 1-16 weeks of acoustic exposure prior to deafness onset. Overall, >9 weeks of acoustic experience resulted in no enhanced visual abilities. With >4 weeks of acoustic exposure, enhanced motion detection was not evident. As acoustic experience increased during development, the overall size of auditory cortex, and the size of individual auditory areas also expanded. These results demonstrate that increasingly longer periods of perinatal acoustic exposure result in reduced enhanced visual abilities and an increased size of auditory cortex.

Monday June 10, 15.10–15.30

Brain reorganisation measured using functional near infrared spectroscopy can predict cochlear implant outcome

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Ian Wiggins[1], Carly Anderson[1]

[1]Nottingham Hearing Biomedical Research Centre, School of Clinical Sciences, Nottingham University, UK
[2]Nottingham Auditory Implant Programme, Nottingham University Hospitals NHS Trust, UK

Many patients receiving cochlear implants unexpectedly fail to reach, or unexpectedly exceed predicted performance. Individual differences in brain reorganisation following deafness and cochlear implantation may help explain these variable outcomes. Our research at the Hearing Biomedical Research Centre in Nottingham aims to improve our understanding of the changes that occur in the brain following deafness and subsequent restoration of auditory input by a cochlear implant. We use a novel functional neuroimaging method called functional near infrared spectroscopy (fNIRS) that provides a highly valuable avenue of investigation because it is completely safe for use in an implanted population and, unlike other neuroimaging methods, is unaffected by electrical and magnetic artefacts associated with the implant. fNIRS allows investigation of brain reorganisation after cochlear implantation, and we have used it to develop a neuroimaging marker that correlates with clinical cochlear implant outcome in adults. In ongoing studies in our laboratory we are evaluating whether this prognostic tool can predict cochlear implant outcomes in children. Our long-term goal is to use this tool to improve post-operative rehabilitation based on the predicted needs of an individual, and provide recipients with realistic expectations of performance following implantation.

Monday June 10, 15.30–15.50

Adaptive neural states and traits in the listening brain

Jonas Obleser[1]

[1]Department of Psychology, University of Lübeck, Germany

Recently, our research group has been enquiring how an individual listener's performance is becoming affected by neural states and neural traits. Neural states comprise intra-individual, moment-to-moment fluctuations of neural excitability, while neural traits denote inter-individual, more stable, and potentially age-related differences (e.g. in brain-wide connectivity). How is a listener's performance affected by neural states (e.g., intra-individual, moment-to-moment fluctuations of neural excitability) and neural traits (i.e., inter-individual differences in brain-wide connectivity)? I will present some tentative answers to this question from recent EEG and fMRI work in our laboratory, with the goal of explaining better the large variation in successful auditory communication.

Abstracts

Tuesday

Tuesday June 11, 8.35–8.55

Cognitive contributions to understanding acoustically challenging speech

Jonathan Peelle[1]

[1]Washington University in Saint Louis, USA

How does hearing impairment affect the way our brains process speech? I will review data from behavioral and brain imaging studies that speak to the added cognitive demands associated with acoustic challenge. Evidence from multiple sources is consistent with a shared resource framework of speech comprehension in which domain-general cognitive processes supported by discrete regions of frontal cortex are required for both auditory and linguistic processing. The specific patterns of neural activity depend on the difficulty of the speech being heard, as well as the hearing and cognitive ability of the listeners. Although frequently studied in the context of hearing loss, these principles have broader implications for our understanding of how auditory and cognitive factors interact during spoken language comprehension. I will present neuroimaging data from listeners with normal hearing, age-related hearing loss, and cochlear implants implicating executive attention networks in understanding acoustically challenging speech.

Tuesday June 11, 8.55–9.15

Objectively measuring speech intelligibility: impact of individual participant factors

Tom Francart[1]
Lien Decruy[1], Damien Lesenfants[1],
Eline Verschueren[1], Jonas Vanthornhout[1]

[1]KU Leuven - University of Leuven, Dept. Neurosciences, ExpORL, Belgium

Objective measures of hearing are essential to on the one hand complement behavioural measures in difficult to test populations such as young children, and on the other hand enable fully automatic fitting of auditory prostheses. Most current objective measures use artificial stimuli, such as repeated pulses, tones or single vowels, which are far from natural speech. We recently developed an EEG-based objective measure of hearing using fully natural speech, based on a measure of neural tracking of the speech envelope. In an evaluation with young normal-hearing listeners we found that the objective measure was strongly correlated with the behaviourally measured speech reception threshold.
For clinical application, our measure needs to be valid across the life span and for all levels of hearing impairment and cognitive function. We therefore investigated the effect of the following factors on neural tracking of the speech envelope: task (active or passive listening), listening effort, attention, age and hearing impairment. While most of these factors influenced the degree of neural envelope tracking, we found an increase in neural envelope tracking with increasing stimulus signal-to-noise ratio in all participants and conditions, allowing to derive our objective measure of speech intelligibility.

Tuesday June 11, 9.15–9.35

Listening and learning difficulties in children

Dave Moore[1, 2]
Hannah Stewart[1], Cecilia Nakeva von Mentzer[1, 3],
Jennifer Vannest[1], Lisa Hunter[1]

[1]Cincinnati Children's Hospital, USA
[2]University of Manchester, UK
[3]University of Uppsala, Sweden

Families of children attending audiology clinics report 'listening difficulty' (LiD), usually associated with hearing loss and multiple learning problems. For children without audiometric hearing loss (LiDNH), most common concerns are 'school problems', developmental language delay (DLD), and attention deficit disorder (ADD). DLD and ADD are each reported in ~50% of children with LiD we enrolled in a large, NIH-funded longitudinal study. Multi-faceted cognitive deficits were also found using the NIH Cognition Toolbox. Sub-clinical hearing loss (10 dBHL<PTA<20dBHL; PTA9-16kHz>20dBHL) and reduced DPOAE were seen in some cases of LiDNH, but generally little evidence of peripheral or brainstem dysfunction. Poor speech-in-noise intelligibility has a strong association with immature hearing and LiD, but a weaker association with specifically auditory processing. In contrast, resting state MRI has revealed dramatically greater functional connectivity of cortical 'speech' areas in typical children than in children with LiDNH, but no difference for 'non-speech' auditory areas. Children with primary ADD had reduced connectivity re typical children for speech and, more so, for non-speech processing. We are now examining functional connectivity in children with DLD, some of whom have sub-clinical hearing loss in addition to phonological discrimination and reproduction difficulties. Current data suggest LiDNH is primarily a cortically-mediated speech/language problem.

Tuesday June 11, 9.35–09.55
Poster no 4

Over-representation of speech in older adults originates from early and late responses in auditory cortex

Jonathan Z. Simon[1]
Christian Brodbeck[1], Alessandro Presacco[1],
Stefanie E. Kuchinsky[1], Samira Anderson[1]

[1]University of Maryland, College Park, USA

Compared to young adults, older adults tend to have increased difficulty comprehending speech, especially in challenging acoustic environments. However, previous research has surprisingly found that their cortical responses to speech demonstrate more robust tracking of the acoustic speech envelope than those of younger adults. Using source-localized magnetoencephalography responses to continuous narrative speech, we show that this cortical enhancement is due to increased responses at multiple latencies, suggesting multiple underlying causes. Responses to clean speech and to speech from two simultaneous talkers were used to distinguish between bottom-up and task-related brain activity. Results indicate that older adults' cortical responses are magnified even at the earliest cortical latencies (~30 ms), adding rapid activation in non-core auditory cortex. This suggests changes to bottom-up processing consistent with explanations based on excitation/inhibition imbalance seen in animal models. However, later, task-driven responses (~120 ms and later) are also increased, suggesting that the increase in older adults is also due to additional neural resources newly recruited for speech comprehension.

Tuesday June 11, 10.25–10.45

Selective and distributed attention to speech: depth of processing and individual differences

Elana Zion Golumbic[1]

[1]The Gonda Multidisciplinary Brain Research Center, Bar Ilan University, Israel

A primary challenge posed by many real-life settings is that of appropriately allocating attention to a desired speaker in noisy, multi-talker situations. Successfully accomplishing this feat depends on many factors, related both to the acoustic properties of the competing speech as well as on the listeners behavioral goals. In this talk I will discuss data from a series of experiments studying individual differences in the way that different listeners allocate processing resources among concurrent speakers, in accordance to task-requirements. We tested the contribution of working memory capacity and acquired experience to performance on increasingly demanding auditory-attention tasks, as well as variability eye-gaze scanning pattern in a virtual multi-speaker environment. I will further discuss what we can learn about the capacity of parallel processing of concurrent speech from 'pushing the system' to its limits and requiring the division of attention among multiple concurrent talkers. The cumulative results contribute towards furthering our understanding of the factors contributing to individual differences in attention to speech under ecological conditions and the underlying processing bottlenecks.

Keynote: Tuesday June 11, 10.45–11.10

The plasticity of the reading circuit in deaf adults

Karen Emmorey[1]

[1]San Diego State University, USA

Recent neuroimaging and neurophysiological evidence reveals how the reading system successfully adapts when phonological codes are relatively coarse-grained due to reduced or distorted auditory input. The evidence suggests that the optimal end-state for the reading system may differ for deaf versus hearing adults and indicates that certain neural patterns that are maladaptive for hearing readers may be beneficial for deaf readers. Our research focuses on deaf adults who have achieved reading success and who use sign language in their everyday lives and reveals that such deaf readers exhibit a more bilateral neural response to written words compared to hearing readers, as measured by evoked response potentials (ERPs; N170 component) and by fMRI (rapid adaptation within the visual word form area, VWFA). Further, better deaf readers (but poorer hearing readers) exhibit a larger right hemisphere N170 response to visual words. Results from the rapid adaption fMRI paradigm indicate that while skilled deaf readers demonstrate coarsely tuned phonological representations in temporoparietal cortex (TPC), they develop finely tuned orthographic representations in the VWFA, suggesting that phonological tuning in the TPC may have little impact on the neural network associated with skilled reading for deaf adults.

Keynote: Tuesday June 11, 13.15–13.40

Listening difficulties can be caused by deficits in auditory processing, speech processing, cognition and language

Harvey Dillon[1, 2, 3]

[1]Macquarie University, Sydney, Australia
[2]University of Manchester, Manchester, UK
[3]National Acoustic Laboratories, Sydney, Australia

Children and adults can have abnormal difficulty understanding speech in acoustically challenging situations, despite having normal hearing thresholds. In principle, this difficulty can be caused by deficits in any of auditory processing, speech processing, cognition, or language, either in isolation or in combination. Identifying the primary cause is complicated. Firstly, tests in any one domain (e.g. auditory processing) inevitably place demands on skills in another domain (e.g. cognition). Secondly, it is possible, if not likely, for an individual to have deficits in more than one of the causal domains. Even when a domain causing the deficit is identified, identifying the specific deficits within that domain is challenging. Identification is necessary, however, if remediation therapy that intensively exercises the skill in deficit is to be applied. The talk will show some relationships, analysed using structural equation modelling, between measurements on children using existing tests that aim to target the different domains. The talk will propose a more systematic way to quantify the magnitude of the deficit in each domain, while controlling for the effects of deficits in the other domains. Some examples of how to identify specific deficits in each domain will also be given.

