

CHSCOM2017

18 - 21 June * Linköping * Sweden

Abstract book

**Fourth International Conference on
Cognitive Hearing Science
for Communication**

**18–21 June 2017
Linköping, Sweden**



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Cognitive Hearing Science
for Communication**

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Produced at Linköping University 2017 by Maria Hugo-Lindén.
Cover illustration: Colza field, Sweden.
Printed by LiU-Tryck.

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Welcome

It is an honour and a real pleasure for the scientific and organising committees to welcome you to Linköping and the fourth International Conference on Cognitive Hearing Science for Communication. The conference is an important step in 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 quantity and quality of abstract submissions. We have a pre-conference programme which targets presentations by PhDs and young researchers in the field, four of whom are awarded sponsored scholarships. We are convinced that this year's conference will be another 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 this event.

Jerker Rönnerberg
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 Rönnerberg, chair
Björn Lyxell, co-chair
Mary Rudner, co-chair

Gerhard Andersson, Stig Arlinger, Ruth Campbell, Berth Danermark, Henrik Danielsson, Louise Hickson, Larry Humes, Ingrid Johnsrude, Birgitta Larsby, Thomas Lunner, Elina Mäki-Torkko, Claes Möller, Brian Moore, Kathy Pichora-Fuller, Birgitta Sahlén and Stefan Stenfelt.

Organization committee

Maria Hugo-Lindén, Marie-Louise Lund Mattsson and
Britt-Marie Alfredsson-Svensson

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. 85 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. 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.

For further information about Linnaeus Centre HEAD, 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, 21 doctoral students are enrolled and a further 30 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 **HE**aring **And** **D**eafness
this is the research focus of
Linnaeus Centre **HEAD**
and **HEAD** Graduate School.
Working for excellence in
Cognitive Hearing Science.

Pre-conference programme

Sunday, June 18

- 09.00 – 16.00 Registration (Marmorfoajén) and pre-conference, Linköping Konsert & Kongress.
- 09.00 – 09.30 Technical/practical information for pre-conference speakers (Musikalen).
- 09.55 – 10.00 Welcome to CHSCOM2017 pre-conference: **Mary Rudner** (Musikalen).
- 10.00 – 12.00 Pre-conference session 1. Moderators: **Rina Blomberg, Victoria Stenbäck and Heléne Hjertman**
- 10.00 – 10.20 The neural struggles of hearing loss: How compensated hearing loss affects cognitive speech processing. **Eline Borch Petersen**
- 10.20 – 10.40 The search for neural correlates of speech perception difficulties across the adult lifespan. **Tine Goossens**
- 10.40 – 11.00 The cognitive functions of older cochlear implant recipients: a cross-sectional study using the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing impaired individuals (RBANS-H). **Annes J. Claes**
- 11.00 – 11.20 COFFEE BREAK (Galleri K)
- 11.20 – 11.40 Does the auditory environment of children with cochlear implant influence their language development? **Tobias Busch**
- 11.40 – 12.00 Cognitive and auditory factors underlying the ability to understand speech in noise: clinical implications for diagnosis and rehabilitation. **Ingrid Yeend**
- 12.00 – 13.00 LUNCH (Verdefoajén)
- 13.00 – 16.00 Pre-conference session 2. Moderators: **Lisa Palmqvist, Michaela Socher and Eline Borch Petersen**
- 13.00 – 13.20 The effect of noise and second language on turn-taking in task-oriented dialogue. **Anna Josefine Sørensen**
- 13.20 – 13.40 Deficits in attention affect speech in noise processing: a pilot study. **Rina Blomberg**
- 13.40 – 14.00 Speech recognition in noise and listening effort – The role of working memory capacity and inhibitory control. **Victoria Stenbäck**

- 14.00 – 14.20 COFFEE BREAK (Galleri K)
- 14.20 – 14.40 Effects of age and multiple talking faces on the visual speech advantage. **Julie Beadle**
- 14.40 – 15.00 Qualitative data supporting the FUEL: Perceived listening effort in cochlear implantation. **Sarah Hughes**
- 15.00 – 16.00 COFFEE BREAK (Marmorfoajén)

Conference programme

Sunday, June 18

- 09.00 – 16.00 Registration (Marmorfoajén) and pre-conference, Linköping Konsert & Kongress.
- 16.00 – 16.05 Welcome to CHSCOM2017: **Bengt Westerberg**, Main moderator and chair of the Swedish Institute for Disability Research (Crusellhallen).
- 16.05 – 16.20 Welcome to Linköping and to the complex world of Audiology: **Stig Arlinger**, Professor Emeritus, Linköping University.
- 16.20 – 16.25 General information CHSCOM2017: **Bengt Westerberg**, Main moderator.
- 16.25 – 16.35 Introduction to Cognitive Hearing Science: **Jerker Rönnberg**, Chair of the scientific committee and Director of Linnaeus Centre HEAD.

Introductory keynotes

- 16.35 – 17.05 **Kathryn Arehart**. Quantifying the relationship between listener response and amount of hearing aid signal processing.
- 17.05 – 17.35 **Bruce Schneider**. How older adults achieve speech comprehension in challenging listening situations.
- 18.00 – RECEPTION (Marmorfoajén)

Monday, June 19

07.30 – 08.30 Technical/practical information for speakers (Crusellhallen)

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

Theme: Communication in Challenging Conditions

Session moderator: **Henrik Danielsson**

08.35 – 09.00 Keynote: **Antje Heinrich**. On the (differential) influence of cognition for speech intelligibility in a range of listening situations.

09.00 – 09.20 Learning about speaker idiosyncrasies in visual speech.
Alexandra Jesse

09.20 – 09.40 Competing talkers, attention and cognitive load. **Hartmut Meister**

09.40 – 10.00 Determinants of listening effort and their effects on sympathetic and parasympathetic activity. **Michael Richter**

10.00 – 10.30 COFFEE BREAK (Marmorfoajén)

10.30 – 10.50 Ten years of measuring Text Reception Thresholds: What are we actually measuring? **Adriana Zekveld**

10.50 – 11.10 Investigating memory for tones and speech in noise performance in hearing impaired listeners. **Maja Serman**

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

12.15 – 13.15 LUNCH (Garden)

Session moderator: **Carine Signoret**

13.15 – 13.35 Effects of noise, accented speech, and language experience on speech understanding and listening effort. **Jens Schmidtke**

13.35 – 13.55 Effect of degraded auditory input on memory span using cochlear implant simulations in normal-hearing listeners. **Jasenia Hartman**

13.55 – 14.15 Adult aging affects the balance between linguistic context and response competition in speech recognition by cochlear Implant users. **Art Wingfield**

14.15 – 14.45 COFFEE BREAK (Marmorfoajén)

14.45 – 15.05 How conversation behaviour changes with increasingly challenging listening conditions in people with normal and impaired hearing.
Gitte Keidser

- 15.05 – 15.25 About the impact of hearing impairment on processing effort and the benefit of hearing aid signal processing. **Dorothea Wendt**
- 15.25– 17.00 Poster session for posters with even numbers (Marmorfoajén)
- 18.30 – SOCIAL ACTIVITY – DINNER (Marmorfoajén/Backstage)

Tuesday, June 20

- 07.30 – 08.30 Technical/practical information for speakers (Crusellhallen)
- 08.30 – 08.35 Welcome and general information: **Bengt Westerberg**,
Main moderator (Crusellhallen)

Theme: Brain Plasticity

Session moderator: **Stefan Stenfelt**

- 08.35 – 09.00 Keynote: **Stephen G. Lomber**. Crossmodal plasticity in auditory cortex following deafness: vocalization processing cortex in the hearing becomes a face processing region in the deaf.
- 09.00 – 09.20 A distorted representation of sound is important for speech encoding. **Anders Fridberger**
- 09.20 – 09.40 The new early filter model. **Tom Campbell**
- 09.40 – 10.00 What we know about the pupil dilation response related to speech processing in noise. **Thomas Koelewijn**
- 10.00 – 10.30 COFFEE BREAK (Marmorfoajén)
- 10.30 – 10.50 EEG indices of speech and auditory object processing and how they are affected by attention. **Ed Lalor**
- 10.50 – 11.10 The role of gestures in spoken language comprehension: insights from brain and behavior. **Asli Ozyurek**
- 11.10 – 12.15 Poster session for posters with odd numbers (Marmorfoajén)
- 12.15 – 13.15 LUNCH (Garden)
- 13.15 – 13.40 Keynote: **Velia Cardin**. Deafness and cortical plasticity in the human brain.
- 13.40 – 14.00 Functional hearing loss is associated with cerebral grey matter loss: neuroimaging evidence from over 5000 individuals included in the UK Biobank resource. **Mary Rudner**

- 14.00 – 14.20 Impact of hearing loss on brain and cognition in older adults.
Fatima T Husain
- 14.20 – 14.40 Deafness-related deficits in temporal attention: hearing loss or linguistic deprivation? **Matthew William Dye**
- 14.40 – 15.10 COFFEE BREAK (Marmorfoajén)
- Theme: Translational Cognitive Hearing Science**
Session moderator: **Rachel Ellis**
- 15.10 – 15.35 Keynote: **Harvey Dillon**. Auditory processing disorders, reading deficits and dichotic perception.
- 15.35 – 15.55 Listening comprehension and effort in class-rooms with dysphonic teachers and background babble noise. **Birgitta Sahlén**
- 15.55 – 16.15 Child-directed interactions can enhance early language and cognitive development in children with hearing impairment: the roles of speech, music, and play. **Tonya Bergeson-Dana**
- 16.15 – 17.30 Poster session for posters with odd numbers (Marmorfoajén)
- 18.30 – 19.00 Refreshments (Garden)
- 19.00 CONFERENCE DINNER – ENTERTAINMENT (Garden)

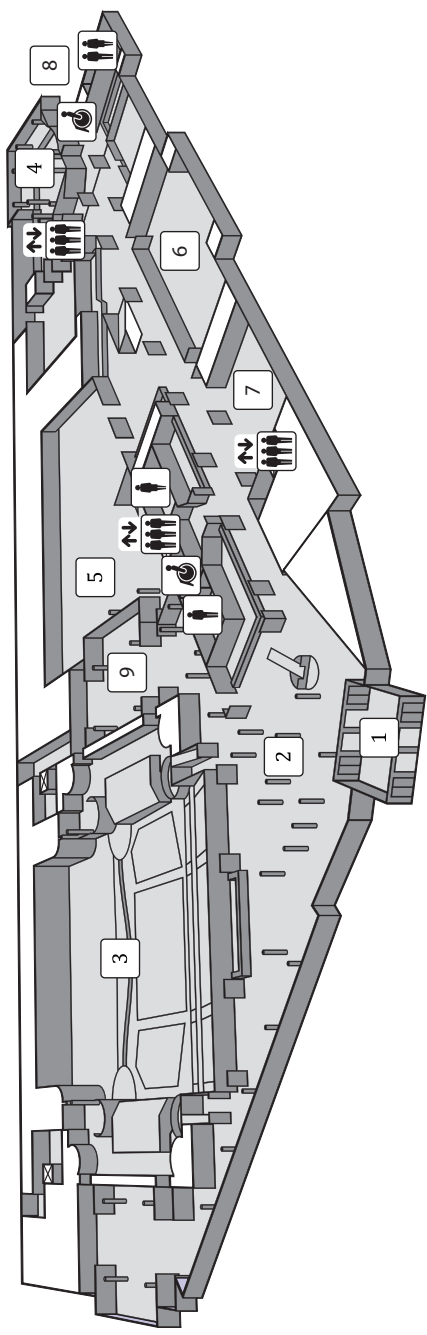
Wednesday, June 21

- 07.30 – 08.30 Technical/practical information for speakers (Crusellhallen).
- 08.30 – 08.35 Welcome and general information: **Bengt Westerberg**,
Main moderator (Crusellhallen).
Session moderator: **Björn Lyxell**
- 08.35 – 09.00 Keynote: **Astrid van Wieringen**. Improving communication in children with unilateral to profound hearing impairment with a cochlear implant.
- 09.00 – 09.20 Understanding speech via a cochlear implant: the role of predictive and automatic processing. **Anita Wagner**
- 09.20 – 09.40 Assessment of listening effort and speech understanding in every-day life. **Inga Holube**

- 09.40 – 10.00 Temporal fine structure processing in older adults: beyond the syllable boundary. **Ira Kurthen**
- 10.00 – 10.30 COFFEE BREAK (Marmorfoajén)
- 10.30 – 10.50 Impact of hearing loss, hearing aids use in aging: Results from a population-based study. **Hélène Amieva**
- 10.50 – 11.10 The consideration of hearing, vision, and cognition in the Canadian Consortium on Neurodegeneration in Aging (CCNA).
Natalie Phillips
- 11.10 – 11.30 Linking sensory and cognitive aging: The influence of social factors.
Margaret Kathleen Pichora-Fuller
- 11.30 – 11.50 Thanks and summary: **Bengt Westerberg** and **Jerker Rönnerberg**
- 11.50 LUNCH-TO-GO (Marmorfoajén)

Welcome back in 2019!
**Fifth International Conference on
Cognitive Hearing Science
for Communication**

**9–12 June 2019
Linköping, Sweden**



- 1 Main entrance
- 2 Marmorfoajén
- 3 Crusellhallen
- 4 Backstage
- 5 Garden

- 6 Musikalen
- 7 Galleri K
- 8 Entrance
- 9 Verdefoajén

Abstracts

Pre-conference

Sunday June 18, 10.00–10.20

The neural struggles of hearing loss: how compensated hearing loss affects cognitive speech processing

Eline Borch Petersen^{1,2,4}

Malte Wöstmann³, Jonas Obleser³ and Thomas Lunner^{1,4}

¹Eriksholm Research Centre, Snekkersten, Denmark

²Technical Audiology, Department of Clinical and Experimental Medicine,
Linköping University, Sweden

³Department of Psychology, University of Lübeck, Germany

⁴Linnaeus Centre HEAD, Linköping University, Sweden

It is well-established that hearing loss affects the ability to understand speech presented in noise. However, the effect of hearing acuity on the central aspects of speech processing remains relatively unknown. Here, we provide an overview of the effects of hearing loss observed on the electroencephalogram (EEG) activity recorded during listening from 29 elderly listeners (mean age 72.24) with varying degrees of hearing loss. The results showed that worse hearing was associated with reduced neural inhibition of irrelevant speech (neural tracking of the speech envelope, Petersen et al. 2016) and increased working-memory involvement (alpha activity, Petersen et al. 2014) during speech processing. In combination, these observations suggest that the inability to suppress irrelevant information could result in increased inhibitory activity with worse hearing. Interestingly, the neural measures of speech processing were affected by an interaction between hearing loss and the level of background noise, indicating that the effects of hearing loss were especially harmful during adverse listening. Taken together, our findings suggest that despite providing adequate hearing-aid amplification and individualizing the level of background noise, hearing loss has a detrimental effect to the neural processing of speech, requiring the engagement of additional cognitive resources to ensure successful speech understanding.

The search for neural correlates of speech perception difficulties across the adult lifespan

Tine Goossens

Jan Wouters and Astrid van Wieringen

Department of Neurosciences – Research Group ExpORL, University of Leuven, Belgium

It is widely acknowledged that hearing impairment and aging drive speech perception difficulties. Moreover, there appears to be an association between the degree to which neural activity is synchronized to speech(like) sounds and speech perception performance. As such, it is suggested that neural synchronization along the central auditory pathway may be affected by hearing impairment and age.

Previously, we have demonstrated that aging goes together with increased synchronization to syllabic-rate modulations (4 Hz) and decreased synchronization to voicing/stress-related modulations (80 Hz). In the current study, we investigated whether similar neural effects result from hearing impairment.

We selected normal-hearing as well as hearing-impaired adults belonging to three age groups, i.e., 20-30, 50-60, and 70-80 years of age. Neural synchronization was investigated by means of scalp-recorded steady-state responses to speech-related acoustic modulations. In addition, we evaluated open-set sentence identification in various background noises.

We observe more synchronized activity to both 4 Hz and 80 Hz acoustic modulations in hearing-impaired young and middle-aged persons compared to their normal-hearing peers. In the oldest group, however, no such neural differences appear between normal-hearing and hearing-impaired counterparts. First analyses indicate small, though noticeable correlations between these age-/hearing-related neural deviances and speech perception performance.

The Repeatable Battery for the Assessment of Neuropsychological Status for Hearing impaired individuals (RBANS-H) in an older population with age-normal hearing: preliminary results of a cross-sectional study

Annes J. Claes^{1,2}

Griet Mertens^{1,2}, Annick Gilles^{1,2,3}, Jasmien De Krem³, Anouk Hofkens¹,
Vincent Van Rompaey^{1,2} and Paul Van de Heyning^{1,2}

¹Univ. Dept. Otorhinolaryngology, Head and Neck Surgery,
Antwerp University Hospital (UZA), Belgium

²Faculty of Medicine and Health Sciences, University of Antwerp, Belgium

³Department of Human and Social Welfare, University College Ghent, Ghent, Belgium

Objective: The RBANS-H (Claes et al., 2016, doi:10.3389/fnins.2016.00512) is an adaptation of the RBANS, a well-accepted cognitive assessment tool. The RBANS-H was especially developed to examine cognition in older adults with a severe hearing impairment. The aim of the study is to investigate whether the norm scores of the RBANS are valid for the RBANS-H.

Study design: cross-sectional study.

Patients: Twenty-six subjects (13♂ and 13♀) aged 55 or older (mean age: 71 [56;86] years) with bilateral hearing thresholds normal for their age and sex.

Methods: The subjects performed a cognitive assessment by means of the RBANS-H and a comprehensive audiometric assessment. In addition, the Health Utilities Index-2/3, the Dizziness Handicap Inventory and a general questionnaire on education and profession, medical history, hearing aid use and tinnitus were administered.

Results: The mean RBANS-H total score of this group is 99.96, which is statistically equal to the total mean norm score of the RBANS, i.e. 100 ($p=0.984$). Furthermore, the one-sample t-tests do not demonstrate a difference between any of the five RBANS-H index scores and the mean index norm score of the RBANS.

Conclusion: The norm scores of the RBANS may be used for score calculation and interpretation of the RBANS-H.



Sunday June 18, 11.20–11.40

Does the auditory environment of children with cochlear implant influence their language development?

Tobias Busch^{1,2}

Filiep Vanpoucke² and Astrid van Wieringen¹

¹Department of Neurosciences – Research Group ExpORL, University of Leuven, Belgium

²Cochlear Technology Centre, Belgium

Many deaf children receive a cochlear implant (CI) early in life. CIs are hearing prostheses that bypass the damaged cochlea and stimulate the auditory nerve electrically. Although CIs grant access to spoken language, developmental trajectories vary widely. Some variation can be explained by environmental factors: Language development is shaped by the language that children encounter in their environment. Moreover, children with CI are especially vulnerable to noise, and their auditory rehabilitation can be hampered by non-compliance (i.e. low device use). Such factors can be investigated with the Cochlear Nucleus 6. This CI sound processor logs the duration of CI use and time spent in different acoustical environments. Previously, we found substantial variation between children regarding the amount of speech and noise reported in their CI data logs (Busch, Vanpoucke, van Wieringen, in press). In the current study we investigate whether such differences predict language development. In the pilot phase we have collected logs and language tests of n=9 deaf children. Here, we present the outcomes of the exploratory data analysis, specifically evidence for associations between aspects of the CI logs and language test results. We discuss methodological issues and implications for the design of a larger study with adequate power.

Sunday June 18, 11.40–12.00

Cognitive and auditory factors underlying the ability to understand speech in noise: clinical implications for diagnosis and rehabilitation

Ingrid Yeend^{1,2,3}

Elizabeth Beach^{2,3}, Mridula Sharma^{1,3} and Harvey Dillon^{2,3}

¹Department of Linguistics, Macquarie University, Australia

²The National Acoustic Laboratories, Australian Hearing, Australia

³The HEARing Cooperative Research Centre, Australia

Using data from a large scale investigation of noise-induced cochlear synaptopathy in 122 adults, aged 30-57 years with normal or near-normal hearing, we sought to determine the factors that underlie the ability to understand speech-in-noise.

For each participant, a composite score was calculated based on scores from three speech-in-noise measures, a) the SSQ12 (average of speech items); b) the Listening in Spatialized Noise-Sentences test (high-cue condition); and c) the NAL Dynamic Conversations Test. The composite score was then used to create two subgroups, each comprising 30 participants: those with the lowest scores and those with the highest scores.

We compared these two groups by testing for differences in hearing thresholds, temporal perception, noise exposure, attention, and working memory. We found that the groups differed on: age, hearing level, sensitivity to temporal fine structure, linguistic closure skills, and working memory. We then fitted a multiple regression model with these variables as predictors which showed that extended high frequency thresholds ($p=.006$) and working memory scores ($p=.0006$) were highly significant predictors of the composite speech-in-noise score.

Potential clinical applications arising from this work include the development of new diagnostic and rehabilitation tools for people who present with communication difficulties in challenging listening conditions.