Tuesday June 11, 13.40–14.00

Measuring listening effort: pitfalls, pertinence & potential

Helen Willis[1]

[1]University College London, UK

There are several methodological pitfalls that must be avoided in order to successfully develop a behavioural measurement of listening effort using a dual-task paradigm. However, this endeavour is pertinent because there is increasing evidence that excessive levels of listening effort can have harmful effects on both mental and physical health. This is potentially via the activation of the hypothalamic-pituitary-adrenal (HPA) axis, causing a series of damaging hormonal effects. A dual-task using performance in a digit stream visual task (as an indicator of listening effort involved in understanding sentences simultaneously heard) shows potential. The results, using 30 normal hearing (NH) participants and 25 cochlear implant (CI) users, suggested that NH participants could perform the dual-task with no difficulty in quiet, and were only affected by noise. However, when NH participants listened to CI simulations, their performance became the same as the CI users: i.e. listening effort was significantly increased even in optimum listening conditions. Furthermore, the NH participants listening to CI simulations still performed better in noise than the CI users, indicating that the deafened brain presented further challenges in adverse listening conditions. With further development, this dual-task paradigm has the potential for optimising rehabilitation outcomes by monitoring listening effort levels.

Tuesday June 11, 14.00–14.20

A new patient-reported outcome measure of listening effort: development and preliminary testing of the Listening Effort Questionnaire (LEQ-CI)

Sarah Hughes[1, 2]
Hailey Hutchings[2], Isabelle Boisvert[3, 4],
Catherine McMahon[3, 4], Frances Rapport[5]

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[2]Swansea University Medical School, UK
[3]The HEARing Cooperative Research Centre, Australia
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[5]Australian Institute of Health Innovation, Macquarie University, Australia

The Listening Effort Questionnaire – Cochlear Implant (LEQ-CI) is a new patient-reported outcome measure (PROM) that has been developed specifically for the measurement of perceived listening effort in adult cochlear implant candidates and recipients. It provides a global measure of listening effort as experienced by individuals in the listening situations of everyday life.

The construction of a new PROM is a rigorous and systematic research process. During the development phase, preliminary testing the new instrument with patients, researchers, academics, and clinicians enables scale developers to rectify problems with items and response scales that may not be otherwise identified. Preliminary testing also enables developers to confirm the PROM is acceptable, clear, and relevant to members of the target population.

This presentation will focus on the development and preliminary testing of LEQ-CI. The iterative process of item generation and scale construction will be described. We will present data from quantitative assessments of item quality and qualitative field tests involving an expert review panel and cognitive interviews with patients. When taken together, these findings provide further evidence of the LEQ-CI's content validity. Importantly, the steps taken to minimise measurement error prior to undertaking evaluation of the LEQ-CI's psychometric measurement properties will be discussed.

Tuesday June 11, 14.50–15.10

Exploring the self-regulatory behavior of elementary students with hearing loss in inclusive classrooms: helping children & teachers

Sheila Moodie[1]
Kendra DiBacco[1], Devon M. Trower[2],
Cassandra E. Trevisani[2], Lynda Hutchinson[2]

[1]Western University, School of Communication Sciences & Disorders and The National Centre for Audiology, London, ON, Canada
[2]King's University College, Western University, Department of Psychology, London, ON, Canada

The term “self-regulated” (SR) describes how individuals apply cognition and behavior to attain goals (Zimmerman, 2008). Our study asked: (1) Do students with hearing loss (SHL) differ from students with typical hearing (NHS) in terms of their emotion regulation (ER; regulation of affect), self-regulated learning (SRL; regulation of learning during tasks) and socially responsible self-regulation (SRSR; regulation of social interactions using self-awareness plus social competence) (Hutchinson, 2013); and (2) How do teachers of SHL use academic tasks and practices to support their students' ER, SRL, and SRSR in school? Data were gathered from 10 elementary school teachers (kindergarten through grade 6) who provided ratings of 131 students’ (with 8 SHL) SR and academic achievement. Also, a half-day of observations were conducted in these classrooms. Results of non-parametric tests will be discussed. We will also discuss how our findings relate to the importance of understanding how hearing loss can influence students’ ER, SRL, and SRSR in school, and how the SR promoting tasks and practices used by teachers in the classroom may help to meet a wide range of student learning needs.

Tuesday June 11, 15.10–15.30

Practice Listening and Understanding Speech (PLUS): two novel auditory-cognitive training programs for people with hearing loss

Antje Heinrich[1]
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[3]School of Medicine, University of Nottingham, UK
[4]National Acoustic Laboratories, Sydney, Australia

Our research suggests that auditory training, using an adaptive phoneme discrimination task, results in significant improvements in speech perception and cognition for people with hearing loss (PHL) and for hearing aid (HA) users, and that these improvements are driven by refinements in higher order cognitive control. Furthermore, a recent meta-analysis shows the largest benefits to cognition for PHL may be achieved by combined auditory-cognitive training approaches.
Based on these previous findings we have developed two bespoke auditory-cognitive training programmes that target bottom-up refinement of sensory and cognitive skills (phoneme discrimination n-back training) and the top-down development of cognitive control for speech perception (2-talker competing speech training). Phoneme stimuli are those reported by Ferguson et al. (2014), presented within an n-back odd-one-out paradigm. Novel stimuli for competing speech training are based on challenging listening situations HA users encountered regularly as identified using the qualitative method Photovoice.
The training programs will be provided to first-time HA users across two UK National Health Service (NHS) audiology services to assess the feasibility of conducting a full-scale NHS multicentre RCT of intervention effectiveness and cost-effectiveness.

Keynote: Tuesday June 11, 15.30–15.55

Attention switching and multi-talker listening in normally hearing and hearing impaired listeners

Simon Carlile[1]
Gaven Lin[1], Tamara Simpson[1]

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In a conversation, interlocuters must continually switch spatial and non-spatial attention to listen to the talker of interest. With normally hearing listeners and matrix sentences, we observed a decrease in hit rate and sensitivity, and an increase in masker confusions following a change in voice. This highlights the cognitive demands of engaging attention on a new talker and disengaging attention from a previous target voice. When switching spatial attention we found a listening cost (10-15% decrease hit rate and increased masker confusions) associated with switching spatial attention. With moderately hearing impaired listeners, we have previously shown a significant decrease in localization of a target word when presented in a mixture of 4 talkers, but near normal performance when presented in isolation. In the switch spatial attention task above, hearing impaired listeners were completely unable to perform the task showing chance performance. This indicates a key deficit in spatial attention or localization in the presence of multiple talkers that goes well beyond decreased localization ability. Whether this relates to a reduced ability to disengage attention (as we have previously shown with some APD chilldren) or to other interactions between the concurrent talkers is a matter of significant theoretical and practical interest.

Abstracts

Wednesday

Keynote: Wednesday June 12, 8.35–9.00

Hearing, cognition, and brain structure: Initial findings from the COMPASS-ND study

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There is a strong relationship between sensory and cognitive function in older adults and sensory impairment (hearing, vision, and/or olfaction) is independently associated with dementia. The Comprehensive Assessment of Neurodegeneration and Dementia (COMPASS-ND) study is a large-scale study of older Canadians who are living with, or are at risk for, dementia, including those with subjective cognitive impairment (SCI), mild cognitive impairment (MCI), Alzheimer's disease (AD), other causes of dementia, and normal controls. We collect clinical data, MRI imaging, measures of sensory function, key biomarkers, and extensive data on a broad range of cognitive function.

I will present preliminary findings from participants with SCI (N=24), MCI (N=59), and AD (N=19). Controlling for age, sex, and education, cognitive performance measures decreased over the groups (SCI>MCI>AD), as expected. The groups differed in reading acuity, contrast sensitivity, and olfaction, but not hearing (audiometric category, perceiving digits in noise). Different measures of cognitive function correlated with vision and olfaction, but not hearing. Interestingly, however, poorer hearing was associated with lower cortical grey and/or white matter. These results illustrate a complex interplay between sensory-cognitive-brain measures in older adults with or at risk for dementia and suggest that hearing status has important implications for brain structure.

Wednesday June 12, 9.00–9.20

Working memory for signs with poor visual resolution

Mary Rudner[1]
Emil Holmer[1], Krister Schönström[2], Josefine Andin[1]

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[2]Department of Linguistics, Stockholm University, Sweden

In the speech domain, stimulus degradation increases working memory (WM) load. We studied the effect of stimulus degradation on WM for signs. 17 deaf early users of Swedish Sign Language and 22 hearing non-signers performed a sign-based n-back WM task during functional Magnetic Resonance Imaging (fMRI). Stimulus resolution was either high or low and load was n=1, 2 or 3. ANOVA of in-scanner behavioural results showed poorer performance when resolution was lower and that this effect was greater when load was higher, as in the speech domain. There was no between-group difference in performance. As expected, wholebrain fMRI results (fwe $p < .05$) showed greater activation of the fronto-parietal network as load increased. Better resolution was associated with greater activation in the ventral visual stream and poorer resolution with greater activation in the dorsal stream. Hearing non-signers also showed more activation in the dorsal stream while deaf signers showed more activation in the superior temporal lobe, confirming previous findings of cognitive plasticity in "auditory" cortex. This pattern of preliminary results suggests that WM for signs becomes less reliant on identification in the ventral stream and more reliant on localization in the dorsal stream when resolution and representation are poorer.

Wednesday June 12, 9.20–9.40

Hearing and vision impairment and mental well-being in older age

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[2]Macquarie University, Australia

Age-related hearing loss is a marker of risk of cognitive decline and dementia. I will outline possible links between hearing/vision impairment and cognition, including hearing/vision loss as a biomarker for cognitive well-being, the impact of cognitive declines on function and sensory impairment as a causal contributor to cognitive decline and poor quality of life in older age.

I will share recent research including our own work modelling i) relationships between age-related impairment of sensory function and cognition and ii) modelling the impact of sensory interventions (i.e. hearing aid use and cataract surgery) on cognitive outcomes between intervention and control groups.

I will argue that effective prevention, identification and management of hearing and vision problems represents an important opportunity to optimise mental well-being and quality of life in older age.

Wednesday June 12, 9.40–10.00
Poster no 5

The relationship between age-related hearing loss, working memory and cognition

Stephanie Rosemann[1, 2]
Dakota Smith[1], Marie Dewenter[1], Christiane M Thiel[1, 2]

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Previous research showed that additional frontal brain areas are recruited in hearing-impaired participants to compensate for the decreased auditory input. These frontal brain areas are usually involved in working memory, cognitive control and flexibility. Therefore, it seems likely that hearing loss also impacts neural processing of working memory and other cognitive abilities. Using functional magnetic resonance imaging (fMRI), we here investigated the influence of untreated age-related hearing loss on neural correlates of working memory as well as its relation to other cognitive abilities. Nineteen mild to moderate hearing-impaired and twenty-one normal-hearing subjects between 50 and 75 years participated in the study. The measurements taken included a working memory task (n-back paradigm) in the MRI and additional behavioral measures of general cognitive abilities, verbal intelligence, cognitive flexibility and interference control. Further, speech-in-noise perception and everyday listening effort were assessed. Analysis of behavioral data indicates that speech-in-noise perception is related to general cognitive abilities and processing speed; however, hearing thresholds determined by pure-tone-audiometry are not. Further, hearing-impaired participants perform slightly worse in the working memory task. Functional MRI data are currently being analyzed to investigate the relationship between neural activity during the working memory task, hearing impairment and the additional cognitive scores.