Sunday June 18, 13.00–13.20

The effect of noise and second language on turn-taking in task-oriented dialogue

Anna Josefine Sørensen¹

Ewen N MacDonald¹, Michal Fereczkowski¹

¹Dept. of Electrical Engineering, Technical University of Denmark, Denmark

Previous studies of floor-transfer offsets (FTO), the interval between one talker stopping and the other starting, suggest that normal conversation requires interlocutors to predict when each other will finish their turn. We hypothesized that noise and/or speaking in a second language (L2) would result in longer FTOs due to increased processing demands. Conversations from 20 pairs of normal hearing, native-Danish talkers were elicited using the Diapix task in four conditions consisting of combinations of language (Danish vs. English) and noise background (quiet vs. ICRA 7 noise presented at 70 dBA). Overall, participants took longer to complete the task in both noise and in L2 indicating that both factors reduced communication efficiency. However, L2 had very little effect beyond completion time, likely because the participants were very good in English. In contrast to our predictions, in the presence of noise, the median of the FTO distribution decreased by approximately 30 ms and the standard deviation decreased by approximately 10 %. However, the average duration of inter-pausal units (i.e., utterances of continuous speech) increased by 40 % in noise. These findings are consistent with talkers holding their turn for longer, allowing more time for speech planning.

Deficits in attention affect speech in noise processing: a pilot study

Rina Blomberg¹

Mary Rudner¹, Henrik Danielsson¹, Göran Söderlund²
and Jerker Rönnerberg¹

¹Linnaeus Centre HEAD, Linköping University, Sweden

²Department of Education and Sport, Sogn & Fjordane College, Norway

Objective: Moderate levels of white noise have been shown to help individuals with attentional difficulties (ADHD) focus on cognitive tasks (Sikström & Söderlund, 2007). This is a counterintuitive finding given that our research (Rönnerberg et al., 2013) indicates that noise interferes with speech understanding tasks and that individual performance is predicted by i.a. differences in attentional capacity. To understand this phenomenon better, the current study tests hypotheses of auditory distraction in persons with ADHD using a speech understanding task in noise conditions that vary in attentional load.

Method: Participants (ADHD vs. controls) are presented with everyday sentences in two different intelligibility conditions: clear and vocoded speech. Speech recognition thresholds (SRT) for the intelligibility conditions are estimated under three different noise conditions: white noise, fluctuating speech-shaped noise, and two-talker babble.

Preliminary Results: ADHD had higher SRTs particularly under distorted speech conditions, suggesting that deficits in attention affect both noise attenuation performance and subsequent signal interpretation. However, no differences in SRT were observed between groups when the speech was free from distortion in the presence of white noise. Continuing research investigates the types of acoustic environments that are disturbing versus facilitating for ADHD with respect to individual differences in cognitive capacity.

Speech recognition in noise and listening effort: the role of working memory capacity and inhibitory control

Victoria Stenbäck¹

Björn Lyxell¹, Mathias Hällgren³ and Birgitta Larsby²

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²Department of Otorhinolaryngology and the Department of Clinical and Experimental Medicine, Linköping University, Linköping, Sweden.

³Department of Clinical and Experimental Medicine, Division of Technical Audiology, Linköping University, Linköping, Sweden.

Every day individuals engage in communication situations with other human beings in sound environments filled with background noise and / or competing talkers. Various background noises carry different masking characteristics that can lead to decreases in speech intelligibility. Common complaints among hearing-impaired individuals involve difficulties in identifying a single talker in a group conversation, and poor awareness about environmental sounds and occurrences, leading to an increase in listening effort. The decreasing ability to hear speech in noise, is also believed to be due to age-related changes in cognitive abilities such as working memory and inhibitory control.

The present study investigated hearing ability, listening effort, and age-related declines in WMC, inhibitory control, and their respective roles in speech recognition in noise performance. 24 young normally-hearing, 24 older normally-hearing, and 24 older hearing-impaired individuals participated. They completed a cognitive test battery assessing WMC and inhibitory control. Two speech materials; one closed-set (Hagerman sentences) and one open-set (HINT) masked with different background noises were presented. After each background noise they rated perceived listening effort. We will present results comparing cognitive abilities in young normally-hearing individuals, older normally-hearing, and older hearing-impaired individuals, and how hearing ability, age and cognitive abilities relate to listening effort and speech recognition in noise.

Effects of age and multiple talking faces on the visual speech advantage

Julie Beadle¹

Chris Davis¹ and Jeesun Kim¹

¹The MARCS Institute for Brain, Behavior and Development,
Western Sydney University, Australia

Seeing a talker's face helps speech recognition in noise compared to an auditory only baseline (i.e., a visual speech advantage). In a cocktail party listening environment, however, more than one talking face is likely within an individual's visual field. The present study investigated how seeing multiple talking faces affects speech recognition in noise for 20 younger and 20 older adults.

For each trial, participants listened to a sentence presented in speech-shaped noise and typed what they heard. There was an auditory-only (AO) condition and four talking face conditions in which 1, 2, 4, or 6 silent talking face videos were presented. One face always matched the auditory signal; the other face(s) did not. Responses were scored for key words correct.

For both younger and older adults, speech recognition was best for the single talking face condition. Younger adults' recognition rates gradually declined as more talking faces were presented, whereas older adults' recognition abruptly declined (to AO levels) when just one additional talking face was presented. These results will be discussed in terms of the idea that processing a talker's visual speech requires attention and that older adults have difficulty attending to the appropriate talker when multiple talking faces are visible.

Qualitative data supporting the FUEL: perceived listening effort in cochlear implantation

Sarah Hughes^{1,2}

Isabelle Boisvert^{3,4}, Catherine McMahon^{3,4} and Frances Rapport⁵

¹South Wales Cochlear Implant Programme, Abertawe Bro Morgannwg University Health Board, Wales UK

²Swansea University Medical School, Swansea University, Wales UK

³Department of Linguistics (Audiology Section), Macquarie University, NSW Australia

⁴The HEARing CRC, Australia

⁵Australian Institute of Health Innovation, Macquarie University, NSW Australia

For individuals with a cochlear implant (CI) listening is frequently reported to be effortful even when sounds are audible and speech can be understood. The Framework for Understanding Effortful Listening (FUEL) (1) is a new conceptual framework developed to support hearing healthcare professionals' understanding of individuals' investment of effort in everyday listening. Empirical evidence in support of the FUEL has not yet been reported in the literature. This poster will describe a qualitative study involving focus groups and questionnaire data that utilised constructivist Grounded Theory (GT) methodology to develop an explanatory model explicating CI candidates' understanding and experiences of listening effort. Specifically, participant accounts describing the multi-dimensional nature of the listening effort construct, the experience of effortful listening before and after cochlear implantation, and, importantly, the association between listening effort, social connectedness, and effort-reward balance will be described. The GT will be mapped to the FUEL as empirical evidence in support of the proposed relationship among the factors of demand, effort, and motivation in everyday listening. Together, the participant data and the theoretical framework presented in the FUEL will provide evidence of content validity for a patient-reported outcome measure (PROM) – a new clinical tool designed to evaluate self-reported listening effort.

Scholarship sponsored by:



Tine Goossens is a PhD student at the Research Group Experimental ORL, Department of Neurosciences at the University of Leuven (Belgium) and is supervised by ringen and Jan Wouters. She obtained a Master's degree in Speech Therapy and Audiology Sciences (2011) and a Postgraduate degree in Audiology and Hearing Aid Fitting (2012) at the University of Leuven. She undertook internships in the VU Medical Center in Amsterdam (the Netherlands) and Hearing Centers in Flanders (Belgium). Tine became passionate about the aging auditory system while working on her Master's thesis which was on

binaural processing and speech intelligibility in aging persons. The main topic of her PhD project is speech perception performance and its potential neural correlates throughout the adult lifespan. Her aim is to gain a thorough understanding of what causes the highly prevalent speech perception problems when people age. More specifically, she investigates to what extent age-related hearing impairment, on the one hand, and normal-hearing aging, on the other hand, affect speech perception performance and neural processing of temporal speech features. In addition to behavioral speech testing, she conducts electrophysiological measurements to look into deviances in neural temporal processing that may contribute to impaired speech perception. Her research is supported by the Research Foundation Flanders (FWO) through a personal aspirant grant.

Scholarship sponsored by:

PHONAK
life is on



Anna Josefine Sørensen is a PhD student in the Hearing Systems Group headed by Prof. Torsten Dau at the Technical University of Denmark (DTU). Her project is supervised by Ewen MacDonald from DTU and Thomas Lunner from the Eriksholm Research Centre, Oticon A/S. Her research focuses on conversational turn-taking behaviour in normal-hearing and hearing-impaired listeners, and how measures of conversational dynamics can potentially be used as objective measures in hearing diagnostics.

Scholarship sponsored by:



In 2015, Julie Beadle received a BA in Psychology (First Class Honours) from St. Francis Xavier University in Nova Scotia, Canada. Julie is currently a PhD candidate at The MARCS Institute, Western Sydney University, Australia, working under the supervision of Professor Chris Davis and Professor Jeesun Kim. In collaboration with the Australian Hearing Co-operative Research Center, Julie is investigating how cognitive processes such as attention and memory are used when older adults try to perceive speech in difficult listening circumstances, as well as how and when visual cues may aid understanding.

Scholarship sponsored by:



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Sarah Hughes is Principal Speech and Language Therapist at the South Wales Cochlear Implant Programme (UK). She received her Master of Health Science in Speech-Language Pathology from the University of Toronto (Canada) in 1996 and is currently a doctoral student at Swansea University Medical School (UK). The objective of her PhD research is to develop and validate a patient reported outcome measure (PROM) of perceived listening effort in adult cochlear implant candidates. Sarah is also a visiting scholar at Macquarie University (Department of Linguistics/Audiology), in Australia, a member

of the Adult Rehabilitation Interest Group (ARIG) steering committee for the British Society of Audiology, and former chair of the Royal College Speech and Language Therapists' (RCSLT) South West and Wales Clinical Excellence Network for Deafness.

Abstracts

Sunday

Quantifying the relationship between listener response and amount of hearing aid signal processing

Kathryn H. Arehart¹
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¹Speech, Language, Hearing Sciences, University of Colorado, USA

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When listening in challenging environments, we have to separate the sounds we are interested in ("the target sounds") from the competing sounds in the environment. As listeners, we encode sounds within our auditory system and then use higher-level processes to decode the spoken message. For people with hearing loss, the process is made more complicated as hearing-aid processing modifies the sounds and hearing loss changes the cochlear outputs. Furthermore, older adults can also have age-related changes in cognition (e.g., changes in working memory) that may affect the listening process. In this talk, I will discuss our research that considers hearing-aid signal processing in the context of this complex listening chain. We use computational metrics based on models of hearing loss to quantify the effects of hearing aid signal processing on the perception of noisy speech signals. We emphasize relationships among the environment (type and amount of noise), individual listener factors (age, working memory, audiogram) and the type and amount of hearing aid signal processing with the long-term goal of developing evidence-based protocols for customizing hearing aid fittings based on individual listener abilities.

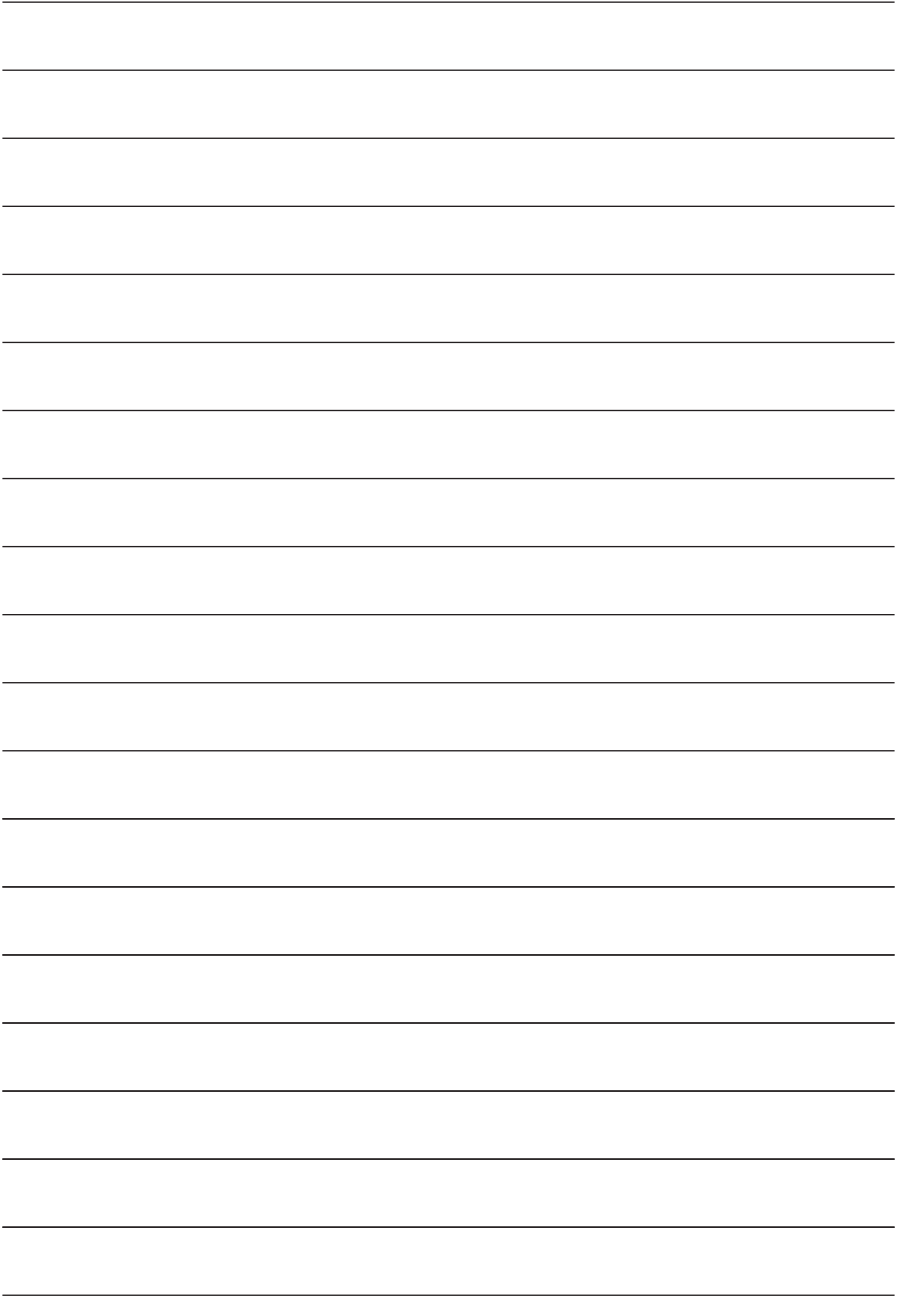
Keynote: Sunday June 18, 17.05–17.35

How older adults achieve speech comprehension in challenging listening situations

Bruce A. Schneider

Department of Psychology, University of Toronto, Canada

In noisy situations, age-related changes in the auditory, cognitive, and/or linguistic processes supporting speech comprehension are likely to disrupt the smooth and rapid integration of heard information, and lead to a reorganization of how spoken language is processed. For example, age-related declines in auditory processes will likely impede spoken-word recognition in noisy situations. In such difficult listening situations, listeners can draw on their knowledge of the language, and on the supporting context, to access the correct word in the lexicon. Because older adults have acquired a broader world knowledge and have a more extensive vocabulary than have younger adults, they may engage this compensatory mechanism more readily and with greater efficiency than do younger adults. On the other hand, age-related declines in processes subsequent to lexical access (working memory, extraction of meaning, storage and retrieval of heard information, etc.) may lead older adults to rely less on these processes than do younger adults when listening becomes difficult. In this talk we will explore how the difficulty of the listening situation interacts with the age of the listener to alter the manner in which spoken-language comprehension is achieved. Specifically, we will investigate the extent to which listening comprehension is correlated with a listener's vocabulary knowledge, working memory capacity, and reading comprehension, and how this changes with age and the listening situation.



Abstracts

Monday

Keynote: Monday June 19, 8.35–9.00

The differential contribution of cognition to speech perception in various listening situations

Antje Heinrich

Medical Research Council Institute of Hearing Research,
University of Nottingham, UK

There is a broad consensus that cognition is important for speech perception, yet its exact role in intelligibility remains to be understood. Working memory has been suggested to be particularly important, although other cognitive abilities have also been implicated. I will bring together results from a number of recent studies that investigated the role of working memory (complex and simple) and related cognitive abilities (text comprehension and vocabulary knowledge) for intelligibility of word and sentences in different types of maskers and in a range of signal-to-noise ratios (SNR) and discuss the following questions: Are some cognitive abilities more predictive of speech perception in general than others? Does the role of cognition depend on the particular listening situation? Is the nature of cognitive involvement modified by hearing loss? By combining different techniques including association testing, linear mixed modeling and experimental manipulation, I aim to shed light on the diverse role of cognitive abilities in speech perception for different groups of listeners.

Monday June 19, 9.00–9.20

Learning about speaker idiosyncrasies in visual speech

Alexandra Jesse

Department of Psychological and Brain Sciences,
University of Massachusetts Amherst, USA

Seeing a speaker typically improves speech perception, especially in adverse conditions. Audiovisual speech is more robustly recognized than auditory speech, since visual speech assists recognition by contributing information that is redundant and complementary to the information obtained from auditory speech. The realization of phonemes varies, however, across speakers, and listeners are sensitive to this variation in both auditory and visual speech during speech recognition. But listeners are also sensitive to consistency in articulation within a speaker. When an idiosyncratic articulation renders a sound ambiguous, listeners use available disambiguating information, such as lexical knowledge or visual speech information, to adjust the boundaries of their auditory phonetic categories to incorporate the speech sound into the intended category. This facilitates future recognition of the sound. For visual speech to best aid recognition, listeners likewise have to flexibly adjust their visual phonetic categories to speakers. In this talk, I will present work showing how lexical knowledge and auditory speech information can both assist the retuning of visual phonetic categories to speakers, but that the retuning process seems to rely on attentional resources. Furthermore, listeners rapidly form identity representations of unfamiliar speakers' facial motion signatures, which subserve talker recognition but may also aid speech perception.

Monday June 19, 9.20–9.40

Competing talkers, attention and cognitive load

Hartmut Meister

Jean Uhrmacher Institute for Clinical ENT-Research,
University of Cologne, Germany

Everyday communication typically comprises situations with more than one talker speaking at a time. These situations pose high sensory and cognitive demands: auditory objects have to be formed, competing auditory streams have to be segregated and attention has to be focused on the talker of interest. However, not only focused and selective attention play a role. Since verbal communication is typically dynamic, attention has to be redirected occasionally or has to be divided between several talkers.

These situations appear to be especially detrimental for elderly persons. First, hearing loss might yield less accurate analysis of the acoustic speech input. Moreover, cognitive load might be associated with attending to a talker in a crowded auditory scene. Since both hearing and cognitive capacity typically decline with age the problems experienced in multi-talker scenarios might be inflated.

This presentation addresses different forms of attention relevant with competing talkers. It shows speech recognition scores and potential underlying error sources and focuses on mechanisms related to the interplay of sensory acuity and cognitive functions. Possible consequences and clinical perspectives with regard to auditory diagnosis and rehabilitation are discussed.

Monday June 19, 9.40–10.00

Determinants of listening effort and their effects on sympathetic and parasympathetic activity

Michael Richter¹

Kate Slade¹

¹School of Natural Sciences and Psychology,
Liverpool John Moores University, UK

Drawing on Brehm's motivational intensity theory and physiological research on physical effort, we will present a theoretical framework that specifies the determinants of listening effort – the effort involved in carrying out listening tasks – and that suggests a physiological operationalization of listening effort. According to the framework, listening demand and success importance are the main determinants of listening effort. Moreover, the framework postulates that listening effort is characterized by a shift from parasympathetic dominance to sympathetic dominance. We will present data from two studies that corroborated these predictions. Study 1 manipulated listening demand across four levels. Study 2 manipulated both listening demand and success importance across two levels. In both studies, the effort-related shift in autonomic balance was measured by assessing pre-ejection period and high-frequency heart rate variability as indicators of sympathetic and parasympathetic activity. Supporting the predictions of the theoretical framework, we observed that increases in listening demand reduced parasympathetic activity and increased sympathetic activity if success importance was high. However, if success importance was low, increases in listening demand did not lead to a shift in autonomic balance.

Monday June 19, 10.30–10.50

Ten years of measuring Text Reception Thresholds: what are we actually measuring?

Adriana A. Zekveld^{1,2}

Marieke Pronk², Henrik Danielsson¹ and Jerker Rönnerberg¹

¹Linnaeus Centre HEAD, Linköping University, Sweden

²Section Ear & Hearing, Dept. of Otolaryngology-Head and Neck Surgery and
Amsterdam Public Health research institute, VU University medical center,
the netherlands

The visual Text Reception Threshold (TRT) test has been designed to assess modality-specific factors relevant for speech perception in noise. In the last 10 years, the test has been adopted in audiology labs worldwide. The first aim of the present study was to examine which factors best predict inter-individual differences in the TRT. Secondly, we aimed to assess the relationships between the TRT and speech reception thresholds (SRTs) estimated in various conditions.

First, we reviewed studies reporting relationships between the TRT and auditory and/or cognitive factors and formulated specific hypotheses regarding the TRT predictors. These hypotheses were tested using prediction models applied to a rich dataset of 200 hearing-impaired participants. In separate association models, we tested the relation between the TRT and SRT, taking into account potential confounder variables.

Preliminary results indicate that sentence completion ability is the strongest predictor of the TRT, together with a set of linguistic and more general cognitive abilities (e.g., verbal working memory). We will furthermore present the associations between the TRT and SRT of the hearing-impaired participants.

The present review and results are highly valuable for the interpretation of the data collected with the TRT test in future studies.

Monday June 19, 10.50–11.10

Investigating memory for tones and speech in noise performance in hearing impaired listeners

Maja Serman

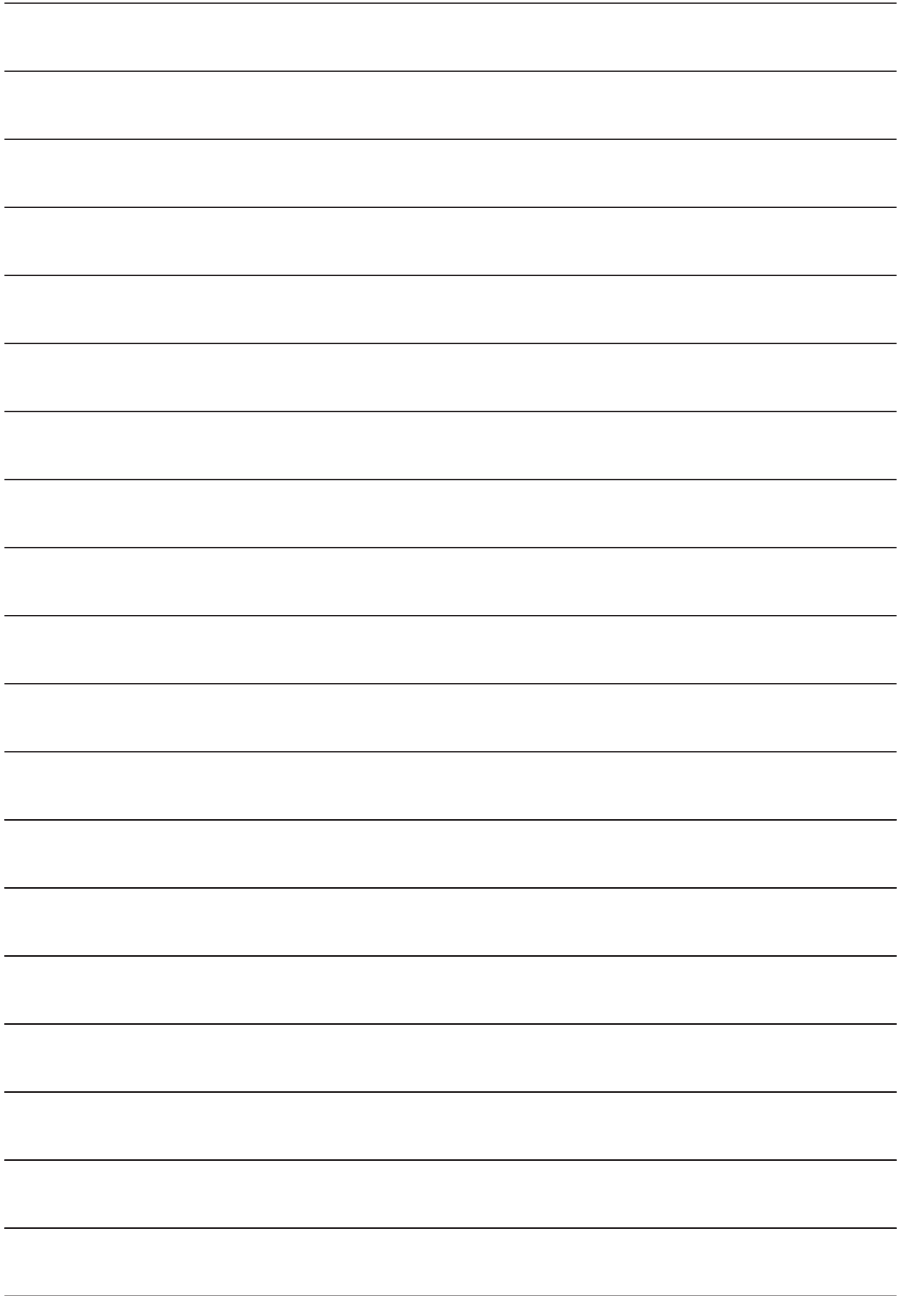
Rosa-Linde Fischer, Kaja Kallisch and Ronny Hannemann

Sivantos GmbH, Erlangen, Germany

Listening involves different levels of information processing, from fine spectro-temporal information, towards more and more abstract symbolic representations of the sound signal. It is clear that cognitive functions relate to speech perception and recognition. For example, auditory short term memory assessed with the Letter Number Sequencing task has been linked to speech-in-noise performance in hearing impaired listeners. Recent studies indicated that musicians have an advantage in noisy listening situations and that this advantage may be related to their auditory short term memory, as assessed with the digit span backwards test.

Given that musicianship involves manipulation of the basic aspects of sound (e.g. pitch and duration), we were interested in the role of working memory for some of these sound attributes with regard to the speech-in-noise performance of hearing impaired listeners. For this purpose, we used a memory for tones task consisting of auditory rhythmic sequences of low frequency tones (a same/different judgment of a standard and a target tone, separated by a series of six intervening distracting tones).

Previously, we found significant correlations between the outcome measures of the memory for tones task and self-assessed listening skills in hearing impaired listeners. Here, we report on the correlations between the memory for tones task and performance in different speech-in-noise scenarios.



Monday June 19, 13.15–13.35

Effects of noise, accented speech, and language experience on speech understanding and listening effort

Jens Schmidtke

German Jordanian University, Jordan

Age, a hearing impairment, dyslexia, and bilingualism are all factors associated with a disadvantage in speech understanding in noise (SUN). The last group stands out because bilingualism per se does not negatively affect cognitive functions or hearing acuity. Therefore, researching bilinguals offers the opportunity to investigate the unique effect of language experience on SUN. Results from the first study I present in this talk suggest that even early bilinguals perform below monolinguals on SUN tests because they have less experience in each of their languages. The second study compared monolingual English (L1) speakers to second language (L2) learners of English on their adaptation rate to an American English and foreign-accented English speaker, respectively (all participants were familiar with American English but unfamiliar with the foreign accent). Results suggest that the adaption rate to foreign accented English was slower in L2 speakers compared to L1 speakers. These results are interpreted in terms of the quality of lexical representations, which is dependent on language experience.

Effect of degraded auditory input on memory span using cochlear implant simulations in normal-hearing listeners

Jasenia Hartman¹

Sara Misurelli², Alan Kan² and Ruth Y. Litovsky^{1,2}

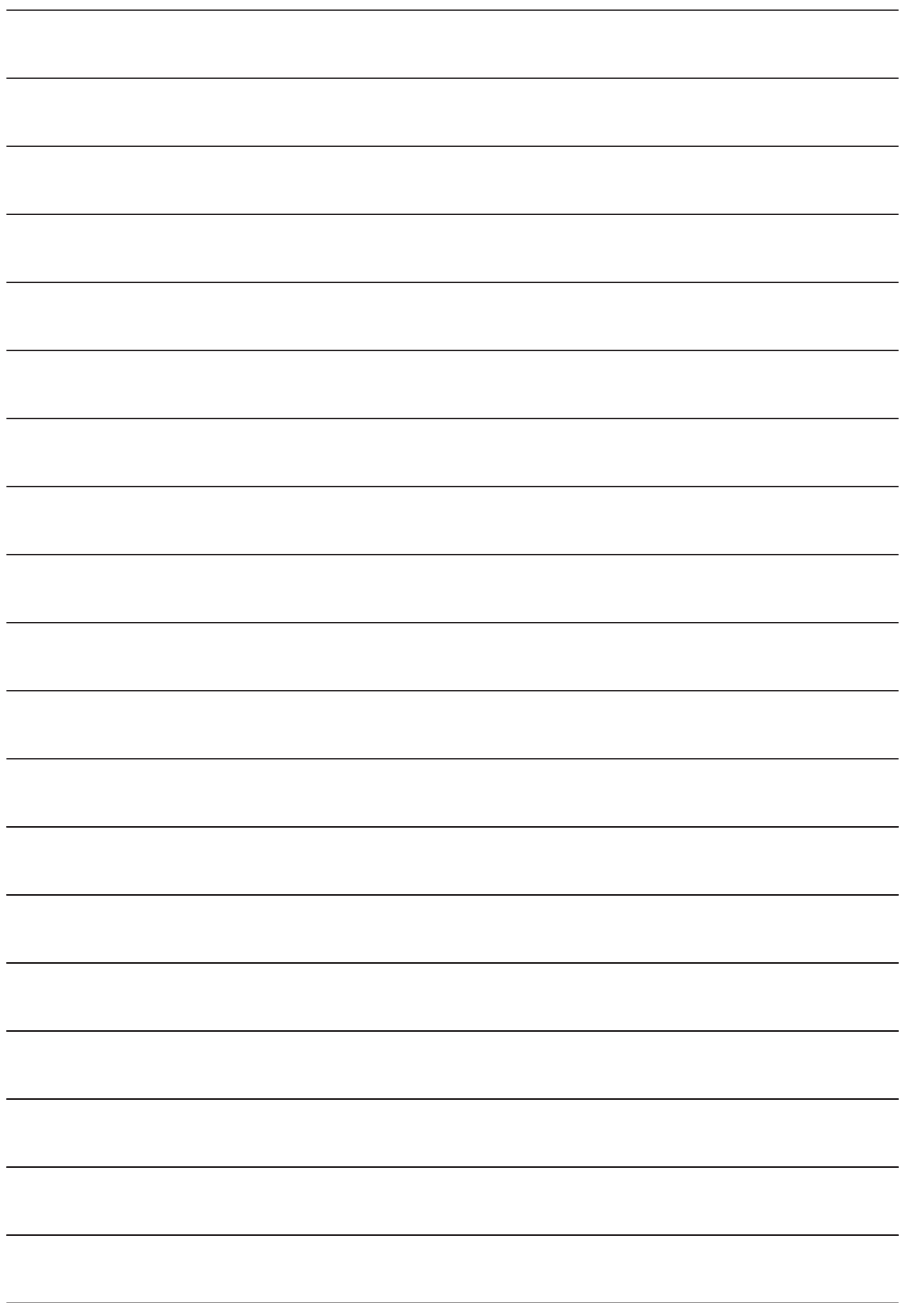
¹Neuroscience Training Program, University of Wisconsin-Madison, USA

²Communication Science and Disorders, University of Wisconsin-Madison, USA

Although multisensory input is easier to remember than unisensory input, it is unclear whether information from different modalities is encoded separately or together in the brain. Research has shown that individuals with cochlear implants (CIs) have reduced memory capacities relative to their normal-hearing (NH) peers, possibly due to the degraded auditory input they receive. Yet, little research has been done as to how this degraded input might affect working memory when combined with visual input. In this study, we investigated the effects of degraded auditory input on memory, when audio-visual information was provided.

24 young NH adults were tested using a computerized version of the digit span test. Digits were presented under five conditions: (1) audio, (2) degraded audio, (3) visual, (4) normal audio+visual, and (5) degraded audio+visual. In the degraded audio conditions, stimuli were processed through a 4-channel vocoder.

Results thus far suggest that performance on the digit span test decreases in conditions with degraded auditory input, even in the presence of visual input. Performance was lower in the degraded audio+visual vs. normal audio + visual condition, suggesting the degraded auditory signal might interfere with processing visual information. These results could give insight into how multisensory information is encoded.



Monday June 19, 13.55–14.15

**Adult aging affects the balance between linguistic context
and response competition in speech recognition
by cochlear implant users**

Arthur Wingfield¹

Nicole Amichetti¹, Eriko Atagi^{1,2} and Ying-Yee Kong²

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

²Department of Speech and Hearing Sciences, Northeastern University, USA

In spite of the fact that speech arrives at the ears at rates that can exceed 200 words per minute, both younger and older adults can nevertheless follow speech content quite well. One reason why speech can be understood at this rapid rate is that words can often be recognized before their full acoustic duration has been heard, especially when the word is heard within a linguistic context. The technique of word onset gating, in which recognition is tested as the listener is allowed to hear increasing amounts of a word's onset duration, was introduced in the 1980s to model this presumption of on-line interactive processing as speech is being heard. Although one can debate its validity as a model of online discourse processing, it can be a useful technique for examining top-down and bottom-up interactions in word recognition. In ongoing studies we are using onset gating to examine speech recognition by severely hearing-impaired younger and older adults who interact with the acoustic world via cochlear implants. In this presentation we show that speech recognition in the older adult implant user reflects a balance between the facilitating effects of a linguistic context and the reduced ability to inhibit semantic competitors. These results support the generality of an inhibition deficit as an accompaniment of adult aging.

How conversation behaviour changes with increasingly challenging listening conditions in people with normal and impaired hearing

Gitte Keidser^{1,2,3}

Tim Beechey^{1,2,4} and Jörg Buchholz^{1,2,4}

¹National Acoustic Laboratories, Australia

²The HEARing CRC, Australia

³Department of Audiology, University of Queensland, Australia

⁴Department of Linguistics, Macquarie University, Australia

It is widely accepted that hearing loss and noise have negative effects on people's ability to communicate, and that people with better cognitive function and linguistic knowledge take advantage of such resources in adverse listening situations. However, little is known about how much each of these factors contribute to a person's communication efficacy in various acoustic environments. This talk presents data from a study in which a novel paradigm was used to elicit natural conversations between pairs of people in each of a realistic library, office, café, traffic, and food court environment. Acoustical, phonetic, prosodic, and interactional measures were extracted from the recorded speech and analysed. The analysis of conversational speech from twenty normal-hearing people revealed typical Lombard effects on the acoustic and phonetic levels as the listening environment became more challenging. The change in environment had relatively minor effect on the prosodic and interactional measures. Using this data as reference, preliminary data obtained from conversations between pairs of people where one has normal hearing and the other has impaired hearing will be presented and discussed, including correlations between measures of supra-threshold deficit and cognitive ability related to verbal processing and communication effort.

Monday June 19, 15.05–15.25

About the impact of hearing impairment on processing effort and the benefit of hearing aid signal processing

Dorothea Wendt^{1,2}

Renskje Hietkamp¹, Barbara Ohlenforst^{1,3} and Thomas Lunner^{1,4,5}

¹Eriksholm Research Centre, Oticon A/S, Denmark

²Department of Electrical Engineering, Technical University of Denmark, Denmark

³Section Ear & Hearing, Dept. of Otolaryngology-Head and Neck Surgery,
VU University Medical Center and Amsterdam Public Health Research Institute,
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⁴Linnaeus Centre HEAD, Linköping University, Sweden

⁵Department of Clinical and Experimental Medicine, Linköping University, Sweden

Speech perception in adverse listening situations can be exhausting. Hearing loss particularly affects processing demands, which requires increased processing effort for successful speech perception in background noise. Signal processing in hearing aids and noise reduction (NR) schemes aim to counteract the effect of noise and reduce the effort required for speech recognition in adverse listening situations. This talk outlines some studies investigating the impact of hearing loss on processing effort and the benefit of a NR scheme on speech recognition and effort. The influence of hearing loss and NR processing on effort was evaluated by measuring the Peak Pupil Dilation (PPD) of listeners while performing a speech recognition task. Speech recognition performances and PPDs were measured in different listening situations varying in SNR and/or speech intelligibility. A significant interaction effect between SNR and hearing-status on effort was found. Moreover, a benefit of the NR scheme on effort was demonstrated for hearing-impaired listeners at positive SNRs, i.e. for listening situations where speech recognition was at ceiling performance. The results emphasized the relevance of measuring processing effort in situations where the traditional speech reception measures fail due to ceiling effects.

Abstracts

Tuesday

**Crossmodal plasticity in auditory cortex following deafness:
vocalization processing cortex in the hearing becomes
a face processing region in the deaf**

Stephen G. Lomber¹

M. Alex Meredith², Carmen Wong¹ and Andrej Kral³

¹Department of Physiology and Pharmacology, University of Western Ontario, Canada

²Department of Anatomy and Neurobiology, Virginia Commonwealth University, USA

³Department of Experimental Otolaryngology, Hannover Medical University Hannover, Germany

In the deaf, crossmodal plasticity enables enhanced visuospatial functions such as visual localization and motion detection. We hypothesized that supranormal visual abilities extend beyond perception and include cognitive functions such as learning or recall. Using a battery of visual discriminations, deaf cats were found to be superior at learning, but not recalling, conspecific and human faces when compared to hearing cats. Furthermore, bilateral deactivation of temporal auditory field (TAF) resulted in the elimination of the enhanced face (both conspecific and human) discrimination learning capabilities of deaf cats. Unilateral deactivation of left TAF resulted in a partial, but significant, decrease in the enhanced face learning abilities of deaf cats. As left ventral auditory cortex in hearing animals is critical for discriminating conspecifics acoustically (vocalizations), crossmodal reorganization of this ventral region enables enhanced visual learning of conspecific face discriminations in the deaf. This suggests that ventral auditory cortex has the supramodal role of discriminating individuals. Altogether, this study reveals that enhanced visual abilities following acoustic deprivation include cognitive functions, enabling superior face discrimination learning in the deaf.

Tuesday June 20, 9.00–9.20

A distorted representation of sound is important for speech encoding

Anders Fridberger^{1,2}

¹Department of Clinical and Experimental Medicine, Linköping University, Sweden

²Oregon Health & Science University in Portland, USA

Speech, music and animal communication calls contain many different frequencies that change rapidly over time. Yet, studies have shown that a limited amount of information about the slowly varying envelope of the stimulus is sufficient for accurate speech recognition, at least in quiet conditions. Direct evidence for this comes from cochlear implant users, most of whom get very good speech recognition when only a few frequency bands of envelope information are presented through the implanted electrode.

Frequency components corresponding to the envelope are not found in the sound-evoked vibrations of the basilar membrane, but they are clearly present in the discharges of the auditory nerve. How can the auditory nerve encode information absent from the basilar membrane, which provides the stimulus that drives the nerve?

Using experiments in humans, guinea pigs, and rats, we demonstrate that envelope extraction is possible because mechanically sensitive ion channels introduce distortion. This distortion tracks the envelope, excites the auditory nerve, and ensures that information about the envelope is transmitted to the brain. The hearing organ can therefore be viewed as a non-linear real-time extractor of the magnitude of the Hilbert transform of the acoustic stimulus.

The new early filter model

Tom Campbell

University of Helsinki, Finland

The rostral brainstem receives both “bottom-up” input from the ascending auditory system and “top-down” descending corticofugal connections. Working memory capacity (WMC), which is subject to age-related decline, constrains the processing of sounds at the level of the brainstem. Turning to the effects of a visually presented sensory or memory load on auditory processes, I describe a load-dependent reduction of that processing, as manifest in the auditory brainstem responses (ABR) evoked by to-be-ignored clicks. Wave V decreases in amplitude with an increase in visually presented memory load. A visually presented sensory load also produces a load-dependent reduction of a slightly different sort: The sensory load of visually presented information limits the disruptive effects of background sound upon working memory performance.

In a new early filter model of such phenomena (Marsh & Campbell, 2016, doi: 10.3389/fnins.2016.00136), systems within the frontal lobe, affected by sensory or memory load, influence top-down corticofugal connections. Those corticofugal connections constrain the processing of complex sounds such as speech at the level of the brainstem. Selective attention limits the distracting effects of background sound entering the higher auditory system via the inferior colliculus. Attentional selectivity is pivotal when the signal heard is degraded or masked.

Tuesday June 20, 9.40–10.00

What we know about the pupil dilation response related to speech processing in noise in adults with ABI

Thomas Koelewijn

Sophia E. Kramer

Section Ear & Hearing, Department of Otolaryngology-Head and Neck Surgery and
Amsterdam Public Health Research Institute, VU University Medical Center,
Amsterdam, the Netherlands

A significant group of people with a normal pure tone audiogram report difficulties in separating speech from background sounds and experience high levels of listening effort in noisy situations. This type of hearing disability is referred to as the King Kopetzky syndrome. Listening effort in this group seems to be due to disturbed cognitive functioning when processing auditory information, independent of the peripheral hearing system. In this study, we examined the pupil dilation response as an objective measure quantifying listening effort in a group of 20 adult listeners, with acquired brain injury, during speech processing in noise. All had a normal pure tone audiogram, but reported high levels of listening effort. They listened to speech in different types of background sound and at different intelligibility levels. The outcomes were compared to previous results obtained from people without acquired brain injury and with or without sensorineural hearing loss.