Wednesday June 12, 10.30–10.50

The melody and timing of speech: how younger and older adults use sentence prosody to balance comprehension and effort

Art Wingfield[1]

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The prosody of natural speech includes the intonation contour of an utterance, relative word stress, and timing patterns such as pauses and word-lengthening that signal the presence of a syntactic clause boundary. While prosody can convey information as disparate as a speaker's emotion or the semantic focus of an utterance, this presentation addresses the role of speech prosody as an aid to detecting the syntactic organization of an utterance. Using a sentence completion paradigm we show that young adults, older adults, and older adults with mild-to-moderate hearing loss, make similar use of prosodic marking to determine the structure of a sentence at a point of syntactic ambiguity. A second experiment pits recall of sentences with normal prosody against sentences in which the prosodic pattern no longer coincides with their syntactically determined clause boundaries. Recall errors reveal a strong but not absolute influence of prosody on how a sentence is perceived. Concurrent recordings of pupil dilation support the view that older adults achieve processing success at the cost of greater effort than young adults. Although a somewhat different pattern appears for hearing-impaired older adults, data align with the view that normally available speech prosody can act to reduce processing effort.

Wednesday June 12, 10.50–11.10

Auditory-cognitive links and social psychological factors in aging well

Kathy Pichora-Fuller[1, 2, 3]

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One possible explanation for the auditory-cognitive links observed in adult aging is that hearing loss increases a person's risk of social isolation which in turn increases risk of cognitive decline. Data from the Canadian Longitudinal Study of Aging provide evidence of significant associations between hearing and cognition, social engagement and hearing, and social engagement and cognition, but only weak support for social engagement mediating or moderating connections between hearing and cognition. An intriguing possibility is that cognition mediates the association between hearing loss and social engagement or that other factors underpin these complex connections. An unexplored possibility is that negative views of aging (NVOA) accelerate declines in hearing and cognition, as well as influencing social engagement. NVOA encompasses awareness of age-related losses, subjective age, fear of aging, essentialist beliefs about aging, and feelings of age stigma. Data from a sub-project of the Canadian Consortium on Neurodegeneration in Aging provide an opportunity to examine the associations of NVOA with social engagement and self-reported and behavioural measures of hearing and memory. Finding explanations for these connections could help individuals, clinicians and policy makers to find solutions to promote healthy aging for people who are hard of hearing.

Wednesday June 12, 11.10–11.30

The impact of aging and hearing loss on the production and perception of clear speech adaptations in challenging communicative conditions

Valerie Hazan[1]
Outi Tuomainen[1]

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We investigate speech communication using a collaborative problem-solving task (diapix) carried out by pairs of participants in easy and challenging communicative conditions. Our elderLUCID corpus includes recordings from 57 older speakers (30 with normal hearing, OANH; 27 with mild presbycusis, OAHL) and 26 young adults. Acoustic analyses showed that OANH and OAHL groups did not differ in speech characteristics in quiet, although OA speech was slower and with less mid-frequency energy than YA speech. However, in challenging conditions, OAHL speakers showed evidence of increased vocal effort (marked by correlated changes in fundamental frequency and mid-frequency energy), while OANH and YA groups did not. Samples of diapix recordings for 30 talkers (YA, OANH, OAHL) were presented to OANH, OAHL and YA listeners in babble noise at SNRs that equated 'YA-easy' speech intelligibility across groups. For all listener groups, YA talkers were more intelligible than OA talkers and there was a clear speech benefit for the speech produced in challenging conditions. However, while this intelligibility benefit was 22% on average for YA and OANH listeners, it was only 14% for OAHL-listeners. In summary, even mild presbycusis has an impact, beyond aging, on both the perception and production of speech in challenging conditions.

Keynote: Wednesday June 12, 11.30–11.55

Hearing loss, aging, and dementia – from epidemiologic insights to the ACHIEVE trial

Frank Lin[1]

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Public health research has demonstrated the broader implications of hearing loss for the health and functioning of older adults, particularly with respect to brain aging and dementia. I will discuss this epidemiologic research and the ongoing Aging and Cognitive Health Evaluation in Elders (ACHIEVE) randomized trial that is currently taking place in the United States. The ACHIEVE trial is a first-in-kind definitive randomized controlled trial that will determine if treating hearing loss in older adults with mild-to-moderate age-related hearing loss reduces the risk of cognitive decline and dementia in late life.

Posters

Poster no 6

Sensory loss and cognitive function in older adults at different stages of cognitive impairment

Faisal Al-Yawer[1]
M. Kathleen Pichora-Fuller[2], Walter Wittich[3], Paul Mick[4], Nathalie Giroud[1, 5], Sana Rehan[1], Natalie Phillips[1, 5]

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[5]Centre for Research on Brain, Language, and Music, Montréal, Québec, Canada

Sensory loss in older adults has been associated with declines in cognition and, in some cases, with the development of dementia. Using preliminary data from the COMPASS-ND study, we examined sensory differences (hearing, vision, olfaction) and the potential associations of sensory with cognitive function in groups with Alzheimer's disease (AD; N=17), mild cognitive impairment (MCI; N=55), and subjective cognitive impairment (SCI; N=18).

The SCI group scored better on most neuropsychological measures compared to the other groups, as did the MCI group compared to AD. Controlling for age, sex, and education, we observed differences in reading acuity (SCI>MCI; ηp2=.07), contrast sensitivity (SCI>MCI>AD; ηp2=.09), and olfaction (SCI>MCI>AD; ηp2=.11). There were no differences among groups in audiometric hearing loss category or speech-in-noise threshold on a digit triplet test (DTT). Partial correlations were analyzed for the MCI group. Olfaction (Brief Smell Identification Test) was associated with measures of memory (Rey Auditory Learning Test), executive function (Stroop), and working memory (digit span forward & backwards). Measures of vision were associated with measures of visual attention (Trial Making A, Stroop errors). Cognitive measures were not associated with audiometric category nor DTT thresholds. These results highlight sensory-cognitive interactions in individuals at prodromal stages of dementia.

Poster no 7

Cross-modal plasticity in auditory cortex

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In deaf early signers (DES) both primary and secondary auditory cortex are reorganized to support visual and cognitive processing. Here we study activation of primary auditory cortex (i.e. TE1, including subregions TE1.0, TE1.1 and TE1.2) and secondary auditory cortex (TE3) during a sign-based n-back working memory task in 17 DES and 22 HNS. Preliminary results from region of interest analyses of left and right TE1 and TE3 showed significantly stronger relative activation across all ROIs in DES compared to HNS, and stronger relative activation in higher compared to lower WM load for both groups. Further, we found a significant interaction between hemisphere and group for TE3 and a tendency towards significant interaction in TE1. In TE1 both groups show stronger relative activation in the left than right hemisphere. In secondary auditory cortex HNS show a stronger deactivation in the right compared to left hemisphere, whereas DES show bilateral activation that tends to be stronger in the right than left hemisphere. This pattern of results supports and extends previous findings of cross-modal plasticity in both primary and secondary auditory cortex.

Poster no 8

Right horizontal intraparietal sulcus is activated during multiplication for deaf signers

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Peter Fransson[2], Örjan Dahlström[1], Jerker Rönnberg[1], Mary Rudner[1]

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In hearing individuals, the right horizontal intraparietal sulcus (rHIPS) has been described as a region involved in the relatively slow process of magnitude manipulation along the mental number line, used for example in subtraction. This contrasts with multiplication which is usually solved using fast-accessed pre-learned arithmetic facts involving language regions. We have previously found that whereas hearing individuals perform multiplication faster than subtraction, deaf signers perform both tasks equally fast. In the present study we investigate the involvement of rHIPS in multiplication and subtraction. 16 deaf signers and 16 hearing non-signers, well-matched on non-verbal intelligence, education and age, took part in an fMRI-study. Region of interest analysis show that for subtraction rHIPS was significantly activated for both groups, with no significant group differences. For multiplication, significant activation was only found for deaf signers and, despite similar behavioural results, there was a significant difference in rHIPS activation between the two groups. These results suggest that deaf signers successfully can make use of rHIPS when performing multiplication and that they might rely on magnitude manipulation for both subtraction and multiplication.

Poster no 9

Exploring simultaneous assessment of cortical and subcortical entrainment to ongoing speech

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Brainstem responses to auditory stimuli are an important clinical diagnostic tool in patients where conventional hearing tests might not be applicable. Moreover, comparing subcortical responses with cortical measures provide crucial insights into processing along the auditory pathway, and changes thereof with hearing loss and aging. Generally, this interplay has been investigated using different stimuli for the two processing stages. Cortical activity is often assessed with ongoing speech, while brainstem responses are traditionally investigated with repetitions of simple stimuli such as clicks. However, recent research has shown that subcortical responses can also be measured using ongoing speech stimuli. This suggests that it should be possible to simultaneously observe responses at both subcortical and cortical levels to the same ongoing speech stimuli. The present study explores this possibility.

Poster no 10

Brain volume loss is related to functional impairment in elders with presbycusis

Chama Belkhiria[1, 2]
Rodrigo C Vergara[1, 2], Simón San Martín[1, 2], Alexis Leiva[1, 2], Melissa Martínez[3], Maricarmen Andrade[3], Paul H Délano[1, 2, 4], Carolina Delgado[3]

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Age related hearing loss (ARHL) and neuropsychiatric symptoms (NPS) are important risk factors for cognitive decline and disability. Weather NPS and functionality are affected by ARHL is still unknown. 111 independent non demented subjects > 65 years from the ANDES cohort were evaluated with a complete cognitive and neuropsychiatric assessment including functionality in activities of daily living (ADL), also with pure tone average, Distortion Product Otoacoustic Emissions and structural brain imaging. According to their hearing status they were speared into: controls (n=36), presbycusis with normal cochlear function (PCF, n=33) and presbycusis with cochlear dysfunction (PCD, n=38). PCD had worse executive performance and more NPS than the other groups. NPS and executive functions were the main determinants of functional impairment. ADL impairment was significantly correlated to volume loss in amygdala, nucleus accumbens, temporal and parietal areas only in PCD group. Correlations between ADL and anterior and posterior cingulate cortex atrophy of were found only when contrasting PCD versus controls. These structures are linked to cognition and emotion necessary for decision making and social behavior. Therefore, in presbycusis with cochlear dysfunction, volume loss in fronto-striatal network and limbic areas is associated with functional loss, probably preceding disability and dementia.

Poster no 11

Speech processing difficulties in attention deficit hyperactivity disorder

Rina Blomberg[1]
Henrik Danielsson[1], Mary Rudner[1],
Göran Söderlund[2], Jerker Rönnberg[1]

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The Ease-of-Language-Understanding (ELU) model is based on a large body of research which emphasizes the contribution of cognitive processes when listening to speech-in-noise (SIN); however, SIN-processing is yet to be thoroughly tested in populations with developmental deficits in cognition. The purpose of the study was to compare SIN-performance in adolescents with ADHD to age-matched controls. This population was chosen because core symptoms of ADHD include developmental deficits in cognitive control and because these mechanisms are thought to reach maturity during adolescence in individuals with typical development. The study utilized a hearing-in-noise-task (HINT) under conditions that manipulated the dependency on cognitive mechanisms by varying both the type of noise and the quality of the speech signal. In addition, participants were tested on cognitive capacity measures of complex working memory span, selective attention and lexical access. Our results showed that ADHD-participants had greater difficulty than controls at listening to clear and degraded speech – both in noise and in quiet. Furthermore, individual differences in cognitive capacity greatly determined participants' proficiency with understanding SIN. These findings provide additional support for the ELU-model and further highlight the general disadvantage persons with deficient cognitive capacity have when attending to speech under challenging conditions.

Poster no 12

Localisation of speech in noise: a developmental trajectory from childhood to adult

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The ability to localise, i.e. to tell the direction of, speech in noise is important for listening in noisy real world environments. Several studies have confirmed that children can localise in quiet at an adult-like level by 6 years of age, but only one has investigated children's localisation in noise abilities. It showed adult-like performance by 7 years of age in broadband noise, but worse performance in babble and no age effects. Poor speech in babble localisation could compromise children's listening in real world environments, impacting their language acquisition and educational outcomes.

Here we report the first study to accurately quantify the developmental trajectory of localisation of speech in babble abilities of participants aged 6-29 years. We found that children were significantly worse at localising speech in babble than adults, but that performance gradually improved with age. The trajectory of this improvement was closely fitted by an exponential function, with a time constant of 6 years.

The relationships between performance in localisation, detection and identification of speech in babble were also examined. We found that localisation was not dependent upon detection or identification of speech in babble. Links between development of cognitive abilities and speech in babble are being investigated.

Poster no 13

Danish version of the listening effort assessment scale in adults with hearing loss

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Introduction: The Effort Assessment Scale (EAS) is a questionnaire designed to estimate the self-reported listening effort in the daily life of adults with hearing loss.
Objective: The purpose of this study was to translate and culturally adapt the Danish-EAS (D-EAS) and to investigate the reliability and the validity of this instrument in listeners with hearing loss.
Design: The D-EAS consisted in six questions; participants rate their responses using an analog scale from 0 to 10, with 0 indicating “no effort” and 10 “lots of effort”. The total score ranges between 0 to 60 points, where higher scores indicate higher effort. Participants completed the D-EAS in self-administered format. Adults with and without hearing loss will participate in this study. Also, participants who are new hearing aids users will complete the questionnaire pre and post fitting.
Results: Comparison between groups will be conducted. D-EAS internal consistency, repeatability and factorial analysis results will be reported. Listening effort scores between hearing impaired and control group will be compared, also pre and post Hearing Aids fittings scores.Conclusion: The validation of the D-EAS would provide a self-reported tool to measure the listening effort in daily life situations in clinical population

Poster no 14

Associations between subjective tinnitus and cognitive performance: systematic review and meta-analysis

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Subjective tinnitus is very common and is associated with depression, sleep disturbance and concentration difficulties. Concentration difficulties are observable in people with tinnitus through poorer behavioural performance in tasks thought to measure specific cognitive domains such as attention and memory (i.e. cognitive performance). This is the first systematic review to investigate the association between tinnitus and cognitive performance through meta-analysis.
A comprehensive review of the literature was undertaken using an established theoretical taxonomy, with subsequent meta-analysis of available data. The review was reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards. Searches were conducted in MEDLINE, EMBASE, PsycINFO, ASSIA, CINAHL, Scopus, PubMed, and Web of Science (Science and Social Science Citation Index).
52 records were included in the review, with a primary finding that subjective tinnitus is associated with poorer executive functions. Core executive functions of Inhibition and Shifting have moderate and large associations with subjective tinnitus. Improved understanding of the relationship between tinnitus and cognitive performance will enable tinnitus sub-typing and inform therapeutic methods, for example, it may be possible to deliver targeted cognitive training paradigms to improve executive functioning for individuals with tinnitus.

Poster no 15

Multichannel fast-acting dynamic range compression and cognitive load modulate speech separation performance in middle-aged, normal-hearing listeners

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Multichannel fast-acting dynamic range compression (DRC), commonly employed in hearing aids and broadcasting to enhance audibility, introduces signal modulation distortions and impedes speech segregation processes. Negative side-effects of DRC on speech perception may be offset by exerting more cognitive effort. As a result, the perceptual side-effects of DRC may be especially deleterious for those listeners with lower cognitive capacity, independent of any consequences of peripheral hearing loss. Here, a two-talker separation task was combined with a secondary two-level visual working memory task. Middle-aged (45-65 yrs.), normal-hearing (NH) listeners (< 25 dB SPL, 125 Hz - 6 kHz) were required to identify a set of keywords from two simultaneously presented sentences. These were subjected to three different degrees of DRC (none, moderate, severe), applied either before, or after, mixing the two sentences together. Results suggest that both degree and mixing position of DRC hinder participants' performance under increased cognitive load conditions. For the severe DRC condition, listeners were less accurate and slower at performing the auditory task for sentences processed before mixing than after mixing. Effects were weaker at lower degrees of DRC. This pattern of results is consistent with the idea of fast-acting DRC as a modulator of cognitive effort.

Poster no 16

The effect of tinnitus maskability on the amount of listening effort: a pilot study

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Aim. Chronic tinnitus can result in comorbid distressing symptoms, such as impaired concentration related to speech intelligibility. Previous research stated that non-auditory central aspects, such as working memory and selective attention, may influence speech intelligibility. Therefore, speech intelligibility may become more effortful for tinnitus patients. A pilot study showed significantly more listening effort in normal-hearing young adults with tinnitus compared to a control group (Degeest et al., 2017). It was hypothesized that an attention shift towards tinnitus and an extra load on working memory may reduce cognitive capacity when performing several tasks. However, tinnitus patients may profit from background noise to mask their tinnitus. Therefore, the present study aims to evaluate the effect of tinnitus maskability on listening effort.
Method. Two groups of 5 tinnitus patients, categorized based on their residual inhibition response (i.e. (partial) positive or negative response) are included and compared with a control group. All subjects are matched for age, gender, hearing thresholds and educational level. A dual-task paradigm is used to evaluate listening effort (Degeest et al.2015).
Results. Data collection is ongoing and will be presented at the conference. Listening effort will be compared between the two tinnitus groups as well as with the control group.

Poster no 17

How does temporal fine structure relate to cognition and speech recognition in listeners with normal and impaired hearing?

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Many studies have demonstrated a clear link between cognition and speech recognition. There is evidence to suggest that sensitivity to temporal fine structure may explain some of the remaining individual variability in both speech recognition and cognitive performance, once the effects of age and hearing sensitivity are accounted for. The aim of the present study is to further explore the links between temporal fine structure, and both cognition and speech recognition in a large sample of adults with normal and impaired hearing. Additionally, we will investigate the effects of age and hearing sensitivity on performance on the tasks, and on relations between the variables.

The cognitive test battery included measures of working memory and executive function. Aided speech recognition was assessed using an adaptive sentence- in-noise recognition task.

By providing a greater understanding the relations between temporal processing, cognitive ability and speech recognition, the findings will enable us to discuss the effects of supra-threshold processing on speech recognition, and to critically examine competing theoretical explanations of these mechanisms.

Poster no 18

Listen carefully: healthcare design for listening effort and cognitive function

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For today's ageing population, hearing loss and dementia prevalence are expected to increase. Recent research suggests that hearing loss is the highest modifiable risk factor for dementia in midlife. Research also suggests a potential pathway between hearing and cognitive decline, with listening effort, working memory and cognitive load as principal mediators. Research examining hearing impairment, listening effort and fatigue is limited, although a growing amount of research tests listening effort objectively in laboratory settings. The current explorative proof-of-concept study investigates whether increased listening effort, measured objectively using pupillometry, is associated with cognitive function in healthy individuals and those affected by Mild Cognitive Impairment (MCI). For those exhibiting higher listening effort in noisy environments, cognitive performance and listening effort is examined with the use of hearing aids. A negative association is expected between listening effort and cognitive performance, and hearing aid use is expected to reduce listening effort and have a positive impact on cognitive function. Clinicians and practitioners are urged to act on dementia prevention, intervention and care to improve quality of life for society into the future. This study will provide results to design and support the implementation of listening effort testing as a complex intervention in point-of-care settin

Poster no 19

Tau pathology is associated with poorer subjective hearing ratings among cognitively normal adults at increased risk for Alzheimer's disease

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Signs of Alzheimer's disease (AD) pathology are typically present in the brain years before clinical symptoms manifest during a stage termed preclinical AD. Mounting evidence suggests hearing problems occur in AD and may even precede cognitive impairments. However, few studies have examined their relationship to AD biomarkers directly.

Data from 130 late middle-aged, cognitively normal adults enrolled in the Wisconsin Registry for Alzheimer's Prevention (WRAP) was used for this study. Participants underwent a lumbar puncture to collect cerebrospinal fluid (CSF) and completed a five-item hearing questionnaire at separate visits. CSF beta-amyloid (Aβ) and tau levels were measured by ELISA and internal norms were used to designate participants as being Aβ +/ Aβ - and tau+/tau-. Covariate-adjusted regression analyses were used to assess relationships between biomarker positivity and subjective hearing ratings.

Tau+ adults reported poorer subjective hearing ratings overall than those who were tau-, whereas there was no difference in overall ratings between Aβ+ and Aβ- adults. Considering individual questionnaire items, tau positivity was associated with significantly poorer ratings of sound clarity, spatial hearing ability, and speech perception in multi-talker environments. These findings suggest hearing problems are present in preclinical AD, but behavioral measures are needed to further clarify these associations.

Poster no 20

Is cross-modal reorganisation adaptive or maladaptive for speech recognition outcomes in post-lingually deaf cochlear implant users?

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Cortical reorganisation has been proposed as a contributor to variability in cochlear implant (CI) outcomes. Specifically, cross-modal activity in auditory and visual cortices has been shown to correlate with auditory-only speech understanding in post-lingually deaf CI users. However, it remains unclear whether this activity is 'adaptive' or 'maladaptive' for functional outcome, and it is of interest to understand how this may relate to audiovisual speech perception, given that speech perception is inherently multisensory. Importantly, there is variability across studies in the types of visual and auditory stimuli used, e.g. 'basic', such as gratings and noise, vs. 'speech-based' stimuli, which might engage differential cortical networks. This study therefore aimed to examine cortical activations to both basic and speech-based visual and auditory stimuli in a group of normally-hearing controls and post-lingually deaf CI users, and their relationship to speech understanding in auditory-only, visual-only and audiovisual conditions. Functional near-infrared spectroscopy (fNIRS) was employed as a non-invasive technique that is not susceptible to electrical or magnetic artifacts common to other neuroimaging methods. Responses were measured via optode arrays over bilateral auditory and visual regions of interest. Understanding central factors that may contribute to variability in outcomes could help inform and optimise CI rehabilitation programs.