Tuesday June 20, 10.30–10.50

EEG indices of speech and auditory object processing and how they are affected by attention

Edmund C. Lalor^{1,2}

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University of Rochester, USA

²School of Engineering, Trinity Centre for Bioengineering and Trinity College Institute
of Neuroscience, Trinity College Dublin, Ireland

How the human brain extracts meaning from the dynamic patterns of sound that constitute speech remains poorly understood. This is especially true in natural environments where the speech signal has to be processed against a complex mixture of background sounds. In this talk I will outline efforts over the last few years to derive EEG indices of speech processing. I will discuss how these indices are affected by attention and visual input and how attentional selection can be “decoded” from EEG data. I will attempt to convince you that EEG is sensitive not just to the low-level acoustic properties of speech, but also to higher-level linguistic aspects of this most important of signals. And, I will discuss work attempting to identify EEG measures of fundamental computations in auditory cortex that underlie auditory object formation in general, and how these measures too are affected by attention.

Tuesday June 20, 10.50–11.10

The role of gestures in spoken language comprehension: insights from brain and behavior

Asli Ozyurek

Linguistics/Psychology, Radboud University, the Netherlands

In face-to-face communication people use and perceive meaningful gestures in the context of speech. For example as someone as says, "researchers stayed up all night" they might use a drinking gesture that would convey relevant information to what is conveyed in gesture. In this talk, I will show that such gestures in fact influence comprehension of the words conveyed in the speech signal for the listeners . There is growing evidence that gestures prime and disambiguate words in similar ways as words or sentential contexts do. Furthermore even though most audiovisual research has focused on visible speech such lips in enhancing comprehension of degraded speech, work from our lab has recently shown that listeners in fact use more information from gesture than lips to disambiguate the degraded speech signal-due to gestures' rich semantic content. Finally I will also talk about how brain's spatio-temporal dynamics enables listeners to integrate gestures to speech and enhance speech comprehension in clear and degraded contexts as well as in native and non-native listeners. Relevant for the conference I will claim that gestures, mostly neglected, offer a unique source of information and possibly a therapeutic tool for people in cases of speech impairments and learning contexts.

Keynote: Tuesday June 20, 13.15–13.40

Deafness and cortical plasticity in the human brain

Velia Cardin

School of Psychology, University of East Anglia, UK

The extraordinary capacity of the brain for functional and structural reorganisation is known as neural plasticity. Understanding this phenomenon not only provides insights into the capabilities of the brain, but also into its potential for adaptation and enhancement, with applications for sensorimotor substitution, artificial intelligence, policy and education.

In this talk, I will discuss the reorganisation of sensory and cognitive processes as a consequence of early deafness. In deaf humans, neural plasticity is not only the result of hearing loss, but also of cognitive factors, as language must be acquired visually and is often delayed. In a series of fMRI studies, we have dissociated the contribution to cortical plasticity of each of these factors, both in primary and secondary auditory areas. In particular, our findings suggest that the organisation of cognitive networks is shaped by the nature of the sensory inputs available during development.

Tuesday June 20, 13.40–14.00

Functional hearing loss is associated with cerebral grey matter loss: neuroimaging evidence from over 5000 individuals included in the UK Biobank resource

Mary Rudner¹

Mark Seeto^{2,3}, Gitte Keidser^{2,3}, Blake Johnson⁴ and Jerker Rönnerberg¹

¹Linnaeus Centre HEAD, Linköping University, Sweden

²National Acoustic Laboratories, Australia

³The HEARing CRC, Australia

⁴Department of Cognitive Science, Macquarie University, Australia

UK Biobank is a prospective cohort study of over 500,000 middle-aged British adults for whom biological, physical, cognitive, life-style and health data are available. Brain imaging data have been collected from part of this sample, allowing investigation of hearing and cognition in relation to cerebral structure and function. We investigated the association between hearing loss and brain integrity by examining the grey matter volume extracted from the T1-weighted structural images of 5724 individuals for whom such data were available. Speech reception thresholds (SRT) were available for 5218 of these individuals (Digit Triplet Test). 3152 had normal hearing (better ear SRT < -5.5) and 210 had poor hearing (better ear SRT > -3.5, c.f. Dawes et al., 2014). Statistical analysis showed that whole brain grey matter volume was significantly larger for individuals with normal compared to poor hearing. This discrepancy persisted when volumes were normalized in relation to head size and when age and gender were controlled for in linear regression models. These results suggest that functional hearing loss is associated with grey matter loss. Associations between functional hearing loss and the volume of specific brain regions will be presented.

Tuesday June 20, 14.00–14.20

Impact of hearing loss on brain and cognition in older adults

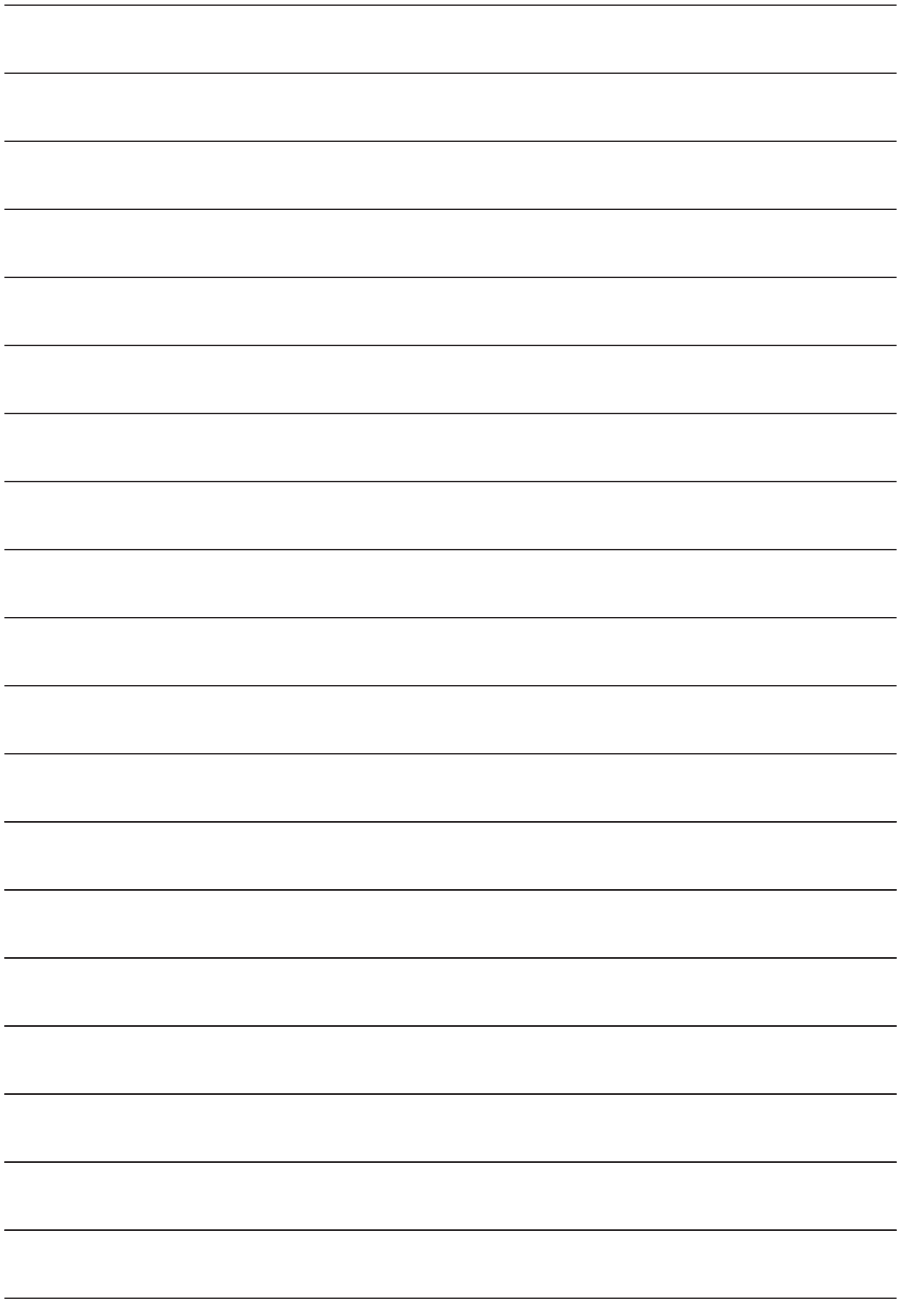
Fatima Husain^{1,2}

Lydia T. Nguyen², YiHSin Tai¹, Shraddha A. Shende¹ and Raksha A. Mudar^{1,2}

¹Department of Speech and Hearing Science, University of Illinois at Urbana-Champaign, USA

²Neuroscience Program, University of Illinois at Urbana-Champaign, USA

Hearing loss is the third most prevalent chronic health condition that affects older adults. Growing evidence suggests that hearing loss is independently associated with reduced cognitive functioning and incident dementia. However, few studies have concurrently investigated the associations among measures of hearing, cognition, and brain function in individuals with age-related hearing loss. The primary objective of our ongoing study is to investigate the associations between hearing loss and cognitive and neural alterations in older adults by comparing a group of individuals with untreated bilateral mild-to-moderate high frequency age-related sensorineural hearing loss to a group of age-, education-, and gender-matched normal hearing controls. In the ongoing study, participants complete clinical audiometric evaluation, cognitive assessment, and electroencephalography (recorded during visual paradigms related to executive function). Data will be analyzed to examine differences in cognitive performance and neural measures between the hearing loss and the normal hearing groups (of 12 subjects each). Additionally, correlations between measures of hearing ability, cognitive function, and neural measures, specifically event-related components (N2 and P3) will be examined. The correlates identified here will be used in future to evaluate the benefits of interventions in modifying the associations between hearing loss and minimizing dementia risk.



Tuesday June 20, 14.20–14.40

Deafness-related deficits in temporal attention: hearing loss or linguistic deprivation?

Matthew Dye^{1,2,3}

Brennan Terhune-Cotter¹, Sarah Kimbley^{1,3} and Peter Hauser^{1,4}

¹NTID Center on Cognition and Language, RIT/NTID, USA

²Department of Liberal Studies, RIT/NTID, USA

³Department of Psychology, RIT, USA

⁴Department of ASL and Interpreter Education, RIT/NTID, USA

Compensatory changes in the spatial vision of deaf individuals are now well documented, and we are starting to understand the cross-modal neuroplasticity that underpins these functional changes in visual processing. In contrast, several studies have documented visual attentional deficits in the temporal domain, notably in deaf children with severe-to-profound hearing losses. Theoretical frameworks invoked to explain these deficits – such as the auditory scaffolding hypothesis or the intersensory redundancy hypothesis – attribute those deficits to hearing loss and a lack of auditory stimulation (or atypical multisensory integration). However, recent data from our group has suggested that the temporal processing deficits observed in deaf children may be absent (or significantly attenuated) in children who are native signers of a natural sign language. Here, we report initial findings from a national longitudinal study of temporal attention in 7-to-11-year-old deaf children. The study was designed to test competing predictions of auditory versus linguistic deprivation models, and includes measures of hearing loss, sequence learning, working memory, executive function, ASL and spoken English language abilities, reading proficiency, NVIQ, and arithmetic skill. The findings have implications for rehabilitation of speech and language in deaf children, as well as for amelioration of attention-related behavioral problems.

Keynote: Tuesday June 20, 15.10–15.35

Auditory processing disorders, reading deficits and dichotic perception

Harvey Dillon

Sharon Cameron and Kiri Mealings

National Acoustic Laboratories, Australia

People with reading deficits (dyslexia) can have deficits for irregular words (which must be learned by sight, e.g. yacht), deficits for regular or non-words (which most efficiently are learned phonetically, e.g. cat) or mixtures of both deficits. We hypothesised that phonologically-based deficits might be caused by either poor categorical perception of speech sounds, or poor perception of syllable boundaries. To test this, we devised two new tests, the Phoneme Identification Test (PIT) and the Parsing Syllable Envelopes (ParSE) test. Data currently being collected are generally consistent with the hypothesis: Children with phonetically-based reading deficits score outside normal limits on either the PIT or ParSE tests, whereas those with sight-based reading deficits perform typically for age on both PIT and ParSE.

Test batteries for auditory processing disorders invariably include one or more dichotic tests. However, dichotic tests have been used to investigate selective attention, working memory, executive function, aging and mental retardation! Consequently, it is most unclear what an atypically low score on a dichotic task actually means. We have devised the Dichotic Digits difference Test (DDdT) that includes a diotic control condition. Dichotic and diotic scores are highly correlated, and both are correlated with working memory.

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Tuesday June 20, 15.35–15.55

Children with hearing impairment in adverse listening conditions. What can be done to support teachers and students?

Birgitta Sahlén

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In spite of medical, technical and pedagogical advances, the risk for language impairment is still much higher in children with hearing loss than in normal hearing peers. Our research on linguistic and cognitive development in younger and older generations of Swedish children with hearing impairment (HI) indicate similar problems as in hearing children with ideopathic language impairment (SLI) in language skills (nonword repetition, verb morphology and listening comprehension). Twenty to thirty percent of the early implanted children with CI still seem to meet criteria for language impairment. Today, the majority of children with HI are mainstreamed, often in class-rooms where listening conditions are poor. Results from our studies show that when a hoarse teacher is speaking in background babble noise, performance, effort and memory in passage comprehension tasks is affected. Children with weak working memory capacity are particularly affected. Current intervention projects aiming at improving listening conditions and language supporting interactions in mainstream class-rooms by teacher education will be reported.

Tuesday June 20, 15.55–16.15

Child-directed interactions can enhance early language and cognitive development in children with hearing impairment: the roles of speech, music, and play

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Modern developments in child psychology such as executive function, grit and growth mindset suggest that growing up is hard work for both children and parents, even more so for those who have a hearing impairment. However, there is a growing body of research that suggests that children learn best in playful environments. It is also important to note that assistive devices such as hearing aids and cochlear implants do not simply turn up the volume of the sound, and are designed to maximally benefit speech rather than music listening. And yet children who have hearing loss and use hearing aids and cochlear implants enjoy music and participate in music lessons and activities. This talk will focus on the importance of play in the early communicative interactions between caregivers and children with hearing impairment, the different types of playful interactions (such as speech, singing, and music), and the roles they might serve in developing the fundamental skills necessary for optimizing outcomes.

Tuesday June 20, 16.15–16.35

**What is the value of normality in identifying deficit?
A universal marker for dyslexia in deaf and hearing children**

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Dyslexia can be understood through the double-deficit model (1), with impairments in phonological processing and/or naming-speed. This model is based on hearing individuals with severe reading difficulties. A separate group with reading difficulties, deaf children, are known to exhibit pervasive phonological deficits; however, the role of naming speed has not to date been fully explored (2). We report on a study that collected naming-speed, literacy and phonological data from a large sample of 79 deaf children aged 10-11 years, all users of spoken English, recruited from primary schools across the UK and 20 hearing dyslexic controls (3). Relationships between naming-speed and reading revealed that naming speed performance has the potential to be a universal marker for dyslexia, not only in hearing students, but also for their deaf counterparts.

Abstracts

Wednesday

Improving communication in children with unilateral to profound hearing impairment with a cochlear implant

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Every year, neonatal hearing screening services in Flanders (Belgium) detect single sided hearing loss in approximately 60 neonates, of whom about 16 have a profound sensorineural hearing loss, also called single sided deafness (SSD). As these children have no binaural hearing, they often will experience difficulties with localization of sounds and with speech intelligibility in noisy situations. Furthermore, an increasing body of research suggests that single sided hearing loss is a risk factor for speech-language delays.

A cochlear implant (CI) on the deaf side has the potential to restore binaural hearing. For congenital SSD, recently positive results have been reported for two children implanted early in life, but not for four children implanted at an older age. It is likely that early implantation is critical for bilateral auditory development.

We currently report on data of five infants with SSD who received their CI at the age of resp. 0;8, 1;0, 1.2, 1;9 and 2;2 (yr;mo) and are tested with age-appropriate materials at regular intervals. We compare behavioral and questionnaire data of these children to those of matched normal hearing peers and matched children with SSD without a CI. The children are assessed with regard to their receptive and expressive language skills (Bayley-III language subscales or the Schlichting Language Tests), their cognitive abilities (Bayley-III cognitive subscale or WPPSI-III) and when old enough their ability to localize sounds and speech in noise understanding. Also, their language environment is studied (LENA system) and parents are asked to complete questionnaires on auditory behavior (Littleears and/or PEACH+), language development (N-CDI) and social-emotional and adaptive behavior (Bayley-III questionnaires or Vineland Screener). Results of the first testing sessions, 2 months pre implantation and 4/(10/16/22) months post implantation, will be presented at the conference.

Wednesday June 21, 9.00–9.20

Understanding speech via a cochlear implant: the role of predictive and automatic processing

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Understanding speech is easy for normal hearing listeners because perceptual mechanisms automatically percolate the signal through a hierarchy of analyses, from acoustic feature extraction to the integration of meaning into the context of a conversation. Profoundly deaf listeners, who can regain access to speech perception via cochlear implants need to learn to decode signals that are very unlike speech. These signals challenge the perceptual processing hierarchy at the very early levels, and it is yet an open question whether and how cochlear implant users learn to re-establish automatic processing of speech.

I will present a series of EEG and eye-tracking experiments that examine how cochlear implant users process speech within the architecture of models of speech perception. The experiments investigate the time-course of speech perception, as well as the involvement of attentional resources while processing speech at various analysis stages. Objective and behavioral measures will be presented in relation to measures of cortical entrainment, predictive processing of speech (as measured in ERPs), and the clinical measures of success in adaptation to the cochlear implant for individual listeners.

Wednesday June 21, 9.20–9.40

Assessment of listening effort and speech intelligibility in every-day life

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A common method to assess speech intelligibility in noise in laboratory conditions estimates the signal-to-noise ratio for intelligibility scores of 50%, which is known as the speech reception threshold (SRT). At this threshold, study participants rate their subjective listening effort as considerable to extreme. To assess subjective speech intelligibility and listening effort in every-day life conditions, we developed a privacy-aware smartphone-based system that allows for long-term ecological momentary assessment. This system combines descriptions of the environment and subjective ratings on predefined scales with objective features derived from the acoustical signal. The audio signal itself is not stored to respect the privacy of all communication partners and bystanders. Forty-seven elderly listeners used the system for about four consecutive days in a field study. In contrast to the common laboratory tests, the subjects reported high speech intelligibility and low listening effort for most of their everyday listening environments. More demanding situations were comparatively rare and included restaurant or car environments. The presentation summarizes the study results and their possible impact on evaluation methods in the laboratory.

Temporal fine structure processing in older adults: beyond the syllable boundary

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Previous studies showed that older adults have difficulties processing fine structure (FS) speech cues such as voice onset time (VOT). In our study, differences between younger (YA) and older (OA) adults in FS perception and their relation to cognitive abilities were investigated behaviorally and electrophysiologically. YA and OA categorized and discriminated syllables (/da/ and /ta/) with varying VOTs. OA had significantly higher error rates than YA both when the difference in VOT was small (discrimination within the same syllable type) and large (discrimination across the /da-/ta/ boundary), indicating that OA have more problems discriminating VOT in general and especially across the syllable border. Also, OA showed less specificity in the categorization task, suggesting that difficulties in categorization are related to discriminatory abilities across the syllable border. OA had significantly longer latencies and significantly smaller amplitudes of the P2 ERP component evoked by the syllables than YA, reflecting slower and more inaccurate stimulus encoding. Latency of the P2 component was related to perceptual speed in both groups, suggesting that latency reflects perceptual speed rather than encoding effort. Attentional and inhibitory abilities were associated with better discrimination across the syllable border only in OA, showing a beneficial influence of cognitive ability.

Wednesday June 21, 10.30–10.50

Impact of hearing loss, hearing aids use in aging: results from a population-based study

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Numerous consequences of hearing loss on health and well-being of older adults have been reported. Surprisingly, less is known about the impact of hearing aids use on such adverse health events. The study is based on the PAQUID study, a prospective community-based study of 3777 participants aged 65 and over followed-up for 25 years. At baseline, 176 participants reported hearing loss using hearing aids, 1113 reported hearing loss and not using hearing aids and 2290 reported no hearing trouble. Several health events were considered: death, cognitive decline, dementia, depressive symptoms, and disability in activities of daily living (ADL) and instrumental ADL. The risk of occurrence of negative outcomes was assessed with a Cox proportional hazards model or linear mixed model. Adjusting for sociodemographics, an increased risk of depression, ADL and IADL disability, cognitive decline and dementia was found for participants with hearing loss not using hearing aids compared to the participants reporting no hearing loss whereas no increased risk was found for those using hearing aids. Our study confirms that hearing loss is associated with increased risk of depression, disability, cognitive decline and dementia. No such association was found in those using hearing aids, a result which has never been reported.

The consideration of hearing, vision, and cognition in the Canadian Consortium on Neurodegeneration in Aging (CCNA)

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Scientific studies show that people with hearing, vision, and/or cognitive problems have poorer health outcomes. Moreover, there is a strong relationship between sensory impairment and cognitive function. Hearing impairment is independently associated with incident dementia and there are parallel findings for visual impairment. Potential mechanisms for these relationships include common biological substrates, the exhaustion of cognitive reserve, environmental deafferentation, and/or increased social isolation from communication difficulties. This presentation will briefly review research findings concerning the relationships between sensory impairment, cognitive impairment, and dementia in older adults. I will present an overview of the Canadian Consortium on Neurodegeneration in Aging (CCNA), a nation-wide research consortium aimed at understanding the mechanisms of neurodegenerative illness. Extensive clinical, biomedical, cognitive, and brain imaging data is being gathered on 1600 participants who range from having no clinical impairments in cognition, to those suffering from various forms of dementia, including Alzheimer disease. I will focus on the activities of our Sensory-Cognitive research team that examines the relationship between sensory function, cognitive function, health, and quality of life in older adults with dementia. I will describe how measures of hearing, vision, and cognitive function are incorporated into the CCNA battery and will report on preliminary research findings.

Wednesday June 21, 11.10–11.30

Linking sensory and cognitive aging: the influence of social factors

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Data from numerous studies have demonstrated a link between auditory and cognitive aging, although the mechanisms underlying this link remain relatively unexplored. One hypothesis is that social isolation mediates the influence of sensory aging on cognitive aging. Another hypothesis is that the influence of sensory aging on cognitive aging manifests in increased risk of social isolation. Preliminary data from the first wave of the Canadian Longitudinal Study of Aging (CLSA) indicates that compared to those reporting no sensory loss, older adults who report hearing and/or vision loss are at increased risk of loneliness and reduced social support, whereas only those reporting vision loss or dual sensory loss are at greater risk of reductions in activity participation and social networks. This presentation will emphasize the relevance of different social factors that may be causes or consequences of sensory and cognitive aging and the links between them. The possibility of using interventions to modify social psychological factors linked to sensory and cognitive aging will be discussed.

Posters

Sensitivity and specificity of the Montreal Cognitive Assessment after the omission of hearing-dependent subtests

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A third of adults over 65 years of age suffer from hearing loss. The prevalence of mild cognitive impairment (MCI) can be up to 42%. The co-occurrence of hearing loss and MCI poses a challenge for cognitive assessment. The Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) is a quick and efficient screening tool used globally to detect MCI in older adults; however, it assumes normal sensory function. The present research examines how omitting auditory subtests affects the MoCA's psychometric properties.

The original MoCA validation data were reanalyzed (MCI, n=94; Alzheimer's Disease, n=93; healthy controls, n=90), excluding four subtests that depend on proficient hearing (delayed recall, digit span, sentence repetition, sustained attention). We assessed the test's psychometric properties using absolute and proportional cut-off score adjustments and compared them to the original MoCA values (MCI sensitivity:90%, specificity:87%). Results showed that MCI sensitivity was substantially reduced (Absolute:44%, proportional:68%). Excluding only three subtests and maintaining delayed recall had no effect on sensitivity but reduced specificity (sensitivity:94%, specificity:71% using proportional cut-off). ROC curves were developed to determine ideal cut-offs. Overall, exclusion of memory-related subtests led to expected changes in sensitivity and specificity. Recommendations for screening in primary care settings will be discussed.

Outer hair cell damage hinders aural identification of consonants

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Outer hair cells (OHC) function by mechanically amplifying low-level sounds and thereby sharpen frequency selectivity. In speech, consonants generally have lower sound level than vowels, suggesting poor identification of consonants in individuals with OHC damage. We tested 200 individuals with bilateral, mild-to-severe sensorineural hearing loss, using the gating paradigm in which successively longer segments of consonants and vowels are presented using auditory and audiovisual modalities. Distortion product otoacoustic emissions were obtained to determine OHC function. For OHC function at 1000 Hz, where all vowels were louder than all consonants tested, there was a three-way interaction between modality of presentation (audio, audiovisual), type (consonants, vowels) and OHC status (intact, damaged), $F(1,190) = 21.6$, $p = .040$. The benefit from adding visual support was stronger for consonants than vowels, especially in individuals with damaged OHC. Further, identification took longer in individuals with OHC damage than individuals with intact OHC in the auditory modality, while no such difference was found for the audiovisual modality. No such effects were observed for OHC function at 2000 Hz and 4000 Hz. The results emphasize the importance of visual cues as well as of OHC for consonant identification in speech sounds at low frequencies.

The impact of sequential comparison on lateralized processing of sound features: insights from fMRI-studies using the contralateral noise procedure

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Auditory scene analysis requires sequential comparison of fundamental acoustic parameters of sounds that unfold over time. For this, the information from individual sound segments need to be stored and sequentially updated until the evaluation is finished.

With functional magnetic resonance imaging we investigated the effect of sequential comparison on the lateralization of activity in the human auditory cortex (AC) as compared to mere categorization by utilizing the contralateral noise procedure. In several experiments we explored three different fundamental sound features, i.e. duration, direction of frequency modulation, and intensity.

Adding the task component of sequential comparison leads to a strong involvement of the left AC. This was independent of whether extracting a given sound feature alone (categorization) more strongly involves the left or the right AC.

In accordance with previous studies, these results demonstrate that the need to sequentially compare a feature between sounds in a given task drives an additional involvement of the left AC. This finding may contribute to explaining the inconsistent results on hemispheric specialization of auditory processing in the literature since the tasks employed in the studies vastly differ with respect to the demand on sequential processing.

How sound source diffuseness affects speech recognition in noise

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The variety and nature of daily auditory scenes have changed significantly over the years due to the growing use of electronic amplification and surround sound systems. When amplification is used, sound sources often are presented over several loudspeakers, creating a more diffused auditory image of the original sound source. It is important to understand how changing the diffuseness of sources in the auditory scene affects one's ability to communicate in it. Here, we investigated how the diffuseness level of target sound source may affect speech recognition in the presence of diffuse maskers.

Younger and older native-English and younger nonnative-English listeners were asked to repeat anomalous sentences masked by one of three possible maskers (speech-spectrum noise, 12-talker babble or competing speech). The target sentences were either presented over three loudspeakers (diffused image), or over a central loudspeaker only (compact image). The maskers were always presented over three loudspeakers (diffuse image). Under all conditions the sentences as well as the masker were perceived as emanating from the center.

The results imply that a contrast between the diffuseness of the target and that of the masker can provide a release from masking. The release found was similar in all three groups of participants.

Eye-tracking reveals the locus of aging and hearing acuity effects in spoken sentence comprehension

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Caplan and Waters (1999) posited that sentence comprehension is achieved by two sequential operations: interpretive processes (direct extraction of meaning from a linguistic signal, unaffected by working memory resources) and post-interpretive processes (using that meaning for subsequent tasks). They further argued that any age difference in speed or accuracy of sentence comprehension is due to changes at the post-interpretive level. In the current experiment participants heard sentences while viewing words representing the agent and the recipient of an action named in the sentence, and were asked to select the agent of the action. Comprehension challenge was manipulated by (1) increasing syntactic complexity (subject- vs. object-relative structures) and (2) increasing working memory demands by increasing the number of words between the agent and recipient. Testing younger adults and older adults with good and poor hearing using the visual world paradigm puts Caplan and Waters' hypothesis to the test. Their hypothesis would be supported by minimal effects of age and/or hearing acuity in speed of eye fixations due to syntactic complexity (interpretive level), albeit with slower fixations with agency separation (post-interpretive level). Slowing due to syntactic complexity as well as agency separation would negate this hypothesis. (NIH Grants RO1 AG019714, T32 GM084907).

Effects of auditory transcranial alternating current stimulation on auditory temporal resolution of elderly people is dependent on frequency of endogenous neural oscillations in auditory cortex

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Recent research provides evidence for a functional role of brain oscillations for perception. Auditory temporal resolution seems to be linked to the endogenous frequency of auditory cortex. Individual gamma frequency (IGF), measured in an auditory steady-state (ASSR) paradigm, correlates with performance in between-channel gap detection (GD) tasks and can be modulated with auditory transcranial alternating current stimulation (tACS). Aging changes auditory performance and also electrophysiological frequency components of processing mechanisms. Therefore, we conducted a study to investigate the link between IGF and GD performance in normal hearing elderly (9 subjects, age range: 64–75 years) using optimized auditory tACS. Participants were electrically stimulated with individualized tACS frequencies: 3 Hz above their IGF (A-tACS) and 4 Hz below their IGF (B-tACS, as control condition) while they were performing GD tasks. Only in the A-tACS group, within-subject analyses revealed a significant correlation of GD with IGF (Spearman's $\rho = 0.79$, $p = 0.007$). Hence, in elderly effect of tACS on auditory temporal resolution seems to be dependent on endogenous frequencies in auditory cortex: elderly people with slower IGFs and lower auditory temporal resolution profit from auditory A-tACS. This study supports the relevance of individualized auditory tACS protocols for modulation of auditory processing.

Listening effort through depth of processing age, fatigue, and working memory

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We have developed a novel behavioural paradigm to measure listening effort in school-age children based on varying depths of verbal processing. The paradigm consists of a classic word recognition task performed in quiet and in noise coupled to one of three additional tasks asking participants to judge the color of simple pictures or a certain semantic category of the presented words. The response time from the categorization tasks is considered the primary indicator of listening effort. The results from the first study suggest that degrading auditory signals through energetic masking reduces word recognition performance as well as increases the response times needed to make categorical judgments. Increasing the depth and elaboration level of semantic processing increases listening effort but does not significantly affect word recognition performance. To extend the validity of the paradigm, a follow-up study examines the effect of age in a larger group of normal-hearing school-age children, teenagers, and adults. Short questionnaires are administered alongside the paradigm to better understand how people evaluate themselves in terms of listening fatigue and distractibility. The link between working memory capacity and listening effort is also investigated through additional digit span measures.

Measuring communication effort in patterns of speech variability during conversations in realistic noise

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Modifications of speech produced in noise, which reflect vocal effort, have been described in the Lombard speech literature in terms of changes in the means or medians of acoustic and phonetic parameters. For example, mean F0 has been shown to increase with vocal effort. However, measuring the full distributions of speech data captures the dynamics of speech and provides a richer source of information about difficulty and effort levels during verbal communication. Comparison of distributions may also be useful for distinguishing different sources of speech modifications. This study will present a Bayesian analysis of the statistical distributions of speech production data elicited from conversations across five realistic acoustic environments of varying complexity. This presentation will consider the information contained in distributions of speech data at two different time-scales: (i) F0 and (ii) cycle-to-cycle temporal jitter in vocal fold vibration. As the acoustic environment becomes more challenging F0 becomes more varied, representing increased expressiveness. Simultaneously, vocal fold vibration becomes less variable with increasing complexity of the environment, indicating increased power and precision in the voicing source and the vocal tract. These measures are robust and repeatable and may form the basis of a behavioral measure of effort relevant to spoken communication.

Response delays as an indicator of cognitive load during listening

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In addition to recognition accuracy, speech understanding tasks can also be evaluated by the level of cognitive-resource allocation, i.e., the cognitive load, they elicit in the listener. Cognitive load can be influenced by many factors, such as the difficulty of the listening situation and the listener's hearing acuity. Higher cognitive load during task performance is usually interpreted as larger listening effort. Self-report measures are often used to assess subjective experiences of how effortful a listening task was. In contrast, behavioral and physiological measures are applied for assessing cognitive load during listening. In the behavioral domain, one potential indicator of cognitive load during speech understanding may be response delays (RDs), that is, the time from the target-sentence offset until the start of the listener's response. The current study was set up to examine whether such RDs are sensitive to changes in target speech-intelligibility level (80% vs. 95%), type of masking noise (stationary vs. fluctuating), and listener age and hearing acuity (younger normal hearing, older normal hearing, older hearing impaired). We found RD effects for all types of manipulations, i.e., intelligibility level, masking noise, listener age, and hearing acuity. Furthermore, subjective ratings of listening effort differed by intelligibility level.

Physiological correlates of listening: moving towards natural conversations

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This study aimed to evaluate the feasibility of using wireless equipment in a realistic laboratory environment to measure physiological correlates of listening difficulties, while maintaining a perception of natural conversation. Specifically, 20 young adults participated in dyadic conversations in quiet, as well as in low and high 3D virtual café noise. Cortical activity and heart rate were recorded using an adaptation of a gaming headset, and pupil dilation was captured using SMI eye-tracking glasses. Participants rated the naturalness of the conversations as well as their level of perceived stress during conversation, using an adapted Borg scale. The naturalness of the conversations was rated relatively high (7.4/10), although communication anxiety, measured with a validated questionnaire, was positively related to the ratings of stress during conversation, but negatively related to the ratings of the naturalness of the conversations. Preliminary analyses suggested that the alpha activity of the cortical recording was consistent with that recorded using standard fixed equipment. Pupil analyses needed to be adapted to account for gaze fixations away from the conversational partner. Heart rate data could not be extracted reliably with this equipment. This study supports that wireless equipment and natural conversations may be viable options to measure physiological correlates of listening.

Influences of working memory on hearing abilities in cochlear implant users

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The aim of the study was to investigate the influence of working memory load on auditory distraction. We recorded the electroencephalogram (EEG) of CI users during an n-back task. WM load was manipulated by n-back task difficulty. We were interested how event-related potentials (ERPs) in response to distractor sounds change and how visual task stimuli change depending on participants' WM load and whether we find dissociable load-induced ERP modulations in CI users. We presented visual numbers and participants had to compare the presented number either to the previous (1-back) or to the previous to last number (2-back). Within the visual inter-stimulus interval, auditory distractors stimuli were presented (standards or novel sounds (25%)). Behavioral and also EEG results indicate that CI users show an influence of WM. The reduced amplitudes of the auditory ERPs suggest an effect of working memory on hearing - not only for speech, but also for tonal stimuli. Behavioral, but also electrophysiological results indicate a facilitation rather than a distraction effect of the novel sounds. The novel sounds may cause an unspecific state of readiness which might lead to a modulated ERPs response. All in all these results underline the role of cognition in hearing with CIs.

Cochlear implant performance in noise: influence of noise processing strategy and cognition

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Objectives: The purpose of this study was to investigate the impact of cognition and noise reduction technology in cochlear implants (CIs) on speech perception and listening effort.

Methods: Adults fitted with unilateral CI with at least one year CI experience (Nucleus[®] 6, CP900) and a control group with normal hearing participated in this study.

Participants performed: 1) cognitive tests of working memory, 2) speech recognition in noise assessment, 3) an auditory-visual dual-task paradigm and 4) self-rated questionnaires to quantify listening effort. Both the participant and the tester performing the outcome measures were blinded to the noise reduction settings (ON/OFF) in programs 1 and 2 of the CI. Listening effort was assessed using questionnaires and by examining reaction time and performance on the secondary visual task.

Results: Working memory ability varies across CI participants. Results of a repeated measures analysis investigating effects of noise reduction setting on reaction times and performance on the secondary task will be presented. Participants with good and poor working memory will be compared.

Conclusion: Improved understanding of the interaction between cognition and CI noise reduction algorithms will facilitate the optimisation of CI settings for individual implant users.

The repeatable battery for the assessment of neuropsychological status for hearing impaired individuals (rbans-h) in an older population with age-normal hearing: preliminary results of a cross-sectional study

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Objective: The RBANS-H (Claes et al., 2016, doi:10.3389/fnins.2016.00512) is an adaptation of the RBANS, a well-accepted cognitive assessment tool. The RBANS-H was especially developed to examine cognition in older adults with a severe hearing impairment. The aim of the study is to investigate whether the norm scores of the RBANS are valid for the RBANS-H.

Study design: cross-sectional study.

Patients: Twenty-six subjects (13♂ and 13♀) aged 55 or older (mean age: 71 [56;86] years) with bilateral hearing thresholds normal for their age and sex.

Methods: The subjects performed a cognitive assessment by means of the RBANS-H and a comprehensive audiometric assessment. In addition, the Health Utilities Index-2/3, the Dizziness Handicap Inventory and a general questionnaire on education and profession, medical history, hearing aid use and tinnitus were administered.

Results: The mean RBANS-H total score of this group is 99.96, which is statistically equal to the total mean norm score of the RBANS, i.e. 100 (p=0.984). Furthermore, the one-sample t-tests do not demonstrate a difference between any of the five RBANS-H index scores and the mean index norm score of the RBANS.

Conclusion: The norm scores of the RBANS may be used for score calculation and interpretation of the RBANS-H.

The cognitive functions of older cochlear implant recipients: a cross-sectional study using the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing impaired individuals (RBANS-H)

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Objective: To investigate cognition and its association with speech understanding in noise (SPIN) in older cochlear implant (CI) recipients.

Study design: Cross-sectional study.

Patients: Sixty-one subjects (30♂ and 31♀, median age: 71 [58;94] years) with a bilateral severe to profound hearing impairment and at least 1 year of CI experience (median: 12 [1;19] years).

Methods: An audiological examination is performed including best aided speech audiometry in noise using the LIST. Cognition is measured by means of the RBANS-H (Claes et al., 2016, *Front Neurosci.* doi:10.3389/fnins.2016.00512).

Results: One-sample t-tests reveal that the RBANS-H total scores, as well as the index scores for each of five cognitive domains, are significantly lower than the mean norm score ($p < 0.001$). Furthermore, a significant correlation is found between RBANS-H total scores and SPIN, independently of age ($r_{\text{part}} = -0.275$, $p = 0.034$). RBANS-H total scores, however, do not correlate with CI experience.

Conclusion: Cognitive functioning in older CI recipients is poorer compared to the norm in age-matched adults. Furthermore, cognition is correlated with speech understanding in noise, independently of age. Since CI experience does not correlate with cognition, the accelerated cognitive decline -which is observed in older individuals with severe, uncorrected hearing loss- may be curbed after cochlear implantation.

Can cognitive capacity predict listening effort?

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The Ease of Language Understanding model (ELU; Rönnerberg et al., 2013) predicts that individuals with larger working memory capacity (WMC) will expend less listening effort in challenging situations. In this study, the ELU listening effort hypothesis was tested using a variety of measures, the relationships of which were analyzed using hierarchical linear modelling.

Participants' WMC was assessed with the Reading Span Test (Daneman & Carpenter, 1980). We then assessed participants listening effort during a speech recognition in noise task, using both high- and low-predictability sentences and two different masking signals (babble and speech-shaped noise). Listening effort was assessed with a combination of self-report, secondary task performance, pupillometry, and electroencephalogram (EEG) techniques.

Hierarchical linear models indicated that working memory capacity was predictive of listening effort, and speech recognition in noise. These results and their implications for hearing aid signal processing and future research will be discussed. This research serves as an early step toward more cognitively attuned hearing aid designs and fittings.

Searching for specificity in cognitive screeners: MoCA vs PNT

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Cognitive decline and hearing loss often co-exist (Lin et al., 2013; Dawes et al., 2015). Therefore, clinical assessments of cognitive ability may be pertinent to audiology practice. The Montreal Cognitive Assessment (MoCA) is popular but relies on verbal directions, which may be confounded by hearing loss. Ongoing research suggests that the Philadelphia Naming Test (PNT) may be as sensitive to mild cognitive impairment as the MoCA (Oliver et al., 2016), and does not rely on verbal directions. We sought to test the hypotheses that MoCA scores are affected by hearing status and that the PNT is as sensitive as the MoCA.

In this study, 32 experienced hearing aid users (mean age: 68.4 years) completed the MoCA and PNT with and without hearing aids at two sessions, one month apart. Hierarchical models of cognitive screening results were constructed with hearing thresholds, aided and unaided speech intelligibility indices as predictors.

Increased hearing loss was associated with lower MoCA and PNT scores.

There was no difference between aided and unaided MoCA scores. MoCA and PNT scores were moderately correlated; however, the PNT was not significantly predictive of MoCA scores.

Effects of cognitive load on neurophysiological activity among persons with tinnitus

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Tinnitus is an auditory sensation without the presence of an external acoustic stimulus and the prevalence is about 10% in the general population. The neural mechanisms of tinnitus are not well understood, although studies have proposed involvement of various networks. Tinnitus severity has been shown to be related to cognition, but it is still not clear how. The aim of the present study is to examine the role of tinnitus on neurophysiological activity during cognitive load. Thirty participants with different degrees of tinnitus and 15 participants without tinnitus participate in an fMRI-session performing 2-back and 0-back tasks, visually and auditory. Preliminary results will be presented, comparisons will be made for auditory and visual tasks, as well comparisons related to tinnitus severity. More specifically, two hypotheses are examined: (1) If tinnitus activation involves regions normally involved during cognitive load, such regions should show similar activation during high and low cognitive load for persons with tinnitus but different activity for persons without tinnitus. (2) If tinnitus activity is inhibited while focusing on another task, that should be reflected by deactivation in regions not associated with cognitive load among persons with tinnitus but not for persons without tinnitus.

Communication environment has selective effects on cognition in older adults with mild-to-moderate hearing loss

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Previous studies have shown associations between different types of social participation, cognition and hearing loss. Based on the disuse hypothesis, the positive association between social participation and cognition could be understood as more verbal communication enhances cognition. The present study investigated the effect of the communication environment on cognition in older adults with mild-to-moderate hearing loss. Communication environment was operationalized as how many people lived at home with the participant (alone, with spouse, or with ≥ 2 family members) and self-reported frequency of social activities. Results showed that more people living at home was associated with higher episodic long-term memory. Effects on other types of cognition were small and nonsignificant. Frequency of social activities had nonsignificant associations with all types of cognition measured. This indicates that the home communication environment is more influential than the outside communication environment, which is reasonable since older adults typically spend more time at home. The specific effect for episodic long-term memory is compatible with a disuse hypothesis and the ELU model.