Poster no 21

Hearing loss in older adults: a marker of ageism and self-ageism

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A qualitative study was designed to capture the perception of older adults concerning aging and hearing loss associated with aging. A group of 35 older adults participated in a semi-structured interview during which they were invited to describe: (1) their perception of society's view of hearing loss in older adults, (2) society's view of aging, (3) their personal view of hearing loss associated with aging and, (4) their personal view of aging. An analysis of the interviews revealed that some older adults hold negative stereotypes of aging as well as negative views of hearing loss associated with aging. A secondary analysis of the interviews was conducted to further analyse the association that the participants made between aging and hearing loss associated with aging. The results of revealed that some older adults hold a negative view of hearing loss. However, for other participants, negative attributes are associated with hearing loss because this health condition serves a marker of aging. In fact, aging (i.e., ageist attitudes) seems to be the predominant stigmatizing trait. The poster will report the sub-themes that emerged under the major theme labelled 'perception of hearing loss and aging'. Implications for audiological rehabilitation will be reported.

Poster no 22

Prevalence and degree of hearing loss in 85-year-olds: a birth cohort study with a longitudinal design

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Introduction: As the proportion of older people increase, there is a need to investigate the prevalence of age-related hearing loss.
Aims: To determine hearing thresholds in a birth cohort of 85-year-olds (born in 1930) and to identify differences in hearing acuity between two birth cohorts, 30 years apart. Results from longitudinal data between ages 75–85 is also presented.
Methods: This study was part of The Gothenburg H70 Cohorts Studies (H70), a large gereontological and epidemiological study with a cross-sectional population-based design. Hearing thresholds were measured, using automated pure-tone audiometry, in an 85-year-old unscreened population (n=286). A subsample (n=182) was studied longitudinally. A birth cohort of 85-year-olds, born in 1901–02, was investigated earlier (n=249).
Results: Based on WHO´s criteria, the hearing loss prevalence was 86% for men and 81% for women. The prevalence rate has decreased in men but retained in women, over three decades. The longitudinal study showed a significant hearing deterioration with similar annual rate of decline in men and women.
Conclusion: The hearing acuity has improved significantly among men over three decades, but not in women, in Sweden. Despite improved hearing in men, the future need of aural rehabilitation is expected to increase, due to demographic changes.

Poster no 23

A multimodal investigation of noisy conversations: Movement, gaze, and speech strategies when communication becomes difficult

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Most conversations do not occur in perfect quiet. Gossiping in a café, talking in a restaurant, or chatting in a car all require people to ignore the background noise to concentrate on what their partners are saying. While these situations are challenging, prior studies have shown that strategies such as increasing vocal intensity, adjusting head orientation, or directing gaze to the speaker can be beneficial. However, these studies have used artificial contexts that did not include real interaction. It is not clear whether these strategies hold when social constraints are also present.

We investigate how individuals with varying hearing ability have conversations in noise. Specifically, we report the fine-grained dynamics of natural conversation between unfamiliar dyads and triads of age-matched interlocutors (n = 63), addressing how different levels and types of background noise affect speech, head movement, and gaze. We show that many potentially beneficial behaviours are not used optimally, including increases in vocal intensity and head orientation. However, people do move towards each other and speak more loudly when communication is difficult. Understanding conversation behaviours could inform broader models of interpersonal communication, as well as being used to develop new communication technologies.

Poster no 24

Own voice sounds and phonological awareness in hearing aid users

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It has been suggested that postlingual hearing impairment leads to degradation of phonological representations. This notion is supported by data showing poorer phonological awareness as measured by performance in a visual rhyme judgment task by individuals with hearing impairment compared to individuals with no hearing impairment. Surveys of hearing aid users have shown that problems with Own-Voice (OV) sounds are common and affect overall hearing aid satisfaction. Degradation of phonological representations is also likely to affect OV perception.
In the present study, we therefore investigated the association between performance on the Cross-modal Phonological Awareness Test (C-PhAT) and perceived alterations in OV-sounds as well as grade of perceived problems with OV-sounds in 100 hearing aid users. The participants' perception of OV-sounds as well as subjective ratings of hearing problems, physical health and mental health were also collected.
We will discuss correlations between perceived alterations in OV-sounds and performance on C-PhAT, as well as grade of perceived problems with OV-sounds. A special interest is examining the difference in phonological ability in a group perceiving OV-alterations with OV-problems, compared to a group perceiving OV-alterations without OV-problems.

Poster no 25

The perceived benefit of eye gaze steering in noisy environments for hearing aid users

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People with hearing loss experience problems especially in noisy environments. An increasing number of studies reports on solutions where sound is enhanced through the attention of the user. Studies focus typically on the effectiveness of the solution (e.g. Favre-Felix et al, 2018) or which type of solution the users prefer (e.g. Hart et al, 2009). However, little is known about the value attention steering solutions might have for hearing aid users.

The current study examined how hearing aid users perceive the extra benefit from a device that enhances attended speakers by means of eye gaze steering compared to conventional hearing aids. Seven hearing aid users were equipped with a golden standard device that identifies eye gaze position in a virtual environment. The eye gaze position was used to enhance an attended speaker in a competing talker situation presented as video recordings, live size, using an 88'' screen and three loudspeakers. Compared to using hearing aids alone, speech comprehension scores improved by 58%. Furthermore, ratings on a visual analogue scale showed a speech intelligibility improvement of 5.3 points and a decrease in listening effort of 4.1 points.

The poster presents main findings and implications for the development of attention steering techology.

Poster no 26

The effect of hearing loss on cognitive status at age 70

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Introduction: There is a growing body of evidence indicating that persons with hearing loss are at greater risk of cognitive decline and dementia. The aim of this study was to investigate the association between hearing loss and cognitive impairment in the most recent cycle of the The Gothenburg H70 Birth Cohort Studies.
Methods: The study sample (N=1130) consisted of 70-year old individuals representative of the City of Gothenburg. Hearing function was assessed with pure-tone audiometry, and cognitive function was assessed using the Mini Mental State Examination (MMSE) scale. A cut-off score of <24 was considered as abnormal cognitive status. A binary logistic regression analysis was performed, with the outcome on the MMSE (normal vs. abnormal) as the dependent variable. The primary explanatory variable was the four frequency pure-tone-average (0.5-4 kHz) for right and left ear separately. The model was adjusted for educational background, smoking, blood pressure and sex.
Results: Hearing loss in either ear increased the odds of having an abnormal cognitive status (95% CI of OR: 1.006-1.078). The effect remained in the right ear only after adjusting for confounders. Thus, there is some evidence of hearing loss as a risk factor for dementia at age 70.

Poster no 27

The brain basis of working memory for social stimuli

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Working memory tasks typically recruit fronto-parietal regions of the brain. Recently it has been suggested that working memory for social stimuli may additionally recruit regions related to social reasoning. The purpose of the present study was to investigate this. Thirty-one participants performed a 2-back working memory task in which sequences of pictures with faces, depicting female persons with four different emotional expressions were presented against a geometrical background figure. Participants matched the content of each picture to the last picture but one based on two social conditions (facial identity and emotional expression), and one non-social condition (visual figure). In the perceptual control task, participants decided whether the geometric background figure was black. In comparison to the control task, the 2-back task generated greater activity in the fronto-parietal network, including e.g. insula, BA8, and BA39. Compared to the non-social condition, the social conditions showed greater activity in regions (e.g. precuneus) previously reported to be associated with social reasoning. In addition, working memory processing of emotional expressions invoked more activity than equivalent processing of facial identity in areas related to lexico-semantic processing. These results suggest that working memory for social stimuli extends beyond the traditional working memory network in the brain.

Poster no 28

Bridging the gap between hearing screening and successful rehabilitation: a randomized controlled trial of motivational interviewing via internet

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Objective: Not all people who fail an online hearing screening have the same intrinsic motivation to seek help, and might benefit from consultation targeting motivation and ambivalence for hearing behavioral change.
Aim: This randomized controlled trial aimed to: (1) determine the prevalence of help seeking, hearing-aid uptake, and hearing aid use after intervention versus control, (2) explore improvement on self-reported measures of hearing disability, quality of life, anxiety, depression, and hearing self-efficacy after intervention versus control, and (3) explore predictive factors for help seeking behavior.
Method: Principles from Motivational interviewing, self-efficacy, and Acceptance and Commitment therapy were combined into a short, fully automated online intervention, with the aim to elicit and strengthen motivation for behavioral change. A total of 117 participants who failed an online hearing screening were randomized to intervention or control, and 68 (58%) completed a 9-month follow-up.
Results/conclusion: The intervention did not improve hearing help seeking behavior compared to control, and it did not lead to a reduction in self-reported hearing difficulties, anxiety, or depression; nor to an improvement in quality of life. Having discussed one's hearing with health care personnel on an earlier occasion could significantly predict help seeking at follow-up.

Poster no 29

Online attended speaker decoding with EEG

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Many listeners report difficulties in segregating a speech stream from a noisy environment. These difficulties cannot be fully explained by pure tone hearing thresholds. Individual differences in selective auditory attention may play an important role.
In order to better understand the dynamics of selective auditory attention over time, we conducted a two competing speaker electroencephalogram (EEG) study. Participants had to attend to one audiobook story while a second one had to be ignored. An online attended speaker decoding method was applied to identify the attended speech signal in the EEG. The individual decoding performance was analyzed and linked to subjective ratings of listening effort, motivation and fatigue.
The grand average attended speaker decoding profile indicated performance above chance level. A median split based on decoding performance in the EEG indicated that the group of poor performer experienced higher listening effort and fatigue compared to the group of good performers.
Taken together our results show that online EEG based attended speaker decoding in a complex listening situation is feasible. Individual decoding profiles could be used as an objective measure of listening effort and may help to improve hearing aid fitting in the future.

Poster no 30

Individual differences in perceptual adaptation to unfamiliar speech sound categories

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The present study examines whether listeners flexibly adapt to unfamiliar speech patterns such as those encountered in foreign-accented English vowels, where the relative informativeness of primary (spectral quality) and secondary (duration) cues tends to be reversed (ambiguous spectral quality vs. exaggerated duration). This study further tests whether listeners' adaptive strategies are related to individual differences in phoneme categorization gradiency and cognitive abilities. Native English listeners (N=36) listened to continuum of vowels /ɛ/ and /æ/ (as in head and had) varying spectral and duration values to complete a perceptual adaptation task and a visual analogue scaling (VAS) task. Participants also completed cognitive tasks examining executive function capacities. Results showed that listeners mostly used spectral quality to signal vowel category at baseline, but rapidly adapted by up-weighting reliance on duration when spectral quality became no longer diagnostic. The VAS task showed substantial individual differences in categorization gradiency but these differences were not linked to their adaptive patterns. Results of cognitive tasks revealed that individual differences in inhibitory control correlated with the amount of adaptation. Together, these findings suggest that listeners flexibly adapt to unfamiliar speech categories using distributional information in the input and individual differences in cognitive abilities influence their adaptability.