Neural entrainment of the speech envelope: influence of subject-related factors

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Recently it has been shown that neural oscillations are entrained to the envelope of continuous speech, a primary cue for speech understanding. Although a number of studies have reported this phenomenon, there is still no consensus regarding the mechanisms driving entrainment and the link with speech understanding. However, there is growing evidence that entrainment is not purely due to the encoding of acoustic cues but is also modulated by higher-level cognitive processes. Therefore, we investigated the effect of different subject-related factors on entrainment. While recording EEG, speech embedded in stationary noise at various SNRs was presented to young normal-hearing subjects. We related envelope entrainment with behaviourally measured speech understanding and listening effort, using a dual task and self-report. Furthermore, little attention has been paid to the effects of ageing and hearing loss on envelope entrainment. Only two recent studies have examined this and found that older adults showed an exaggerated cortical representation of speech despite normal hearing thresholds. In addition, worse hearing resulted in increased tracking of ignored speech. Consequently, we studied speech envelope entrainment in different age groups with and without hearing impairment, taking cognitive abilities such as inhibition and working memory into account.

Neural and behavioral correlates of auditory stream segregation in humans

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In natural environments, the auditory system is typically confronted with a mixture of sounds originating from different sound sources, which needs to be decomposed into distinct “auditory streams”. Experimentally, this process is commonly investigated by presenting sequences of A and B sounds, either in alternation (ABAB), or in triplets (ABA_) where the A and B sounds can be either segregated into two separate streams or integrated into one stream. In a series of psychophysical and fMRI experiments, we used these streaming paradigms to investigate neural and behavioral correlates of perceptual stream segregation in normal-hearing subjects as well as cochlear implant users. The results of the psychophysical and the fMRI experiments suggest a differentiation of sub-phenomena in the perceptual organization of auditory streams that might be represented at multiple stages of cortical processing. Specifically, we will discuss the function of auditory cortex and higher order cortical regions in the processing of ambiguous sequences that can be perceived as both one integrated and two segregated streams. Together with the psychophysical results, we suggest that the processing of ambiguous sequences not only involve processes related to streaming per se but also to decision making in general.

Temporal processing and cognition in listeners with hearing loss: the relation between TFS, cognition, and duration perception

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The link between cognition and speech in noise recognition is now well established. Recent research has shown that sensitivity to temporal fine structure (TFS) correlates both with performance on cognitive tests, and with speech in noise recognition. It has been suggested that degradation in processing speed may explain the link between cognition and speech in noise perception. Information processing speed has also been shown to link to subjective duration perception, which in turn has been linked to performance in frequency discrimination tasks (which may be considered to be tests of TFS).

Could it be that degraded temporal perception (slowing) explains the link between TFS, cognition and speech? If so, simple duration estimates might give valuable information from tests that are quick and easy to administer.

We will present results from a study aiming to investigate whether TFS perception correlates with the subjective perception of duration. We will also investigate how this relates to performance in cognitive tests, and whether the results support a speed of processing, or working memory based explanation of this link.

Self-reported hearing loss, prospective cognitive performance, and incident mild cognitive impairment

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Though progress has been made in developing biomarkers of Alzheimer's disease (AD) pathology, a precise relationship between pathologic burden and cognition remains elusive. Auditory deficits are present in AD but it is unclear whether they precede or are concomitant with the disease. The aim of this study was to investigate whether self-reported hearing loss is a harbinger of future decline among cognitively-normal adults at increased risk for AD.

783 middle-aged adults enrolled in the Wisconsin Registry for Alzheimer's Prevention participated in this study. Participants underwent serial cognitive assessment and reported whether they had been diagnosed with hearing loss. Diagnosis of mild cognitive impairment (MCI) was rendered via multidisciplinary consensus conference. Regression analyses were used to assess relationships between baseline hearing loss, prospective cognitive performance, and incident MCI.

Relative to those with normal hearing, individuals with hearing loss at initial assessment scored significantly poorer on tests of psychomotor and processing speeds, set switching, and flexibility four years later. Furthermore, those who reported hearing loss at initial or intermediate visits were significantly more likely to be diagnosed with MCI at this four year follow-up. Findings suggest auditory deficits are present early in the disease course and may adversely affect its prognosis.

Examining the relationship between cognitive abilities and auditory-visual cross-modal activation

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Electroencephalography (EEG) studies have demonstrated that variability in speech perception outcomes in post-lingual cochlear implantees may be influenced by the extent of auditory-visual cross-modal plasticity, where visual-evoked potential (VEP) activity in the cortical regions is significantly correlated with speech perception-in-noise performance. As speech perception in adults is associated with cognitive ability, and hearing loss is strongly associated with ageing and cognition, we question whether cognitive ability may be a factor influencing cross-modal activation in an older adult population. This preliminary study (n=13 adults, 55-75 years) investigated the relationship between cognition, speech perception (using words and sentences in background noise) and cortical activation, specifically the occipital (visual) and temporal (auditory) regions, in response to visual stimuli. We compared speech perception outcomes and a novel behavioural measure of cognition (Cogstate) with the P1, N1 and P2 components of the VEP responses, measured using 64-channel electroencephalography. Although no correlations were found between speech and cognitive measures, significant trends were observed between VEP responses (in occipital and temporal regions) and speech perception and cognitive measures. This cohort is being expanded to verify these trends, however these findings suggest cognitive ability as a potential influencing factor in cross-modal activations in adults with significant hearing loss.

Using a measure of listening effort to assess acclimatization to hearing aids by older adults with hearing loss

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Our ongoing study uses a behavioral measure of listening effort to investigate acclimatization to hearing aids in older adults with hearing loss. Specifically, a dual-task paradigm is used to measure the effort deployed to recognize speech in noise. The stimuli used for the primary task is the Hearing in Noise Test (HINT: an adaptive speech recognition task administered in noise that determines the Signal-to-Noise at which a participant performs at a level of 50% correct recognition). The secondary task consists of a tactile pattern-recognition task in which the participant has to identify a sequence of three stimuli that vary in duration (e.g., short-short-long). Participants are tested on eight occasions over a period of 16 months. They are between 60 and 75 years of age and have a bilateral mild to moderately-severe sensorineural hearing loss. Thirty participants are first-time HA users. Another 15 participants who are experienced hearing aid users, are tested with their own hearing aids and serve as a control group. Cognitive abilities, including working memory (the Reading Span test) and the processing speed (the Digit Symbol Substitution Test) are administered at each test session. Our preliminary data suggests that the performance on the HINT constitutes a sensitive measure of acclimatization to hearing aids. Also, the results show that the Reading Span Test correlates with acclimatization. In conclusion, the preliminary results indicate that working memory supports acclimatization to hearing aids by older adults.

N=234

**The listening effort deployed to process speech
in one's non-dominant language:
a comparison of younger and older adults**

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Some bilingual individuals report that they deploy more listening effort to process speech spoken in their non-dominant language than when it is spoken in the native language. A dual task paradigm was used to measure listening effort for sentences spoken in English. The primary task consisted of a closed-set English sentence recognition task (e.g., His brother went to the bank with Norm) heard in noise. The secondary task consisted of a tactile pattern recognition task. Five groups took part in the experiment: 1- Young adults whose L1 was English; 2- Young bilingual adults whose L1 was French and who reported being proficient in English; 3- Young bilingual adults whose L1 was French and who reported not being very proficient in English; 4- Older bilingual adults whose L1 was French and who reported being proficient in English; and 5- Older bilingual adults whose L1 was French and who reported not being very proficient in English. The results revealed that, for both age groups, the bilingual participants who were least proficient in English deployed more listening effort than the young English-speaking adults. Moreover, within each language proficiency group, the older adults deployed more listening effort than the younger participants.

Audiovisual integration and cognition in elderly hearing aid users and non-users

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Research has shown that elderly hearing-impaired individuals show considerable differences in understanding speech in noise which cannot be solely attributed to their hearing abilities. In this context, a number of studies have focused on cognitive factors and also investigated the association between hearing aid supply and cognitive decline. Furthermore, evidence from cochlear implant users suggests that these differ from normal-hearing individuals in their multisensory integration capacity, which has not been investigated in hearing aid users yet.

In this study, we examined whether cognitive abilities and multisensory integration capacity differ as a function of hearing aid experience. Thus, we compared 37 elderly hearing aid users and 37 non-users matched for age and degree of hearing loss (PTA 26-40 dB HL) regarding different cognitive functions (memory, verbal fluency, verbal intelligence, cognitive flexibility) and regarding audiovisual integration (sound-induced flash illusion, SIFI). Results revealed no significant differences between hearing aid users and non-users with a mild hearing loss in any of the cognitive tests. In comparison, they differed significantly in the respective SIFI condition such that hearing aid users displayed enhanced audiovisual integration compared to non-users.

**Prosody – the most useful acoustic cue for
older adults with central hearing loss?
Bridging the gap between brain structure, brain function
and central hearing**

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Behavioral studies suggest that older adults (OA) have difficulties in processing rapidly changing speech cues as compared to slowly changing cues (e.g. prosody). The present multimodal neuroimaging study bridges the gap between structural age-related decline measured by cortical thickness (CT) in bilateral auditory areas, brain function reflected in mismatch negativities (MMNs) evoked by prosodic processing, and central hearing in peripherally normal hearing younger (YA) and OA. Despite the lower performance of OA in supra-threshold tests with rapidly changing cues and lower CT in auditory areas, neither the performance in a prosody task nor MMNs evoked by prosodic processing were different between YA and OA. However, while thinner cortices in right auditory regions were related to lower MMN amplitudes in both groups, thinner cortices in left auditory areas were related to higher MMN amplitudes in OA only.

The relations between CT and MMN amplitudes are in line with the ‘Asymmetric Sampling in Time’ model and point to an age-related from-left-to-right compensatory process during speech processing. Furthermore, these findings suggest that prosodic processing does not decline with age. These results may help to develop novel strategies coping with the decline of central hearing in OA.

Differences in self and parent-proxy reported Health-Related Quality of Life in deaf children with cochlear implants

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Purpose: The study investigates differences in parents and child's perspective on Health-Related Quality of Life (HRQOL) in children with cochlear implants.

All children had a nonverbal IQ ≥ 74 and no additional disabilities that would affect language or HRQOL. At least one of the children's parents had Norwegian as their first language. HRQOL was assessed by means of parent-proxy and self-report using the Pediatric Quality of Life Inventory 4.0 (PedsQL).

Results: PedsQL parent and self-report showed significant correlations on four out of six scales. The strongest correlation was obtained between self and parent reported social functioning, $r = .344$, $p < .001$. When comparing the children's HRQOL score to the parents, was parents higher rating of the child's physical health the only subscale to reach significance, $z = 3.59$, $p < .001$, $r = .28$.

Conclusions: Parents and children have similar conception of HRQOL. The strength of the coherence is however low and might indicate alternate perception of the same situation due to differences in life experience, age, and self and proxy report.

Creating realistic audiovisual testing environments for acquiring ecologically valid behavioral data

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With increased complexity of hearing device algorithms a strong interaction between motion behavior of the user and hearing device benefit is likely to be found. To be able to assess this interaction experimentally an advanced laboratory is required that marks a transition from conventional labs (high sensitivity and reproducibility, unnatural behavior) to the field (low sensitivity and reproducibility, natural behavior).

In this presentation such an advanced lab is described. It aims at acquiring ecologically valid behavioral data in realistic virtual audiovisual testing environments. The lab is equipped with tools to present interactive audio-visual environments while recording subject behavior with gaze and motion tracking systems as well as video. First results of two validation studies are presented. One study evaluates the effect of different types of visual information (e.g., video recordings vs. avatar animation) on behavior and subjective user experience. The other validation study compares subject behavior in the field to that in the lab.

It was found that visual information can have a big influence on behavior and that it is possible to systematically assess this. Moreover, natural behavior can be achieved in the lab in some conditions.

Hearing ability and voice problems in older adults

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Introduction: Voice- and hearing problems can separately affect communication and quality-of-life negatively. Comorbid voice- and hearing problems are associated with elevated depression scores.

The auditory system helps regulate phonation. Deviations in vocal parameters has been observed in children with hearing impairment (HI), although results are often inconclusive and data regarding older adults with HI is lacking.

Purpose: To investigate rates of voice problems and self-perceived voice sound-quality in older adults, based on hearing ability and the use of hearing aids.

Method: Cross-sectional study, n=290 with three groups (matched on age/gender); Unaided HI (n=110, m=74.5yrs, 52F/58M), aided HI (n=110, m=76yrs, 50F/60M) and no hearing impairment (n=70, m=72.5 years, 36F/34M). Participants underwent pure-tone audiometry, completed standardized questionnaires regarding hearing, voice, health and were recorded in a soundproof room.

Results: Participants with aided HI experienced significantly more self-rated voice problems than the other groups and rated own-voice sound quality in more negative terms. Self-assessed hearing problems, gender and age explained 21.9% of self-rated voice problems.

The results indicate that HI and hearing aids affect several aspects of vocal satisfaction in older adults. A greater understanding of how HI and hearing aids relate to voice problems may contribute to better voice- and hearing care.

Hearing aids, Cochlear implants and Extended audiological rehabilitation: factors associated with patients' use and participation

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Rehabilitation for individuals with severe to profound hearing loss may include technical rehabilitation such as Hearing Aids (HA) and Cochlear implants (CI). Extended audiological rehabilitation requires involvement from different professions from the audiological department. The aim of this study was to determine whether various variables are associated to HA and CI use, and participation in extended audiological rehabilitation among patients with severe to profound hearing loss and to compare the use of unilateral and bilateral HAs.

A total of 2297 adult patients from a clinical quality register with a PTA4 (0.5, 1, 2, 4 kHz) ≥ 70 dB HL in the better ear were included. Multiple logistic regression analyses were used to analyse the material.

The results showed that patients with higher education level were more likely to use at least one HA, CI or participate in extended audiological rehabilitation. Education level and sex were two factors that were associated with the use/participation in audiological rehabilitation. Individuals with a higher education level might be better at expressing their needs, which could be an explanation for this results. The sex distribution was evenly divided, but the men indicated a lower level of participation in extended audiological rehabilitation.

Validation of the Swedish HINT for children (HINT-C)

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Speech audiometry is essential for audiological testing, as it provides information about the individual's ability to perceive and process speech stimuli at supra threshold levels. The aim of this study was to develop and evaluate the Swedish version of HINT for children (HINT-C).

Method: One-hundred and twelve children in the age range 6 to 11 years participated with 60 boys (mean 10.0 yrs.) and 52 girls (mean 9.17 yrs.). Twenty-four lists in the adult Swedish HINT material were evaluated at three SNR:s, -4, -1 and +2 dB. Each child was tested for one SNR per list. The scoring of the results was done word by word.

Result: Of the 24 tested lists, eight did not reach 50% recognition at a SNR level of +2 dB. These lists were excluded. Sixteen of the adult HINT were left, which form a Swedish HINT-C.

Conclusion: In the study, children between 6 and 11 years were tested with the HINT which resulted in a HINT-C after removal of the lists that were found to be too difficult for the children. This gives a reliable, valid, and useful speech in noise test for children at ages 6 years and above.

Cross-modal phonological awareness in Swedish speaking high school students who are learning Swedish Sign Language

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Phonological awareness (PA) has been suggested to involve a supramodal mechanism. This would mean that PA generalizes across languages in different modalities, for example, speech and sign language. In this study, 18 normal hearing high school students who learn Swedish Sign Language (SSL) as part of their curriculum did both sign language and speech versions of a task for assessing PA in Swedish (C-PhAT-Swed) and SSL (C-PhAT-SSL). Participants also did tests of non-verbal cognitive ability, verbal working memory, spoonerism, phonological decoding and rapid automatized naming (RAN; in both modalities). Precision on C-PhAT did not differ across modalities. However, there was a main effect on latency of modality (Swedish < SSL) as well as a significant interaction between modality and type of pairs (phonologically similar/dissimilar). The effect of modality on latency was only detectable on phonologically similar pairs, and there was a difference across phonologically similar and dissimilar pairs in Swedish but not in SSL. A strong and positive correlation was observed for latency across modalities. These findings suggests that PA of Swedish and SSL involve a similar mechanism, although the efficiency in searching the lexicon seems to differ across modalities in non-fluent SSL users.

Load and similarity in tactile working memory

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Combined visual and auditory impairment may lead to the tactile modality becoming the main channel for communication. In such cases, tactile working memory (WM) is likely to be a crucial factor for communicative success. In the visual and aural modalities, it is well established that similarity between items interferes with short-term retention. In this study, we investigated whether a similarity effect can be detected in tactile WM. Typically developing high school students ($n = 18$) did a tactile WM span task. Rectangular plastic pieces with tactile patterns on them were presented one by one in sequences. There were four levels of WM load (3, 4, 5, and 6 items) and two conditions (similar or dissimilar). The proportion of items placed in the correct position in a sequence by participants decreased with increasing load, and was lower for similar than for dissimilar trials. However, a significant interaction between load and similarity suggested that the effect of similarity was only present at the lowest and highest levels of load. The results from this pilot study suggest that WM in the tactile modality is influenced both by load and by similarity, although the similarity effect may vary across load or materials.

Working memory for emotions, identities and pictures: The FACEBACK paradigm

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Effective communication involves keeping track of information coded in the language signal as well as non-linguistic cues of the intended message. Non-linguistic information can be emotional (e.g., was that person sad?), person-related (e.g., who was I talking to?) or episodic (e.g., contextual). In a new n-back paradigm, called the FACEBACK, we are investigating interactions between load, presentation modality, sensory status, language modality, and age in working memory for emotions, identities, and pictures. How non-linguistic information is represented in the brain will also be investigated. Behavioural pilot data from nine adults suggests that emotions are particularly difficult to keep track of during high levels of memory load (3-back), with on chance performance regardless of stimuli presentation time (750, 1000, or 1500 ms). Further, memory for identity was better than chance, but worse than for episodic information. The findings from this project will help us better understand how non-linguistic communicative information can be maintained in working memory as a function of load, modality of the signal, sensory/language status, and age.

**Associations between word decoding,
sign language comprehension and reading comprehension
in deaf and hard-of-hearing children who are learning to read**

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At early stages of reading (i.e., Grade 1 reading level), word decoding typically explains more of the variance in reading comprehension than language comprehension. For deaf and hard-of-hearing (DHH) children who use sign language, the relative contribution of decoding respectively language comprehension might be different. This is because successful decoding does not automatically unlock the relevant information (i.e., meaning) from the lexicon, since the form of written language does not correspond to the form of sign language. In the present study, DHH signing children (age range 7-14 years, N = 22) performed tasks of reading comprehension, sign language comprehension and word decoding. Correlations suggested that sign language comprehension but not word decoding was a significant predictor of reading comprehension. Further, hierarchical linear regression showed that word decoding did not explain any additional variance above that of sign language comprehension. These results suggests that for DHH signing children, language comprehension is more important than word decoding in text comprehension at early stages of reading development. In comparison to hearing children, the pattern thus seems different, which might call for a qualitative shift in pedagogic strategies when working with DHH signing children should these findings upheld future assessment.

Speech recognition and cognitive skills in bimodal cochlear implant users

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Purpose: To examine the relation between speech recognition and cognitive skills in bimodal cochlear implant (CI) and hearing aid (HA) users.

Methods: Seventeen bimodal CI users (28-74 years) were recruited to the study. Speech recognition tests were carried out in quiet and in noise. The cognitive tests employed included the Reading span and Trail making tests, measuring working memory capacity, and processing speed and executive functioning respectively. Data were analyzed using paired samples t-tests, Pearson's correlations and partial correlations controlling for age.

Results: The results indicate that performance on some cognitive tests predict speech recognition, and that bimodal listening generates a significant improvement in speech in quiet compared to unilateral CI listening. However, the current results also suggest that bimodal listening requires different cognitive skills than does unimodal CI listening. This is likely to relate to the relative difficulty of having to integrate two different signals, and then map the integrated signal to representations stored in the long-term memory.

Conclusions: Even though participants obtained speech recognition benefit from bimodal listening, the results suggest that processing bimodal stimuli are more demanding in terms of the cognitive resources required. Thus, clinically it is important to consider this when assessing treatment outcomes.

Dichotic digit test (DDT) performance in Swedish adults with normal cognition

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Background: Dichotic digit tests (DDT) are used to examine central auditory function. Normative data for the Swedish version are scarce.

Aim: To study DDT performance in Swedish adults with normal cognition and its relation to peripheral hearing.

Method: 27 native Swedish speaking participants (63% women) between 30 and 78 yrs (mean=59 yrs) were examined with conventional hearing tests and DDT with focused and non-focused report conditions. Cognitive impairment was ruled out by self-rating and screening tests. The DDT presentation level was adjusted to a comfortable level with the subjective sound level equal in both ears. Monosyllabic digits (1, 2, 3, 5, 6, 7) were presented in lists containing series of two.