Poster no 31

Individual differences in plasticity in speech perception under cognitive load

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The present study examines how and to what extent speech perception abilities are modulated by increased cognitive load in a dual task and whether individuals differ in the extent to which they adjust their cue weighting strategies in the utilization of multiple acoustic cues in this challenging condition. This study also investigates how individual differences in the adjustments of cue weighting strategies under cognitive load are related to individuals' cognitive abilities. Native English listeners (N=54) were engaged in a dual task in which they completed a two-alternative forced choice (2AFC) identification task with a concurrent visual search task, after a baseline 2AFC task. Participants also completed cognitive tasks examining working memory capacity and inhibitory control. Results revealed that listeners overall showed increased cue weights under cognitive load, which may be interpreted as compensatory cue weighting strategies for adapting to phonetic categories under cognitive load. However, there were large individual differences in the extent to which these adaptive cue weighting strategies manifest and these individual differences were associated with individuals' cognitive abilities. That is, individuals with better working memory and inhibitory control showed more increases in cue weights than those with poorer working memory and inhibitory control.

Poster no 32

Characterizing the binaural hearing abilities of school-age children with a history of middle-ear diseases

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Introduction and aims: Recently, a number of studies have indicated that recurrent middle-ear disease during early childhood may lead to long-term binaural speech-in-noise deficits. The current study followed up on this by investigating differences in monaural and binaural hearing abilities in noise among school-age children with and without a history of middle-ear diseases. Another aim was to identify efficient measures for the diagnosis of such hearing deficits.
Methods: Thirty children aged 6–12 yrs with a history of recurrent otitis media with infection or effusion and 10 children aged 6–12 yrs without any history of ear diseases participated. All children had normal middle-ear function and audiometric hearing thresholds at the time of testing. We performed various monaural and binaural speech reception measurements in the presence of stationary noise or competing speech. Furthermore, we assessed sensitivity to monaural and binaural phase information in the presence of stationary noise using psychoacoustic methods.
Results: We expect that the results of the current study will shed further light on if and how recurrent early-childhood middle-ear diseases influence hearing abilities in noise and how such deficits can be identified in clinical practice.

Poster no 33

Alpha desynchronization predicts understanding of incomplete sentences

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In everyday conversations, we often do not hear complete utterances (e.g. due to background noise or a bad phone connection). Especially older adults, even when considered normal hearing, report having difficulties understanding speech in such situations. The modulation of cortical alpha oscillations has been established to reflect auditory top-down control as well as language-related working memory. Therefore, it is likely to be involved in the top-down restoration of missing chunks of an auditory signal. In this study, 22 normal hearing older adults were presented spoken sentences into which regular intervals of silence had been inserted. In three conditions, the silence intervals were kept constant (100ms) while the intervals of signal varied (75ms, 100ms, and 150ms). In a fourth condition, both signal and silence intervals had a length of 50ms. Participants were instructed to repeat as much of each sentence as possible. Both signal-to-silence ratio as well as interval size influenced sentence repetition scores: Overall, participants scored highest in the 50ms interval condition. In conditions with the 100ms silence interval, participants scored higher the more signal the sentence contained. Across all conditions, alpha desynchronization over centro-parietal electrode sites predicted sentence repetition scores, even after controlling for age and pure-tone hearing thresholds.

Poster no 34

Brainstem-cortical relationship during easy and challenging listening situations

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Listening difficulties in background noise are common in individuals with auditory processing problems. The study aimed to understand the relationship between different levels of auditory-neural coding (brainstem and cortical) while participants listened to speech-in-noise with varying listening demands. We recorded frequency-following responses (FFRs) and cortical auditory evoked potentials (N1, P2, P3a, P3b) to spoken-digits-in-noise with (easy) vs. without (challenging) preserved temporal fine-structure cues. Twenty-one young adults with normal hearing were tested at the same audibility and performance levels (71% correct score). The results will be discussed based on the following hypotheses: 1) easy-listening may show a positive brainstem-cortical correlation indicating that sensory fidelity at the brainstem during speech-in-noise processing predicts cortical-attentional processing upstream 2) challenging-listening may show a negative brainstem-cortical correlation indicating the compensatory nature of cortical processes as listening demands increases, i.e, as the listening situation gets challenging cortical activity increases to adjust for poor brainstem coding.We also examined how individual selective-attention and TFS processing abilities influenced neural representation. Results will be discussed in the light of: 1) better performers may show no difference between the two listening conditions indicating superior encoding even in challenging-listening situations 2) Poorer performers will show robust neural processing only in the easy-listening situation.

Poster no 35

Sign language and spatial abilities: comparison in deaf users of a sign language (signers) and users of a spoken language (non-signers)

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Across the adult lifespan, cognitive abilities change. Studies have investigated the age-related factor in specific spatial ability subcomponents and have shown that mental rotation (MR), spatial perception (SP), spatial visualization (SV) and perspective taking (PT) are affected by age. The assumption that deaf people have better visual-spatial skills compared to hearing people is widely spread. However, few investigations concentrated specifically on their spatial skills. The aim of this research is to investigate whether there are differences in performance on spatial ability (MR/SP/SV/PT) tasks among participants of different age groups (young adults [YA]/ older adults [OA]) as well as among participants with different language experience (non-signers/signers). We predict that signers will perform better on spatial ability tasks compared to their peer non-signers of the same age group and that OA will perform more poorly compared to YA of the same language modality. Data is collected from 80 participants: 40 OA from 65 to 80 years old (20 signers, 20 non-signers) and 40 YA from 18 to 35 years old (20 signers, 20 non-signers). The spatial skills will be tested using a battery of 7 tests (e.g.: Mental Rotations; Hooper Visual Organization). Statistical analysis will be run based on accuracy and response time.

Poster no 36

Effect of noise-reduction scheme on auditory attention detection and listening effort

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Speech communication often requires the listener's attention to a target speaker while ignoring interfering speakers at the same time. In particular people with hearing impairment report listening as demanding and effortful in such a situation. Hearing-aid signal processing, such as noise-reduction schemes, are designed to help the user overcome such difficulties. Using Electroencephalography (EEG), it has been demonstrated that a listener's neural response can be decoded to detect the listener's attention.

In this study, the impact of a noise-reduction scheme on both attention detection and listening effort was investigated. Participants were instructed to listen to target speech while ignoring competing talkers in a spatial arrangement of loudspeakers. EEG and pupillometry were applied to examine the impact of the noise reduction scheme (active noise-reduction vs inactive) on the selective attention and listening effort, respectively, for a group of hearing-impaired listeners. Preliminary results indicate enhanced selective attention and decreased listening effort with active noise reduction. In conclusion, using EEG-based selected attention detection to study the effect of hearing-aid signal processing may help facilitate our understanding of neural mechanisms involved in aided listening situations.

Poster no 37

Examining relationship between working memory capacity, hearing loss, and hearing in noise

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Previous research has shown that, for people with hearing loss, there is a robust relationship between working memory capacity (WMC) and hearing in noise. For people with normal hearing, on the other hand, the results are somewhat mixed. In the current study, the aim was to examine and compare, this relationship in a sample of people with hearing loss (n = 197) and without hearing loss (n = 183). To this end, performance in three working memory tasks (reading span, semantic word-pair, and visual-spatial working memory), hearing ability (better ear PTA), and speech recognition under one condition of background noise (Hagerman tasks with 4-talker babble) were measured. Preliminary results indicate that WMC (i.e., a composite score of all three WM tasks) is related to hearing in noise in both groups. In normal hearing listeners, the relationship between speech recognition in noise (i.e., 4-talker babble in the Hagerman tasks) and WMC disappeared after controlling by age and PTA. In conclusion, WMC capacity is important for persons with hearing loss in cognitively demanding situations regardless of age. The results of the current study will be discussed within theoretical frameworks (e.g., the Ease-of-Language Understanding model).

Poster no 38

Measuring the effects of task difficulty and signal processing on recall: a new version of the SWIR test

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The Sentence-final Word Identification and Recall (SWIR) test (Ng et al. 2013) was designed to investigate the effect of hearing aid signal processing on memory for intelligible speech in noise. Previous findings showed that benefit from signal processing could be dependent on the task demand and individual cognitive capacity.
This study aims to continue developing the SWIR test by varying the task difficulty (list length). We are also comparing whether knowing the degree of difficulty influences recall performance and strategy. The effects of noise and noise reduction on recall are investigated.
Adults aged 40–70 years are recruited. All participants have moderate to moderately-severe symmetrical sensorineural hearing loss and minimum one year of hearing aid experience. Signal processing is provided via a hearing aid simulator. Besides the modified SWIR test, the Hearing in Noise Test and various cognitive tests are administered.
The preliminary results showed a main effect of list length, suggesting recall performance decreases with increasing list length, and a main effect of noise reduction, indicating that recall performance was higher when noise reduction was on in comparison to when it was off. We will further analyse this benefit based on list length, noise and individual cognitive capacity.

Poster no 39

Conversational dynamics between normal-hearing and hearing-impaired interlocutors

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Having a conversation requires more resources than just understanding speech. Previous studies of the timing of turn taking in conversations suggest that in order to sustain normal, fluid turn-taking, interlocutors have to predict the end of each other's turns. Thus, while noise and hearing loss should make understanding speech more difficult, it should also reduce the resources available for speech planning, introducing a delay in response times. We recorded conversations between 12 pairs of native Danish young normal-hearing (NH) and older hearing-impaired (HI) listeners with mild presbyacusis in quiet and multitalker babble at three levels. The interlocutors conducted a Diapix task, finding differences in two near-identical pictures. The time it took the pairs to complete the task increased with increasing noise level, suggesting that communication was impaired by the noise. Both HI and NH talkers responded more slowly and with more variability with increasing noise level, and the effects were larger for HI. In addition, talkers held their turns significantly longer in increasing noise levels, which allows more time for speech planning and understanding. While the HI talkers kept their speech rates constant, the NH decreased their speech rates with increasing noise level to match that of the HI.

Poster no 40

Relationship between speech perception and cognitive function in people with hearing loss

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The associations between age-related changes in hearing, speech perception and cognition have been investigated extensively. For instance, Rönnberg et al (2016) examined test variables related to speech communication, namely hearing, cognition and aided speech-in-noise outcomes in 200 hearing aid users. The present study sought to investigate whether people with hearing loss who failed the Mini Mental State Examination (MMSE), which is a common screening test for evaluating cognitive function, would perform differently in these test variables. All participants tested in Rönnberg et al 2016 and completed MMSE were included in this study. Among the sample, 8.6% of the participants failed MMSE (scores ≤ 26). These participants' hearing, cognition and aided speech-in-noise outcomes test results were then compared against the results obtained from the rest of the sample who passed MMSE. Despite of comparable age and hearing sensitivity, people who failed MMSE performed worse in a number of aided speech-in-noise tests, such as gated consonant and vowel identification, phonologically-balanced word recognition, and the Hearing in Noise Test and the self-reported auditory disability. These results shed light on how mild cognitive decline could have affected the objective and subjective measures of aided speech perception in people with hearing loss.