Results: There was a ceiling effect for both report conditions. Age, male gender and PTA-High negatively affected the results. There was a tendency to increased right ear advantage with increasing age and PTA-High.

Conclusion: Test results ≥ 90 % are expected from DDT with two-digit pairs in adults without cognitive impairment. Lower results may reflect changes in central auditory function, but also peripheral hearing loss. Further research is needed to verify a ceiling effect and examine the significance of age-related peripheral hearing loss on performance during the DDT.

Characterizing dual-task performance as a function of varying the type of secondary task

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Listeners in complex acoustic environments are often required to process two concurrent speech signals. In such instances, information extracted from one speech signal may be degraded compared to the other. However, the cost of processing both speech signals and making two independent decisions is, as yet, unclear. The current study was designed to measure the cost of identifying keywords in a primary speech stream as the type of secondary task varied. Listeners identified color-number keywords originating at 0° azimuth (primary task), while either detecting or localizing a critical call sign originating from locations ranging from -45° to +45° in the horizontal plane. The difficulty of the primary task was varied by employing an N-back paradigm (0, 1, or 2) to increase memory load. Control conditions were run in which performance was measured in primary-task-only and secondary-task-only conditions with the same stimulus configurations. Results indicated significant costs of dividing attention between the two tasks as the memory load in the primary task increased from 1-back to 2-back. Further, a listener's ability to detect the presence of a critical call sign increased as its spatial location moved farther away from 0° azimuth, but localization accuracy remained relatively unaffected.

Impact of tinnitus, noise and noise reduction on processing effort: a pupillometry study

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Hearing loss affects processing effort, potentially making speech perception in noise exhausting. To achieve successful speech understanding, people with hearing impairment need to increase their effort, particularly in listening conditions with low signal-to-noise ratios (SNRs). Research with pupillometry indicated a benefit of noise reduction algorithms for people with hearing-impairment, where a decreased peak pupil dilation (PPD) reflected a reduced effort. Tinnitus may increase the processing effort further due to the perception of an extra sound stimulus and a general effect of the tinnitus on quality of life.

The present study aims to investigate the effect of tinnitus on processing effort while performing a speech recognition task as indicated by the PPD response. Another objective is to examine the benefit of a noise reduction (NR) scheme on effort.

For a group of hearing-impaired listeners with tinnitus and a control group of hearing-impaired participants without tinnitus, the PPD response was recorded during sentence recognition, in a design with 2 SNRs (corresponding to the individual 50% and the individual 95% intelligibility level) x 2 algorithm modes (NR active vs. inactive). Furthermore, questionnaires are applied to evaluate perceived fatigue and tinnitus. It is expected that hearing-impaired participants with tinnitus will have an increased PPD compared to control participants. Since tinnitus has been found to have a larger impact in quiet surroundings, it is hypothesized that the tinnitus participants will have less benefit of the NR scheme in the condition corresponding to the individual 95% speech intelligibility level. Ultimately, it is also hypothesized that more severe subjective ratings of tinnitus and fatigue will correlate with increased processing effort in the speech recognition task. The results of the study will be presented and discussed.

**Misrecognizing spoken words:
the time course of context effects, and why older adults
are more susceptible to mishearing a word**

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Older adults are known to rely heavily on linguistic context to facilitate spoken word recognition (Lash et al., 2013). One negative consequence of this otherwise adaptive effect is increased misidentification of words based on prior linguistic context. Older adults are more likely than younger adults to produce such misidentifications, and with high confidence (“false hearing”), independently of acoustic degradation (Rogers et al., 2012; Rogers & Wingfield, 2015). We used eye tracking to measure the time course of spoken word recognition on a moment-by-moment basis as a recorded word unfolds over time (Tanenhaus et al., 1995; Allopenna et al., 1998). We tested effects of age, hearing acuity, and signal degradation across three groups: younger and older adults with normal hearing, and older adults with hearing impairment. Our question is whether early and strong linguistic context overrides bottom-up acoustic processing leading to false hearing, or whether misrecognitions reflect a response bias. We also test whether listeners who are more prone to false hearing also perform poorly on a false memory task, indicating a common effect of cognitive decline (Jacoby et al., 2005). Results will provide crucial insight into the online effects of context that disproportionately influence older adults’ spoken language processing.

Comprehension vs sentence recognition and their relation to cognition for verbal processing

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Sentence recognition tests are used clinically to assess hearing-impaired peoples' ability to understand speech. However, these tests do not tap into higher-level speech processes associated with real-life communication, such as comprehending heard information and formulating a response, and therefore may be poor predictors of functional hearing ability. A new Dynamic Conversations Test developed at the National Acoustic Laboratories (NAL-DCT) requires participants to listen to discourse and to answer questions "on-the-go" about the heard information. This presentation examines how performance on NAL-DCT compares to the performance on a traditional sentence recognition test (BKB test) in 41 hearing-impaired listeners tested unaided and aided in a realistic multi-talker noise. Participants also completed a small battery of cognitive tests (reading span, letter matching, lexical decision, and reading comprehension speed) to produce a composite score of their cognitive ability for verbal processing. NAL-DCT was found to be as sensitive to hearing, signal-to-noise ratio, and amplification as the BKB test. In addition, the NAL-DCT was sensitive to cognition, with participants with poorer verbal processing skills performing relatively more poorly on NAL-DCT. The data suggest that traditional sentence recognition tests may over-predict real-life communication efficacy in hearing-impaired people with lower cognitive abilities for verbal processing.

Nonverbal visual sequential learning in children with cochlear implants

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Introduction: Sequential learning contributes to language development, especially grammar. Recent research has proposed that early auditory deprivation can lead to domain-general deficits in sequential learning. To test this theory, we investigated nonverbal visual sequential learning in children with cochlear implants (CIs).

Methods: Participants included 20 children with CIs and 40 age-matched children with normal hearing (NH), ages 6 to 12 years. Age at implantation was between 1.1 and 3.9 years ($M=1.9$, $SD=0.9$). All participants completed a visual serial reaction time (SRT) task that measured sequential learning. Unlike previously used measures, this SRT task minimized the possible influence of verbal ability.

Results: The two groups did not differ in sequential learning rates. During the random sequence phases, the CI group had significantly slower reaction times than the NH group. Age at implantation was not associated with rate of sequential learning in the CI group.

Conclusions: Children with CIs appear capable of nonverbal visual sequential learning that is comparable to that of children with NH. Contrary to the suggestions of previous research, early auditory deprivation may not cause deficits in domain-general sequential learning. Further investigation is needed to understand the cause of the overall delayed reaction times of children with CIs.

Effects of background speech on cooperation

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In open-plan study environments, writing, reading and student-cooperation are common tasks. It is well known that semantic-based tasks like writing and reading are easily disrupted by semantic aspects in irrelevant background speech. Nevertheless, less is known about the effects of background speech on cooperation, also a semantical task as it demands verbal communication. The semantical processes involved in verbal communication should interfere with similar processes involved in the automatic analysis of irrelevant background speech. Hence, background speech with high intelligibility should be more disruptive compared to background speech with low intelligibility. One way to manipulate speech intelligibility in background speech signals is by varying reverberation time. High reverberant signals contain lower speech intelligibility compared to low reverberant signals and should therefore be less disruptive. However, it might be more annoying to work in a high reverberant environment compared to an environment with low reverberation. In the present study, the effects of background speech on cooperation were investigated in an experimental setting. Participants worked in pairs to solve spot-the-difference puzzles, by using the Diapix dialogue elicitation technique, while exposed to background speech signals with short and long reverberation times. Results will be discussed and explained with theoretical frameworks as interference-by-process and attentional capture.

**LUISTER:
Leuven Interactive Scheme for hearing Training Evaluation
and audiological Rehabilitation**

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Communication through spoken language is vital in life, and is jeopardized in the case of hearing impairment (HI). Because of decreasing communication abilities, many persons with HI are prone to social isolation, unemployment, depression and/or declining cognitive functions. As such, careful evaluation and treatment of HI is therefore extremely important for alleviating negative consequences of HI on long-term health and quality of life. Some persons with HI benefit from audiological rehabilitation (AR) in the clinic, but most people do not and those who do often request more training. Moreover, the efficacy of audiological rehabilitation is often debated.

The main goal of LUISTER is to improve the communication skills of adults and children with different degrees of HI by means of a sustainable, personalized, AR scheme installed on a tablet. It will implement a holistic approach to AR using a multitude of assessment tests, questionnaires, training tasks and additional features such as an auditory scene classifier and automatic counselling. LUISTER provides the opportunity to critically evaluate the content, frequency and intensity of AR schemes in an efficient, effective and relevant manner. We intend LUISTER to empower many persons with HI who otherwise struggle daily with listening. We will present an overview of the different factors involved in the development of this e-health scheme.

Mild Cognitive Impairment and hearing aid benefit: a pilot study to compare familiar and unfamiliar amplification

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This pilot study examined hearing aid benefit based on an extreme group comparison of twelve hearing aid (HA) users with Mild Cognitive Impairment (MCI) vs. twelve HA users with inconspicuous cognitive functions (NON-MCI). A cognitive profile (working memory, focused attention, verbal intelligence) revealed significant group differences for several cognitive abilities. Moreover, the groups were further split according to their hearing loss yielding for different groups (i.e., MILD/NON-MCI, MILD/MCI, MODERATE/NON-MCI, MODERATE/MCI). In order to consider both familiar and unfamiliar amplification the participants used their own HAs and a Master Hearing Aid running a novel dynamic compression algorithm. The HA benefit was measured via the German Matrix sentence test in noise OLSA (50% SRT) and the Adaptive CAtegorical Listening Effort Scaling procedure ACELES. Speech reception thresholds showed only slightly different benefit effects between the four groups whereas ACELES revealed higher benefit for the MODERATE/MCI compared to the MODERATE/NON-MCI group. This was even stronger for the unfamiliar amplification than for the participants' own HAs. Possible influences of hearing loss and cognitive functions as well as considerations for future studies in this field are discussed.

Translation of SNR gain into perceptual benefit

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Hearing aid signal processing, such as noise reduction and directionality, has been designed to improve speech intelligibility by increasing the signal-to-noise ratio (SNR) in background noise. This SNR gain, which is the difference between the input SNR and the output SNR as a result of signal processing, should correspond to an improvement in speech intelligibility performance. Moreover, speech intelligibility performance can be predicted using models such as the STOI (Short-Time Objective Intelligibility), which is a method to predict processed and noise polluted speech. The aim of this study was to investigate how SNR gain translates into perceptual benefit of hearing aid use.

Nineteen experienced hearing aid users were recruited. Hearing In Noise Test was administered to measure speech intelligibility in noise in three signal processing conditions: an omni-directional mode with and without noise reduction, and a full directional mode with noise reduction. Output SNR was measured to obtain the SNR gain so as to compare the outcome with the speech intelligibility performance. These results were also compared to the STOI model predictions. The STOI model corroborated the tendency seen in the output SNR measurements and the speech intelligibility performance. Hence, SNR gain is translated into perceptual benefit in terms of speech intelligibility.

Pupillometry as a measure of listening effort: methodological considerations for data and statistical analysis

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Pupillometry is the most common tool used to objectively assess listening effort, and has great potential for clinical implementation. While the field has made remarkable progress, there is a lack of information regarding best practice for pupillometric data analysis and statistical modelling. For example, there exist multiple methods to pre-process data, with many studies applying different scaling and baseline corrections. Moreover, as statistical models become more sophisticated and easier to implement, newer modelling techniques will likely yield different results to the often more conservative, traditional models. This study demonstrates that using different data processing methods and statistical models can influence the results and interpretation of the same dataset. There is an urgent need to address these concerns if pupillometry is to be considered a viable research tool to assess listening effort, and importantly, how these issues influence the candidacy of pupillometry as a clinical tool.

**Audiovisual perceptual doping:
multisensory facilitation effects on subsequent
auditory identification of speech stimuli**

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The presentation aims to introduce the “perceptual doping” phenomenon, referring to how early audiovisual speech exposure dopes (upgrades) phonological and lexical maps in the mental lexicon to facilitate subsequent phonological and lexical access in auditory-only modality. I will present our earlier studies in normal hearing listeners and the recent findings in hearing-impaired listeners (from the n200 project and one independent study) on how a short audiovisual exposure improves the subsequent identification of auditory-only speech stimuli. Theoretical explanations of how perceptual doping works, its application in aural rehabilitation of people with hearing loss, and how to control its effects in experimental designs when auditory and audiovisual data are collected, will be presented.

Investigation of an attention dependent neural component during sentence recognition

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This study investigates the influence of selective auditory attention during speech recognition. In order to find an attention dependent neural component, we recorded the participants EEG during selectively attending sentences presented in a 7 Hz sinusoidally modulated noise. For controlling attention, participants had to perform three different tasks. A speech recognition task, (participants are expected to focus on the speech), a decrement detection task (participants are expected to focus on the noise modulation and to count the number of decremented peaks), and a dual task of both (participants are expected to switch attention between both stimuli). The experiment set up allows to keep all physical parameter constant and to vary only the participants' attention. The behavioral data shows a reduced performance during dual task for the decrement detection due to limited cognitive resources. The analysis of neural data reveals a significant attention dependent effect at the onset of the sentence while participants were performing the speech recognition task. Moreover, correctly repeated trials showed a difference at sentence onset in EEG phase compared to incorrectly repeated trials.

Unilateral cochlear implantation in adults – no correlation between speech recognition and health related quality of life

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An increasing number of adults with post-lingual severe hearing impairment are referred to cochlear implantation (CI). The aim was to examine hearing (speech recognition, SR), health related quality of life (HRQoL), depression and anxiety one year after unilateral CI. Possible predictive factors (age, gender, aetiology, operated side, residual hearing and cognitive performance) were analysed. All CI-recipients aged ≥ 18 years at implantation and who had been implanted at the Dept. of Otolaryngology at Linköping University Hospital April 2011 - May 2013 were eligible to participate. A total of 40 CI-users participated: mean age 71 years at implantation, 16 (40%) men.

The pre-operative assessment includes, in addition to audiological measurements, tests of working memory capacity, phonological and lexical processing skills. The HUI3[®] was used to assess HRQoL and HADS (Hospital Anxiety and Depression Scale) to assess depression and anxiety before and one year after unilateral CI.

SR and HRQoL significantly improved one year post CI, but the results did not correlate ($k=0.27$). Age, aetiology, operated side, residual hearing and cognitive performance did not predict the outcome. To conclude, SR and HRQoL significantly improved after CI but did not correlate. This outcome indicates that hearing only is not enough for measuring CI outcome.

**Working memory and speech reception in noise:
change in the strength of the relation in listeners with
different hearing aid experience**

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In this study, we aimed to investigate how background noise and duration of hearing aid use affect the robust relationship between working memory and speech reception. Participants with at least 2 years of hearing aid experience and bilateral mild to moderate sensorineural hearing loss were included in the data analyses ($n = 148$). Overall, the correlation between working memory and speech reception in noise performance was stronger in a 4-talker babble than in a stationary noise background. Further, the participants were divided into the 3 groups based on their experience of hearing aid use (2 to 5 years, 5 to 10 years and over 10 years). The correlations in the stationary noise was significantly weaker in the 2-to-5-years group than over-10-years group. However, in the 4-talker babble, the differences between the strength of correlations among the three groups were not significant. The results indicated that listening in the 4-babble background required more explicit working memory processes than in the stationary noise. This study also suggested that the matching processes (c.f. Ease of Language Understanding model; Rönnerberg et al., 2008, 2013) were more efficient for long-term than relatively less experienced users when perceiving speech in stationary noise only.

Visual processing in central and peripheral visual space in congenital deaf subjects

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Results from behavioural and neural paradigms, on visual processing in congenital deaf subjects, have evidenced an advantage for peripheral visual space over central. Neural data showed that this enhanced performance in periphery is specifically for stimuli within the horizontal plane, and not so much for vertical. This pattern, which appears in deaf, but not in hearing subjects, has been related to absence of auditory input under congenital deafness, and consequently to a cortical cross-modal plasticity reorganization.

The aim of this study was to replicate the previous results, and test whether behavioural advantage presented by deaf individuals is also restricted to the horizontal plane, according to current neural data. A coherence movement discrimination task at peripheral and central visual space was used. Deaf and hearing adults were studied.

Results are in line with previous data – the deaf group revealed a behavioural advantage for peripheral visual presentations, compared to central presentations, which was restricted to the horizontal plane. These replicated previous data and suggest that the behavioural advantage demonstrated by deaf is causally related to the processing happening within the neuroplastically modified auditory cortex. Considering deaf group characteristics, it is possible to state that these results are a consequence of auditory deprivation.

Role of cognitive functioning in speech recognition in older participants

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Successful communication is one goal of rehabilitation programs for elderly people with hearing loss. Aside from hearing abilities, other sensory skills might play a role in daily life communication. Therefore, hearing and visual acuity, speech recognition, balance, cognition and other sensory skills were investigated. One specific aim of this ongoing study is to identify the impact of different cognitive abilities on speech recognition. To date, 140 participants, aged 55 to 80 years, were assessed. Measurements of speech recognition took place in free field and included varying speech material (words, sentences) and masking (quiet, noise, speech babble, realistic cafeteria simulation). As participants with different hearing acuity and hearing aid provision participated, identical hearing aids were fitted according to NAL-NL2 formula if needed due to German healthcare guidelines. In parallel sessions, cognitive skills data were collected with neuropsychological assessments measuring working and short-term memory, attention, executive functioning and vocabulary. Preliminary results of 103 participants show significant correlations between different cognitive skills and speech recognition, which depended on the specific listening situation (speech material and masking). While for understanding speech in quiet, mainly short-term memory is important; good working memory skills seem to be advantageous in listening situations with stationary noise.

Impact of SNR, masker type and hearing aid signal processing on cognitive processing effort as indicated by the pupil dilation

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The pupil dilation response reflecting cognitive processing effort has been shown to be sensitive to changes in signal-to-noise ratio (SNR) and masker type during sentence recognition in background noise. Our recent research showed that hearing-impaired listeners appear to benefit from a 'multi-channel enhancement' (MCE) algorithm in hearing aids, as smaller pupil responses were shown at 50% and 95% correct sentence recognition performance in a 4-talker babble masker for active versus inactive MCE processing. The objective of this study was to measure the effect of MCE on the pupil dilation response and on speech recognition across a wide range of SNRs for two masker types. For 24 hearing-impaired listeners, the pupil dilation response was recorded during sentence recognition, in a design with 8 SNRs x 2 masker types (4-talker babble vs. stationary noise) x 2 algorithm modes (MCE active vs. inactive). Based on our recent research we hypothesized an inverse u-shaped function of the pupil response across SNRs with relatively small pupil dilations at very low and very high SNRs. In the mid-range of SNRs, we expected improved sentence recognition and decreased cognitive processing effort for active MCE compared to inactive MCE. We will present the results of this experiment.

Differences in how noise affects cognitive performance in adolescents with and without intellectual disabilities

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There has been much research stating the negative effects of background noise on cognitive performance. Earlier research has mainly focused on three areas; type of background noise, difficulty of the task, and personality differences. Little research, however, has focused on differences in the effect of noise amongst individuals with cognitive disabilities. However, there are preliminary results that some cognitive disorders might benefit from certain background noises. In fact, earlier research suggests a benefit for children with ADHD using white noise when performing cognitive tasks. These results motivate further investigation in individual cognitive differences. This study compares the effect of noise on cognitive planning performance in persons with intellectual disability and normal hearing acuity. The results from this study will provide important information on how noise effects individuals with cognitive differences.

Audiologic care for hearing impaired older adults with cognitive loss and other comorbidities

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Older adults seeking audiologic rehabilitation often present with medical comorbidities, including problems with cognition, vision, and/or manual dexterity. Audiologists may need to modify assessment and treatment plans to accommodate non-auditory health issues. There is little data on a) how often older clients seen in audiology clinics present with other medical issues and b) how audiologists can best accommodate their needs. Charts from a geriatric audiology clinic (n=135) were examined and the prevalence of medical comorbidities (as screened by audiologists) compared to data from population studies. Chart reviews and follow-up interviews with the audiologists were conducted to determine which modifications to clinical practice were made to accommodate the needs of older adults with comorbidities. The prevalence of visual (52%) and manual dexterity (38%) problems in the clinical sample (Mage = 86 years) was higher than reported in the literature, while the prevalence of cognitive issues (44%) was consistent with current estimates for this age group. Modifications to practice were made; e.g., prescribing rechargeable hearing aids (manual dexterity issues), creating personalized large print instructions (visual issues), and booking multiple follow-up appointments (cognitive issues). These findings point to next best clinical practices for older adults with sensory, cognitive and other medical comorbidities.

Talker-independent adaptation to Japanese-accented speech in older native English listeners

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This study investigated whether older adults can adapt to foreign accented speech; and the extent that such adaptation is correlated with cognitive measures. Unlike previous studies that examined older adult's talker-specific adaptation to foreign accented speech, we examined whether adaptation is talker-independent. Twenty native Australian-English healthy older adults (Mage = 73 years, SD = 6.6) were given an initial pre-training speech recognition test, accent training (with feedback), and then a post-training recognition test. The pre-test and training sessions consisted of a single talker's Japanese-accented speech; and the post-test consisted of Japanese-accented speech by the same- and also a novel-talker. Participant's hearing acuity, working memory, attention-switching, and processing speed were also assessed. Adaption to the accent was measured by comparing post-test to pre-test recognition scores. Seventeen older adults showed improved recognition for both the same- and novel talkers, indicating that adaptation to the accented speech occurred independent of the talker. In addition, the degree of recognition improvement was positively correlated with the attention-switching measure. Results will be discussed in terms of the role of higher-level processes in speech accent adaptation.

Auditory and visual training for adult cochlear implant users

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The benefits of auditory training on speech recognition are inconsistent amongst cochlear implant (CI) users. Identifying the specific aspects of “listening” that are being targeted by training may further the understanding of this variance. This study evaluates whether auditory-verbal training leads to greater changes than visual-verbal training on short- and long-term, trained and untrained measures of listening abilities in adult CI users.

Ten adults with over one year of CI experience participated in this randomized crossover study. Participants were asked to complete two computer-based training programs – an auditory training (based on the speech reception threshold test) and a visual training (based on the text reception threshold test) – for a 6-week period each. A 3-month no-training interval followed completion of each program. Measures of self-perceived real-world performance, auditory and cognitive abilities, and physiological responses were collected at seven time-points: twice before the beginning of each program, just after completion of each program, as well as following the 3-month interval. Speech recognition and cognition test results for the first stage of this longitudinal study will be presented.

**Auditory semantic illusions:
investigating the effect of semantic cues on
speech understanding**

Mary Rudner

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Sometimes misleading semantic information causes mishearing. The semantic illusion effect (SIE, a false statement that semantically overlaps a true statement is erroneously deemed to be true) is well established in the reading literature. The present study determined whether SIE generalizes to the auditory domain, and how it is influenced by signal degradation and aging. In three experiments, participants listened to spoken statements that were true or false and responded rapidly by button press. The false statements were either lures (approximating true statements) or foils (blatantly false). Preliminary results demonstrate an auditory SIE characterized by poorer ability to distinguish true statements from lures than from foils, as well as slower correct responses to lures than to true or foil statements. Degradation slowed responses and made it harder to distinguish true statements from foils but not lures. Older individuals were slower but relative accuracy was similar. The SIE was related to inference-making ability but not working memory. This demonstrates that the shallow processing that drives SIE generalizes to the auditory domain and is resistant to signal degradation and aging. Thus, the auditory SIE may facilitate investigation of the role of semantic cues in speech understanding.

**Conversation in noise:
investigating the effect of signal degradation and
semantic coherence on response generation**

Mary Rudner

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Signal degradation reduces the ability to repeat spoken sentences. We investigated whether it similarly affects the ability to recast a sentence as a question, which may be appropriate when a statement has not been fully understood. Twenty young adults listened to prerecorded spoken statements and either repeated them or recast them as questions. The statements had either high or low semantic coherence and were either clear or degraded with 6-band noise-vocoding. Repeated measures ANOVA showed statistically significant main effects of all factors, as well as a significant interaction between coherence and degradation (degradation reduced performance more with low coherence sentences in line with previous work). There was also a significant interaction between task and coherence, indicating that semantic coherence was more important for successful performance on the recast than repeat task. Performance on the repeat task correlated significantly with cognitive speed and marginally with inference making ability but not working memory. None of the cognitive measures correlated with performance on the recast task. These results suggest that the semantic coherence of a message is even more important for appropriate response generation than it is for simple repetition of that message, whereas individual differences in cognitive skills are less critical.

The Ease of Language Understanding (ELU) Model: predictive and postdictive aspects

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The current update of the Ease of Language Understanding (ELU) model focuses on the predictive and postdictive aspects of speech understanding and communication. We discuss and evaluate the predictions from the Rönnerberg et al. (2013) paper, many of which have been confirmed empirically. The predictions concern: 1) Signal distortion and working memory capacity (WMC), 2) WMC and early attention mechanisms, 3) WMC and use of phonological and semantic information, 4) Hearing loss, WMC and long-term memory (LTM), 5) WMC and effort, and 6) the ELU model and sign language. New insights that were not anticipated in 2013 have also been generated, e.g. with respect to WMC, attention and brain mechanisms. Further issues and constraints are addressed.

**Phoneme discrimination training in background noise
can improve speech recognition in noise in
elderly hearing aid users**

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Auditory training is a successfully proven tool for improving speech recognition in noise. This study evaluated the effectiveness of a phoneme discrimination training in noise with HA users. Additionally, changes in the working memory span were investigated.

During three weeks, 17 elderly experienced binaural HA users trained via computer with non-sense syllables their ability, to discriminate and identify consonants and vowels out of background noise. The speech recognition for monosyllabic words and sentences in moderate and difficult noise conditions were administered, as well as changes in working memory span pre- to post-training, respectively.

Phoneme discrimination improved significantly during training. Generalised training effects on speech recognition in noise were proven for difficult noise conditions. The improvements in speech recognition correlated partially with changes in working memory span.

Improved ability in phoneme discrimination out of a background noise can increase speech recognition in noise in elderly experienced HA users. Moreover, working memory span may be improved.

**Communication and hearing goals of significant others
within the preliminary German version of the
active communication education program
for adults with hearing loss**

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Significant Others (SO) of persons with hearing loss (PHL), such as family members or friends, play a central role in aural rehabilitation. As frequent communication partners, they can be an important contributing factor for effective communication. Simultaneously they experience various changes in their own everyday lives due to their partners' hearing loss. Thus, the Active Communication Education (ACE) Program for Adults with Hearing Loss (Hickson et al., 2015) includes both, PHL and SO. In order to develop a German Version of the ACE Program an Intervention study (pre-post-design) was conducted by means of a preliminary German version (n=49, SO =19, PHL=30). This presentation focusses on individual hearing and communication goals of the SO (n=19). An adapted version of the Client Oriented Scale of Improvement (COSI) (Dillon et al., 1997, Hickson et al., 2015) was used to identify the individual goals within the first ACE session. After 2 weeks and 6 months post-program the SO assessed the degree of change for each goal. In total, 70 individual goals were identified which provided an important insight into issues of SO associated with their partners' hearing loss. The assessed degree of change showed how goals were influenced by participating in the communication training.

Speech perception in noise: prediction patterns of neural pre-activation in lexical processing

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The purpose of this study is to examine whether the neural correlates of lexical expectations could be used to predict speech in noise perception. We analyse magnetoencephalography (MEG) data from 20 normal hearing participants, who read a set of couplets (a pair of phrases with rhyming end words) prior to the experiment. During the experiment, the participants are asked to listen to the couplets, whose intelligibility is set to 80%. However, the last word is pronounced with a delay of 1600 ms (i.e. expectation gap) and is masked at 50% of intelligibility. At the end of each couplet, the participants are asked to indicate if the last word was correct, i.e. corresponding to the expected word. Given the oscillatory characteristics of neural patterns of lexical expectations during the expectation gap, can we predict the participant's actual perception of the last word? In order to approach this research question, we aim to identify the correlation patterns between the instances of neural pre-activation, occurring during the interval of the expectation gap and the type of the given answer. According to the sequential design of the experiment, the expectation gap is placed 4400 ms prior to the time interval dedicated to the participant's answer. Machine Learning approach has been chosen as the main tool for the pattern recognition.

Phonological expectations override semantic mismatch during speech in noise perception

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Perception of speech in noise is modulated by stimulus-driven and knowledge-driven processes. In the ELU model, working memory capacity (WM) has been proposed to play a determinant role in the resolution of a mismatch between knowledge-based predictions and stimulus-based processing. However, the neural correlates and the temporal course of the mismatch resolution have not been investigated. After exposure to 48 semantically coherent couplets, 20 normal-hearing participants were tested in a MEG study. Couplet sentences were presented in background noise with 80% intelligibility, except the last word of the couplet that was presented with 50% intelligibility. This last word could be either 1) the word that was in the exposure couplet, or 2) a phonologically related but semantically incorrect word, or 3) a semantically coherent but phonologically incorrect word, or 4) a semantically and phonologically incorrect word. Before the presentation of the last word, participants had time to predict it and their task was to answer if the presented word was the correct one. Behavioural results showed more errors in the condition 2 than conditions 3 or 4, suggesting that phonological compatibility overrides semantic mismatch when intelligibility is poor. Preliminary results of the neural correlates reflecting the role of WM in the mismatch resolution between the knowledge-driven and stimulus-driven processes will be presented.

Disturbing sounds: a question of loudness and annoyance?

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Sounds in the daily environment may cause disturbance of a listener. The disturbance may originate in both loudness and annoyance, where loudness is caused by the sound level and the annoyance by the reaction to the specific sound. This would also lead to a decrease of the perception of the desired signals. Here, we present results from two studies on perception of disturbing sounds, one study in participants with normal hearing and one study on participants with mild to moderate hearing loss. In the experiment the participants were tested for their hearing ability and working memory capacity, and rated loudness and annoyance of eight everyday sounds that previously had been shown to be disturbing for hearing aid users. The result showed that most sounds were annoying at a high enough level. Moreover, both annoyance and loudness were closely related to the sound pressure level, regardless of type of sound. Both annoyance and loudness were related to the auditory tests, but seem unrelated to the test of working memory.

Language, cognition and hearing: cognitive intervention for children with a cochlear implant

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A relatively high proportion of children with a cochlear implant (CI) show a delay in their language and cognitive development. Recent studies suggest a connection between the developments of specific cognitive and language skills. Inductive reasoning (the skill used to detect rules, generalizations and regularities) is connected to those cognitive skills, as well as to abilities necessary to acquire language. Training of inductive reasoning may improve language and cognitive skills and help children with a CI to catch up with their peers.

In this study, a well-established inductive reasoning training is used. Cognitive and language skills are tested before, immediately after and some months after training. Preliminary results of a group of hearing children show an improvement in syntax recognition, syntax production, non-verbal reasoning skills, as well as phonologically based word fluency. Furthermore, the inhibition skills of those children performing very low on inhibition tasks before training improved significantly.

A control group is needed to ensure those results are connected to the training and not to the two-time use of the language and cognitive tests. In addition, a follow-up measurement to test the durability of the effects is still remaining to be done.

How concentration shields against distraction: summary of findings so far

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Classic views suggest that people become more distracted by things in the background, such as noise and people talking, when they undertake difficult or challenging tasks. From a theoretical standpoint, this fits well with the load theory whereby tasks that require a great deal with the available cognitive resources leave little left for resisting distraction. Data from our lab (in collaboration with colleagues in Linköping University) during the last 5-6 years challenge this view. We have found that more difficult versions of a visual task reduce the brainstems' responsivity to background sound (Sörqvist, Stenfelt, & Rönnerberg, 2012), constraints the neural processing of the sound in auditory cortex (Sörqvist, Dahlström, Karlsson, & Rönnerberg, 2016), reduces the tendency for the background sound to evoke false memories (Halin, Marsh, & Sörqvist, 2015; Marsh, Sörqvist, & Hughes, 2015), and protects against interference with proofreading (Halin, Marsh, Haga, Holmgren, & Sörqvist, 2014) and long-term memory (Halin, 2016; Halin, Marsh, Hellman, Hellström, & Sörqvist, 2014). We conclude that the classic view of the dynamics between task difficulty and distractibility cannot be applied to situations where people are focusing on a visual task with a distracting background sound environment.

Characterizing hearing-impaired elderly individuals without hearing aid experience

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Age-related hearing loss is a major public health issue in developed countries. However, despite available devices and its benefits, only a minority of hearing-impaired individuals are using hearing aids. It is known that untreated hearing loss is associated with reduced social activity and depression and can thus, greatly affect one's quality of life. Furthermore, uncorrected hearing impairment has been related to cognitive functions, suggesting that it may negatively affect cognitive performance, raising the question whether early hearing aid supply could compensate for this decline. Moreover, there is a gap of about 10 years between the recognition of hearing problems and the treatment. Thus, it is of major interest to target this group of untreated hearing-impaired individuals with hearing support. Therefore, it is necessary to first explore and characterize these individuals to obtain a descriptive profile. For this purpose, analyses were conducted assessing various auditory (speech recognition test, audiogram, categorical loudness scaling), cognitive (verbal-intelligence test, screening test of dementia), and self-reported (subjective hearing problems, health and socio-economic status, technology commitment) test measures in n=72 elderly hearing aid non-users comprising a very mild-to-moderate hearing loss. Results will be presented at the conference.

**Investigating the intelligibility of younger and older adult talkers
in adverse listening conditions within an interactive task:
speech intelligibility in adverse listening conditions**

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This study investigates whether the speech of older adults (OA) is less intelligible when perceived in adverse conditions than that of younger adults (YA). An interactive task was used: 57 OA (65-85 years, 30 F, 30 NH <20 dB 0.25-4 kHz) and 26 YA (18-35 years, 15 F), in 'Talker A' role, read BKB sentences [Bench et al., 1979] to a YA partner ('Talker B') who had to repeat the sentence back. This task was done: in quiet, when Talker B had a simulated hearing loss (HLS), when Talker B heard babble (BAB). The study was novel in that talkers could make clear speech adaptations to help their 'impaired' partner. We analysed the effects of age group, sex and hearing status of Talker A on keywords correctly repeated by Talker B. Across conditions, YA and OA women did not significantly vary in intelligibility; for men, an interaction revealed that OA (44.9%) were less intelligible than YA men (59.7%) in HLS. The hearing status of OA talkers did not impact the intelligibility of their speech. These results of lower intelligibility of OA men's speech concur with our previous findings that they make less acoustic-phonetic adaptations in some adverse conditions than YAs.

A new swedish test of phonetic perception in noise: test word selection and optimization method

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The present project aims to develop a Swedish language test of phonetic perception in background noise for adult persons with hearing loss. The test will be a multiple choice rhyme test based on test word groups consisting of real words with minimal phonemic contrast.

As is pointed out by previous studies, for a speech perception test to be highly reliable, all contrasting test items need to be as equally difficult as possible. In large, this may be accomplished by a careful test word selection method. Therefore, we have identified various factors that influence the perceptibility of single words, and sought to minimize their variation within the selected groups of contrasting test words. The analyzed factors are frequency of occurrence in the Swedish language, lexical competition from phonetic neighbors, probabilistic phonotactics, spelling regularity, and acoustic similarity.

The selected test words will be recorded by a male and a female voice, and perceptually validated in a listening experiment.

In the near future, the test will undergo a clinical validation on persons with mild to severe hearing loss. Ultimately, the test should provide an efficient tool for evaluating the effectiveness of various audiological interventions, such as hearing aid fitting and/or auditory training.

Efficacy of auditory temporal resolution training in older adults auditory temporal resolution training

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Introduction: The study aimed to evaluate the efficacy of 'Auditory temporal resolution training (ATRT)' program, developed by Vaidyanath and Yathiraj (2015) for older adults with temporal processing deficits.

Method: Twenty older adults aged 55 to 75 years, with pure-tone thresholds ≤ 20 dB in the frequencies 250 to 2000 Hz, participated in the study. They were confirmed to have temporal processing deficits as they failed the Gap-In-Noise test, Gap detection test and Duration pattern test. Two pre-training baseline evaluations and two post-training evaluations were carried out. The participants were trained using ATRT program over 13 sessions.

Results: Improvement in the temporal processing abilities was observed in the older adults following training. A significant reduction in the gap detection thresholds was observed on the Gap-In-Noise test and Gap detection test which was maintained four weeks following the cessation of training. However, for the duration pattern test, the improvement observed immediately following the cessation of training was not maintained.

Discussion: It can be construed from the improvements observed following ATRT that the auditory system is plastic even in older adults. These plastic changes can be induced by training and are maintained even after the cessation of training.

Behavioral and electrophysiological detection thresholds of interaural phase differences throughout life

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Part of the processes that underlie stream segregation and understanding speech in noise rely on how we process binaural cues, such as differences in timing/phase between sound waves arriving at the left and right ear. The aim of this study was to investigate the effects of age and hearing impairment on binaural cue processing. We determined interaural phase difference (IPD) detection thresholds for six participant groups, by means of a behavioral and an electrophysiological measure. We investigated three age cohorts (20-30 yrs, 50-60 yrs, 70-80 yrs). For every cohort, a group of participants with normal hearing thresholds and a group of participants with symmetrical sensorineural hearing impairment were recruited. All participants passed a cognitive screening. The behavioral measure consisted of an adaptive, three alternative forced choice task. The IPD detection threshold was calculated as the geometrical mean of the last six IPDs. Electrophysiological detection thresholds were determined by means of auditory evoked potentials, elicited by the rate at which IPD changes were introduced in amplitude modulated pure tones. By decreasing the size of the IPDs, detection thresholds for every participant group could be obtained. Preliminary results showed increasing detection thresholds with age and a superimposed effect of hearing impairment.

Reading fluency and orthographic learning in Swedish children with CI

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The present study examined reading fluency and orthographic learning in 40 children with cochlear implants. Their age range was 6;0-10;11. The children were implanted with their (first) CI at 24 months on average and thirty-four of them were bilaterally implanted. Sixty to 70 percent of the children with CI had reading skills at or above the 45th percentile on the measures of orthographic and phonological word reading fluency. Speech perception in silence was moderately associated with both reading fluency and orthographic learning. Hierarchical regression analyses showed that phonological decoding was a strong predictor of orthographic learning after age and non-verbal skills were accounted for. Receptive vocabulary, verbal fluency and verbal-verbal paired-associate learning predicted additional variance in orthographic learning after phonological decoding was controlled for.

Phoneme awareness was the strongest predictor of both orthographic- and phonological- and decoding fluency after age and nonverbal skills were controlled.

Age at implantation was not a significant predictor of any of the measures of reading or orthographic learning.

These results resemble the pattern typically found in normal hearing children and suggests that phonemic awareness and phonological decoding are crucial for orthographic learning and reading fluency in children with CI.

A multicenter study evaluating the effects of the Swedish ACE programme

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Objective: This study investigated the effects of a modified Swedish version of an interactive group education programme: the Active Communication Education programme (ACE) in five Swedish regions. This study also explored whether the pre- and post-programme outcomes differed with regard to region, age, gender, hearing loss (HL) or the attendance of significant others (SOs).

Design: An intervention study with between- and within-group measurements was applied.

Sample: A total of 77 individuals with hearing impairments and a mean age of 73.9 years (SD=9.8) from five different regions of Sweden participated.

Results: Statistically significant short- and long-term effects were found with regard to communication strategy use, activity, and participation. The ACE programme was most effective for older individuals, women and participants with more severe HL. Individuals who attended with an SO showed a tendency towards better communication strategies. No regional differences were found. The qualitative results indicated that the programme increased individuals' ability to cope and restored their social identities.

Conclusion: The ACE programme is effective, and is suggested to be implemented in clinical settings and considered as an alternative or additional treatment to hearing aid rehabilitation. Additional studies that include younger individuals and a control group are recommended.

Word frequency in the language affects perceived loudness

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Models of lexical processing postulate a word frequency effect in which words with a high frequency of occurrence in the language tend to be more easily accessed in the mental lexicon than low-frequency words. But how is this advantage of preferred mental access reflected in hearing? Here we report a novel finding that high-frequency words are perceived as sounding louder than low-frequency counterparts even when presented at the same acoustic level. When young ($n=24$) and older ($n=21$) adults made a 3-alternative-choice (louder, same, softer) perceptual loudness judgment on trials involving two sequentially-played, monosyllabic nouns that were of different frequency but the same loudness, we observed a significantly higher number of 'louder' than 'softer' responses for the high-frequency words and a significantly lower number of 'softer' than 'louder' responses for the low-frequency words across trials. Performance on catch trials (with an actual acoustic/loudness difference between words) and ratings of word familiarity suggest that this effect is not due to an inability to judge either loudness or word frequency information. Overall, our findings reveal a perceptual effect of processing lexically-relevant acoustic input and suggest a new avenue of exploration where the cognitive mechanisms underlying this phenomenon can be better studied.

How does background babble noise affect the course of new word learning in toddlers?

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The naturalistic acoustic environments of young children are often not ideal for listening. Environments containing acoustic competitors disrupt speech perception and, therefore, may impose challenges on auditory based learning and language development. However, most studies of language acquisition take place in quiet laboratory settings which lack ecological validity. The current study explores the possible effects of competing babble on novel word learning in toddlers. The study employs a single-subject design, whereby the time course of a toddler's novel word acquisition is tracked over multiple sessions. Eight novel CVC words were embedded in two short stories that were presented digitally, one story in quiet and one story in babble. After each story, a four-alternative-forced-choice task was used to quantify the toddler's recognition of each novel word. We hypothesize that novel words introduced in quiet will be acquired sooner (i.e., in fewer sessions) than novel words introduced in the presence of 4-talker babble, while novel words not familiarized in a story will remain unrecognizable. Initial results will be presented and discussed.

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