Poster no 41

Social factors and individual outcomes in cochlear implant users

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Background: Cochlear implants (CIs) can improve the quality of life for people with profound sensorineural hearing loss, but individual users struggle to varying degrees with different listening environments, which can negatively impact social well-being. In this study, our aim was to assess the social engagement of CI users in daily life and relate it to objective hearing outcomes.
Methods: Ecological Momentary Assessments (EMAs) collected using a Smartphone app were used to probe patterns of listening behavior in CI users and age-matched normal hearing (NH) adults to detect differences in social engagement and overall quality of life. Speech perception measures, with accompanying difficulty ratings, were also performed to uncover possible correlations between objective and subjective listening behavior.
Results: Preliminary data suggest that CI users consistently report more difficulty listening in everyday environments than NH peers, but also tend to be in environments with overall lower levels of background noise. Perception of listening difficulty is also very different for CI users and NH listeners, with CI users reporting little difficulty despite poor speech perception performance.
Conclusions: Overall, this data suggests that systematic differences exist between how CI users and NH adults navigate and manipulate listening and social environments in everyday life.

Poster no 42

Using functional near infrared spectroscopy to map lateralization patterns of language networks in children

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Structural and functional activation patterns of language networks become more specialized and progressively begin to span over both hemispheres during development reflecting increased linguistic proficiency. However, detailed lateralization profiles for the different aspects of language processing are still lacking. Therefore, we aim to investigate activation patterns and functional connectivity across language networks in relation to age and task performance and assess language system resting state connectivity.

To accomplish that 40 healthy native English speakers aged between 6 and 16 years old will be recruited. Functional lateralization profiles and neural connectivity will be acquired using functional near infrared spectroscopy, a neuroimaging technique which uses infrared light to measure levels of oxygenated and deoxygenated haemoglobin. Participants will also complete standardized behavioural and language assessments.

We expect that i) variability in lateralization profiles across tasks will be greater with increased age and linguistic performance, and ii) connectivity in language regions will increase as a function of language performance, after controlling for effects of age.

This research will inform future paradigms investigating functional lateralization and connectivity in children with developmental language disorder and will provide insight into how the typical language system matures.

Poster no 43

Objective measures of listening effort in cochlear-implant users

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Cochlear-implant (CI) users report listening to be an effortful task made worse by noisy everyday environments. The ongoing demand for increased mental exertion has negative consequences for communication, participation and potentially long-term cognitive health. Reliable objective measures of listening effort, suitable for CI users, are needed to aid the development and evaluation of effective interventions. This study aims to quantify listening effort in the implanted population by combining two simultaneous physiological measures: brain activity and pupil size. These measures will be recorded using fNIRS-based brain imaging and pupillometry techniques, while a group of 24 CI users and 24 normally-hearing controls listen to sentences masked by background noise. Additional self-reported measures of listening effort will also be obtained.

We hypothesize that i) CI users will show increased activation in frontal brain regions and larger pupil diameter compared to their normally-hearing peers, reflecting greater listening effort even at highly favourable signal-to-noise ratios; and ii) there will be a correlation between physiological and self-reported measures of listening effort.

The results of this study will facilitate an accurate quantification of the cognitive demands of listening through a CI. New insights about the cortical correlates of effortful listening could also inform improvements in CI technology.

Poster no 44

The effect of background noise in a mental calculation task: performance and effort for 10 to 14 years old children

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In learning spaces, listening and performing cognitive tasks are activities that only rarely take place in quiet. In fact the classroom is a complex acoustical environment where reverberation and auditory distractors concur in interfering with children's academic tasks. This study explores the effect of different types of background noise on one of the crucial abilities in the school setting: mental calculation. For this task, both accuracy and speed were examined, the latter informative on the allocation of mental resources (effort).

267 children (10 to 14 years) from three schools located in Ferrara (Italy) participated in the experiment. Mental calculations (addition and subtraction) were presented to the children in three listening conditions: quiet (signal-to-noise ratio SNR >15 dB), students' activity noise (SNR=0 dB), road traffic noise (SNR=0dB). Children were asked to select the correct answer of each operation between multiple choices. The task was simultaneously administered to all children in their classroom via tablet and loudspeakers, in a one-hour session. The children's math fluency was also assessed in quiet.

Children's performance in quiet and in the two background noises were compared, to highlight the specific noise effects. Contextual factors yielding within-students differences (age, school…) were controlled for in the analysis.

Poster no 45

Auditory training and its effects on listening, cognition and quality of life for adult cochlear implant users

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Auditory training (AT) is often recommended to improve speech understanding in cochlear implant (CI) users. However, inconsistencies in AT outcomes have been demonstrated within and between studies. Therefore, it becomes important to understand which individuals may benefit from AT, and which abilities AT may be targeting. This randomized crossover study assessed the effectiveness of an AT program in comparison to a visual training (VT) program at improving short- and long-term trained and untrained measures of listening and cognitive abilities and quality of life. The stimuli used in the AT consisted of speech in adaptive 4-talker babble, whereas the stimuli used in the VT consisted of text masked by adaptive vertical bars (i.e. adapted from the Text Recognition Threshold test). Participants (n=26 adult CI users, m=63.23 years) were assessed twice before (to control for procedural learning) and twice after (short- and long-term effects) undergoing each training program. A statistically significant improvement was shown for trained tasks in both training programs. This, however, did not transfer to untrained measures of listening and cognitive abilities and quality of life. In general, test-retest effects were higher than training effects. The implications of these findings for adult CI users and AT protocols will be presented.

Poster no 46

Assessment of effort mobilization with eeg and pupillometry in hearing aid users

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Individuals who are hard of hearing have to spend more cognitive resources compared to normal hearing in order to comprehend speech in noisy environments. Excessive use of such resources will result in numerous negative effects such as fatigue or disengagement in everyday life conversations. To find out how effort mobilization can be detected in physiological measures, EEG and pupillometry were . Two competing talkers (±30°), consisting of 30-second news clips, and a four-talker babble noise (180°) were presented to the subjects. After instructing the test subjects to pay attention to either right or left target, two conditions (0 dB and -5 dB), were presented randomly to see how the changes of SNR affect pupillometry and EEG data. The results showed that 10 to 25 seconds after the target onset, higher mean pupil dilation and less EEG alpha power activity in parietal lobe were observed in more demanding situation. This study demonstrated the benefits of listening in high SNRs as the results suggested reduced research allocation, and thus less effort mobilization, when attending the target speaker. However, reduced effort mobilization was only shown for specific epochs during listening to a continuous speech as indicated with both EEG alpha power and pupil dilation.

Poster no 47

Different aspects of working memory and their relation to phoneme understanding

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The speed of everyday communication leaves little time for dwelling on the fine spectro-temporal details of perceived speech. Since the speech details are often ambiguous or unavailable to the hearing impaired listeners, they may depend more on cognitive processes to make sense of the speech signal. In the current study, we are interested in different aspects of working memory and their relation to phoneme understanding in normal hearing (N = 14, Age M = 29) and hearing impaired listeners (work in progress, current N = 8, Age M = 64 years). Digit span forward (DST), phoneme span (PST), transposition errors and self-reported internal and external distractibility of the listener (attentional style questionnaire, Van Calster et al. 2018) are being measured as well as phoneme understanding in quiet and in noise. Preliminary results indicate correlations between attentional style of the listener and the transposition errors, for the hearing impaired listeners (Spearman's rho rinternal = .79, rexternal = .73; both ps <.05). Both the DST and PST results correlated with phoneme recognition in quiet and in noise for the hearing impaired listeners (Spearman's rho rDST = .91, $p < .001$; rPST = .83, $p < .011$). Full results will be presented and interpreted.

Poster no 48

Pragmatic language ability: a comparison of children with normal hearing and children with cochlear implants

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Pragmatic language ability refers to the competence to use language in a social context. It has been found to be correlated to success in general education for deaf and hard of hearing children. It is therefore important to study why deaf and hard of hearing children often show a delay in this language skill. In the current study the pragmatic language ability of deaf and hard of hearing children using cochlear implants was rated significantly lower than that of hearing children. Core language ability, verbal reasoning and verbal working memory were significantly correlated with pragmatic ability for the hearing children. For the deaf and hard of hearing children the verbal cognitive measures seemed to be more relevant than core language ability. This was especially the case for verbal fluency. A group comparison revealed that the deaf and hard of hearing children were less able than the hearing children to generate semantical clusters. The relationship between pragmatic language ability and verbal fluency for the deaf and hard of hearing group may be explained by the use of a different strategy for the verbal fluency task. The relationship could also be due to a delayed development of a structured semantic network.

Poster no 49

Logical and auditory inference-making in normally-hearing and hearing-impaired listeners

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Everyday information processing depends on the quality of the information that is picked up by the senses, either via an incoming signal or from memory. In today´s information society we often encounter situations where inferences are drawn based on uncertain information due to noisy or ambiguous sensory stimuli. The present study aimed to investigate differences between two measures of inference making; auditory inference making in speech-shaped noise and visual logical inference making. We will present results from two different groups participating in the longitudinal N200 project; a group of age-appropriate normally-hearing (NH) individuals, and a group of age-matched hearing-impaired (HI) individuals. The results indicate that HI individuals demonstrate significantly faster response times but less accuracy on a logical inference-making task, whereas the groups do not seem to differ in performance in an auditory inference-making task. We will also present results on how these two inference making tasks relate to ageing and working memory capacity.

Poster no 50

Objective and subjective outcome measures of speech recognition in noise in adults

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Every day individuals engage in communication in sound environments filled with background noise and / or competing talkers. In the lab, objective tests of speech recognition are typically used, but it is also important to take into account the individual's subjective view. If objective and subjective measures do not correlate, perhaps findings will not generalise very well to everyday situations and difficulties. The present study aimed to investigate the relation between objective and subjective measures of speech recognition. Two-hundred normally-hearing (for their age) individuals, and 50 individuals with hearing loss, were presented with sentences from the Swedish HINT masked with a speech-shaped noise, and completed the Speech, Spatial and Qualities of hearing scale (SSQ). Results will be presented comparing the performance on the Swedish HINT with the ratings on the speech subscale from the Speech, Spatial, and Qualities of hearing scale (SSQ). This is to determine if the performance in the HINT corresponds to the subjective ratings indexed by the SSQ. The results from the present study may help identify differences and common links between a clinically used, objective measure, and a subjective measure of speech recognition, to further our understanding of how such findings can be generalised to everyday functioning.

Poster no 51

Cortical connectivity for speech and sound listening in children with listening difficulties and ADHD

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There has been prolonged debate whether listening difficulties in noise are a developmental disorder in its own right or a symptom of another. This study used resting state MRI to investigate the functional connectivity of sensory networks in four groups of children: 18 ADHD children; 21 children with ADHD and (parent-reported) LiD; 21 children with LiD but no reported ADHD; and 41 typically developing (TD) children. All children had normal pure tone audiometry. Meta-analysis and data-driven parcellation identified speech-perception, sound (non-speech) hearing and visual networks. TD children showed strong temporal correlations within the speech-perception and sound hearing networks. In the speech-perception network the LiD children showed anticorrelations, and the ADHD children showed weaker correlations. In the sound hearing network, compared to the TD children, the LiD children showed similar correlations (regardless of if they had an ADHD diagnosis or not), and the ADHD children showed anticorrelations. No functional connectivity group differences were found in the visual network. These results suggest that LiD and ADHD both have alternative hearing networks, each with a distinct signature. Cortical areas work at opposing rates in the LiD speech-perception network and in the ADHD sound hearing network.

Poster no 52

Speech listening plasticity in children with mild to moderate hearing loss

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Difficulty understanding speech in noise is a common complaint of hearing impairment. Improving this ability is especially important in children as they develop language skills. In this study 15 experienced hearing aid users aged 8-12 with mild to moderate hearing loss (MMHL) were fit with bilateral omni-directional enabled hearing aids. To assess behavioural and cortical plasticity in response to their new hearing aids outcome measures were completed within a week of initial fit and after two months of hearing aid use. Behavioural measures showed an improvement in speech in noise ability but no improvement on word learning or memory ability. When completing a speech recognition task initial cortical (MRI) activity, compared to typically developing children, showed more activation in visual and motor areas and less activation in the auditory cortex. After two months of use the MMHL children showed further activation in the visual areas and less use of auditory and speech processing areas. This strengthening of alternative cortical activation for speech recognition may indicate that after using the new hearing aids less attention or effort is required to complete the auditory MRI task. We are currently expanding this study to assess plasticity after 8 months of hearing aid use.

Poster no 53

Speech in noise is associated to audibility while inter-hemispheric auditory processing is associated with executive functions in elders

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Introduction: "Central" (eg. cognition) and "peripheral" (eg. pure tone thresholds) factors affect auditory processing (AP). Objective: explore correlation of AP in elderly subjects with cochlear function, cochlear synaptopathy, and cognition.
Material and method: Adults over 65 years, no cognition impairment. AP: Frequency pattern (FP), gap in noise (GIN), speech in noise (SIN), dichotic digits (DD), staggered spondaic words (S-SSW). Cochlear function: DPOAE, pure tone thresholds (PTA). Cochlear synaptopathy: amplitude wave I supra threshold ABR. Cognition: frontal assessment battery (FAB). Statistical analysis: generalized linear models (MAM).
Results: 92 subjects, mean age 73.7 ± 5.4 years, average education 9.7 ± 4.2 years, mean hearing thresholds 28.3 ± 11.7 dB right (RE) and 27.3 ± 11.9 dB left ear (LE). MAM for SIN: age, RE PTA, amplitude wave I of LE. MAM for DD: FAB, RE PTA, RE DPOAE. MAM for FP: education, sex, RE DPOAE, amplitude wave I of LE. MAM for SSW: FAB, PTA, RE DPOAE. MAM of GIN: age, education, RE PTA, amplitude wave V of LE.
Discussion: Speech in noise was more dependent on audibility than on cognitive performance. Dichotic listening was more dependent on cognitive resources, maybe mirroring inter hemispheric connectivity.

Poster no 54

Severe-to-profound hearing impairment: gender differences and benefits of audiological rehabilitation

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Introduction: Based on the Swedish quality register, an estimation of 20,000 adult patients suffer from severe-to-profound hearing loss.
Purpose: To identify patients with severe-to-profound hearing loss who participated in audiological rehabilitation. The study investigated which kind of rehabilitation this patient group had received, and particularly, the benefits of hearing health care. The study also examined gender equality in the hearing health care.
Methods: Data on 4286 patients registered in the Swedish Quality Register of Otorhinolaryngology (2006-2015) were studied. The study analysed demographic data, gender differences, and evaluated the audiological rehabilitation efforts.
Results: Group rehabilitation, extended audiological rehabilitation, visit to a hearing rehabilitation educator, and being fit with a CI provided significantly most benefits in audiological rehabilitation. Only 40.5% of patients received extended audiological rehabilitation, with significantly more women (54.5%). Women also visited technicians, welfare officers, hearing rehabilitation educators, psychologists, and physicians and received communication rehabilitation in a group, and being fit with a CI significantly more often than men. Female patients appeared to have a significantly greater negative impact of hearing impairment on their daily life.
Conclusion: The study emphasizes the importance of participate in group rehabilitation and meet a hearing rehabilitation educator to experience greater benefits of hearing rehabilitation.

Poster no 55

Towards a combined behavioural and physiological measure of listening effort

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Motivation: Understanding speech in adverse listening conditions typically requires increased mental exertion (known as listening effort) and can lead to negative psychosocial outcomes. This research aims to evaluate the efficacy of a methodology that objectively indexes listening effort.
Methodology: Listening effort is evaluated using dual task and electroencephalography (EEG) measures. In the dual task, the primary and secondary tasks consist of digits-in-noise at different signal-to-noise ratios (SNRs) and a cued attention-switching task respectively. Behavioural performance is evaluated in terms of accuracy and reaction time. EEG measures include brain oscillations associated with the decision-taking process.
Results: Preliminary results of 3 participants show that obtaining behavioural and physiological measures of listening effort simultaneously is technologically viable. It is anticipated that dual-task performance will be positively associated with the auditory stimulus SNR, and that it will negatively correlate with alpha power.
Significance: The potential use of the proposed methodology includes (1) characterization of individuals' hearing in noise difficulty, and (2) evaluation of the efficiency of technologies like hearing aids or cochlear implants in reducing listening effort.

Poster no 56

Complex sentence processing in elderly: influence of hearing loss and cognition

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We investigate the processing of complex sentences in mild-to-moderate age-related hearing-impaired participants (HI; age 50-70) compared to normal-hearing (NH) age-matched peers. Processing complex sentences like object-initial sentences (TheACC boy washes theNOM father) is difficult for hearing-impaired elderly. Additionally, age-related hearing loss is associated with declining cognitive abilities. However, it is unknown how these all tie together: Do hearing-impaired individuals process complex sentences differently from normal-hearing peers? And do cognitive abilities moderate this processing?
Participants performed several cognitive tasks as well as a sentence-processing task that recorded fMRI- and behavioral data with complex vs. simple sentences while applying hearing-loss-specific amplification. Preliminary analyses of behavioral data show that, overall, NHs outperform HIs on the sentence-processing task. Additionally, cognitive flexibility, vocabulary size, and cognitive decline correlate with overall performance; cognitive flexibility and vocabulary size correlate stronger with performance on complex sentences. An interaction between vocabulary size and HI indicates that HIs benefit less from a large vocabulary than NHs.
These findings suggest that age-related hearing loss influences general sentence processing. Additionally, HIs benefit from a broader vocabulary less than NHs, possibly because they use different underlying mechanisms for sentence processing; this will be investigated with the fMRI data, which is currently being analyzed.

Poster no 57

Cortical and pupillometric markers of effortful listening with hearing aids

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Hearing-impaired individuals report experiencing greater listening effort in everyday life than their normally-hearing peers. However, we still know surprisingly little about how wearing hearing aids affects listening effort, especially at the sort of positive signal-to-noise ratios that predominate in real-life listening situations. Subsequently, this study aimed to develop objective physiological markers suitable for quantifying the effort of listening through hearing aids at ecologically relevant signal-to-noise ratios.

Experienced hearing-aid users and normally-hearing controls listened to sentences presented against continuous background noise whilst they completed a simple behavioural task to gauge speech understanding. Background noise stimuli were derived from real-world recordings and speech and noise were presented at typical real-world levels (resulting in signal-to-noise ratios between +4 and +16 dB). As participants listened, pupil size was monitored using a head-mounted eye-tracker and brain activity was non-invasively imaged using functional near-infrared spectroscopy.

We hypothesized that, compared to normally-hearing controls, hearing-aid users would be disproportionately impacted by moderate, ecologically relevant levels of background noise. We hypothesized that this would manifest as reduced task accuracy, prolonged response times, increased pupil dilation and elevated activation in frontal brain regions. Data collection is ongoing; results will be presented and discussed at the conference.

Poster no 58

Hearing aid acclimatization by older adults

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The main objective of this study is to investigate acclimatization of older adults (OA) listeners with hearing loss (HL) to hearing aids (HA) using listening effort and behavioral measures. The dual-task paradigm was used to measure the effort to understand speech in noise. The primary task is the Hearing in Noise Test (HINT). The second task is a tactile pattern-recognition task (TPRT) in which participants have to identify the three pulse combinations (i.e. short-short-short, short-short-long, etc.). There were 8 testing sessions over a period of 10 months to measure the effect of acclimatization. The participants, aged between 60 and 75 years of age, all had a bilateral mild to moderately severe sensorineural hearing loss. 30 participants were new HA users and the other 15 participants were experienced hearing aid users (control group). Cognitive skills, including working memory and the processing speed were evaluated using the Reading Span Test (RST) and the Digit Symbol Substitution Test (DSST), respectively. Results show a significant improvement in speech in noise performances in the new HA user group which can be related to an acclimatization effect. The acclimatization period is not correlated to cognitive abilities.

Poster no 59

Assessing cognitive load in normal hearing and cochlear implant users using a word recall task and pupillometry

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Although most adults with severe to profound hearing loss who receive cochlear implants (CIs) derive some benefits regarding speech recognition in quiet, CI users typically expend extra effort compared to normal hearing (NH) listeners in speech recognition.

Many measures using behavioural and physiological tools have been developed to quantify listening effort (LE). However, there is still limited understanding regarding these methods, therefore, cross-validation is required to examine their reliability and precision. Furthermore, as one of the most widely used tools, pupillometry is typically applied when participants perform listening task only. Considering that CI users rarely understand speech without engaging other cognitive functions (conversation, multitasking, driving, etc.), there is a great need to extend our understanding of this research tool to realistic scenarios.

A new paradigm is proposed in this presentation to examine the joint impact of LE and memory on behavioural and pupillary response from NH and CI adult listeners. It will be demonstrated that pupil peak dilation (PPD) is insufficient in capturing aspects of cognitive load that carry over in time, particularly when memory task is engaged. Other pupillary indices need to be considered when examining LE in complex situations.

Poster no 60

The role of affective and linguistic prosody in the cognitive emotional appraisal of language

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Prosody offers a unified expression domain for affective and linguistic communication. Affective prosody (e.g., anger vocalization) reflects pre-cognitive processes, whereas linguistic prosody (e.g., lexical tone) is an acquired cognitive skill. In the present study, we explored the interplay between subcortical affective prosody and cortical linguistic cues during emotional appraisal of speech using stereotyped electroencephalography (EEG) responses. We hypothesized that concurrent affective and linguistic prosody with the same valence will evoke a late positive frontal response, reflecting emotional appraisal supported by complex cognitive processing in frontal cortical areas. Using an auditory oddball paradigm, neural responses to a spoken pair of Swedish words that differed in emotional content due to linguistic prosody were investigated as pronounced with an angry and a neutral voice. The results indicate that when co-occurring, affective and linguistic prosody with the same valence elicit a unique late positive response in the frontal region that is distinct from the neural responses of affective and linguistic prosody alone. This study provides experimental evidence that both affective and linguistic prosody contribute synergistically to the cognitive emotional appraisal of language, and highlights the significance of pre-cognitive affective prosody in language processing, having important implications for both language learning and learning through language.

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