ISAAR

4th International Symposium on Auditory and Audiological Research

ISAAR 2013
Auditory plasticity
Listening with the brain

August 28-30, 2013 - Hotel Nyborg Strand, Denmark

Programme and abstracts

Sponsored by GN ReSound. Organized by the Danavox Jubilee Foundation

ABOUT ISAAR

The “International Symposium on Auditory and Audiological Research” is formerly known as the “Danavox Symposium”. The 2013 edition corresponds to the 25th symposium in the series and the 4th symposium under the ISAAR name, adopted in 2007. The Danavox Jubilee Foundation was established in 1968 on the occasion of the 25th anniversary of GN Danavox. The aim of the foundation is to support and encourage audiological research and development.

Funds are donated by GN ReSound (formerly GN Danavox) and are managed by a board consisting of hearing science specialists who are entirely independent of GN ReSound. Since its establishment in 1968, the resources of the foundation have been used to support a series of symposia, at which a large number of outstanding scientists from all over the world have given lectures, presented posters, and participated in discussions on various audiological topics.

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WELCOME TO ISAAR 2013

The general topic of the ISAAR 2013 symposium is "Auditory plasticity – Listening with the brain". The concept is to consider this topic from different perspectives, including current physiological concepts, perceptual measures and models, as well as implications for new technical applications.

The programme consists of invited talks as well as contributed talks and posters. The symposium is divided into five sessions, to which the following speakers have been invited:

1. ***Basic perceptual studies of training, learning, and generalization***
   Beverly Wright, Brian Moore, Sygal Amitay

2. ***Physiological correlates of auditory plasticity***
   Doris Wu, Jonathan Fritz, Jessica de Boer, Israel Nelken

3. ***Modeling of plasticity***
   Klaus Obermayer, Dan Sanes, Bert de Vries

4. ***Plasticity and auditory disorders***
   Jos Eggermont, Michael Merzenich, Kevin Munro, Andrej Kral, Anu Sharma

5. ***Hearing rehabilitation with hearing aids and cochlear implants***
   Robert Sweetow, Mary Rudner, Paula Stacey

In addition to these scientific presentations, one of the objectives of ISAAR is to promote networking and create contacts between researchers from different institutions in the fields of audiology and auditory research. ISAAR is a great opportunity for young scientists to approach more experienced researchers and vice-versa.

After the symposium, written versions of the presentations and posters will be published in a proceedings book. All participants will receive a copy of the ISAAR 2013 proceedings.

The organizing committee and the Danavox Jubilee Foundation wish you an interesting and fruitful symposium. Happy networking!

WEDNESDAY 28 AUGUST

08:30-10:00 Registration and hanging of posters

10:00-10:15 Torsten Dau:
Welcome and introduction to the symposium

Session 1: Basic perceptual studies of training, learning, and generalization

10:15-10:50 Beverly Wright:
Induction and prevention of auditory perceptual learning

10:50-11:25 Brian Moore:
Studies of pitch mechanisms based on perceptual learning

11:25-12:00 Sygal Amitay:
Auditory learning: uncorking performance bottlenecks

12:00-13:00 Lunch

13:00-13:20 Karen Banai:
Learning after brief exposure and intensive practice: the case of time-compressed speech

13:20-13:40 Helen Henshaw:
Auditory and working memory training: assessing the relative benefits to real-world listening abilities for people with hearing loss

13:40-14:00 Coffee break

WEDNESDAY 28 AUGUST

Session 2: Physiological correlates of auditory plasticity

14:00-14:35 Doris Wu:
Formation of the mammalian cochlea: roles of Sonic hedgehog

14:35-15:10 Jonathan Fritz:
Attention and auditory cortical plasticity

15:10-15:30 Alessandro Tavano:
Coding of higher-order units from individuals events: human EEG evidence for prediction-driven plasticity in audition

15:30-15:50 Coffee break

15:50-16:25 Jessica de Boer:
Are receptive fields fixed or fluid?

16:25-17:00 Israel Nelken:
The representation of surprise in auditory cortex

17:00-19:00 Poster session I

19:00-20:30 Dinner

20:30-23:00 Drinks in the poster area

THURSDAY 29 AUGUST

Session 3: Modeling of plasticity

08:30-09:05 Klaus Obermayer:
Classification and annotation of natural sounds

09:05-09:40 Dan Sanes:
Critical periods for hearing loss and restoration: veering off the developmental path

09:40-10:00 Jeffrey Spencer:
A computational model of sound recognition used to analyze the capacity and adaptability in learning vowel classes

10:00-10:30 Coffee break

10:30-11:05 Bert de Vries:
Is hearing aid signal processing ready for machine learning?

Session 4: Plasticity and auditory disorders

11:05-11:40 Jos Eggermont:
Tinnitus: maladaptive plasticity?

11:40-12:00 Michael Nilsson:
Use of tinnitus masking functions to support or refute the presence or absence of auditory plasticity

12:00-13:15 Lunch

THURSDAY 29 AUGUST

Session 4: Plasticity and auditory disorders (cont.)

13:15-13:50 Michael Merzenich:
Brain plasticity-based training to improve human listening and language abilities

13:50-14:25 Kevin Munro:
Experience-related changes in the adult auditory system

14:25-14:45 Daniel Tollin:
Unilateral conductive hearing loss causes impaired auditory information processing in neurons in the central auditory system

14:45-15:30 Coffee break

15:30-16:05 Andrej Kral:
Auditory plasticity in congenital deafness: sensitive periods in development and deprivation

16:05-16:40 Anu Sharma:
Cortical plasticity and re-organization in deafness

16:40-17:00 Pascale Sandmann:
Electrophysiological signatures of plasticity in the visual and auditory cortex after cochlear implantation

17:00-19:00 Poster Session II

19:00-20:30 Dinner

20:30-23:00 Drinks in the poster area

FRIDAY 30 AUGUST

Session 5: Hearing rehabilitation with hearing aids and cochlear implants

08:30-09:05	Robert Sweetow: Auditory training and challenges associated with participation and compliance
09:05-09:40	Mary Rudner: Cognitive aspects of auditory plasticity across the lifespan
09:40-10:00	Francis Kuk: A localization training program for hearing aid wearers
10:00-10:40	Coffee break
10:40-11:15	Paula Stacey: Auditory training strategies for adult users of cochlear implants
11:15:11:35	Josef Chalupper: Combining acoustic and electric hearing: challenges and approaches
11:35-11:55	Marte Myhrum: Performance of the second CI in 109 sequentially implanted children
11:55-12:15	Bjørn Petersen: Perception of music and speech in adolescents with cochlear implants: effects of intensive musical ear training
12:15-12:30	Torben Poulsen: Closing remarks
12:30-14:00	Lunch and departure

VENUE AND TRAVEL INFORMATION

Venue
The symposium venue is Hotel Nyborg Strand, Østersøvej 2, 5800 Nyborg, Denmark. The hotel is situated in the middle of Denmark (GPS coordinates: Lat: N 55º 19' 5.74", Long: E 10º 48' 43.88"). For more information, visit www.nyborgstrand.dk. You may contact the hotel by phone (+45 65 31 31 31) or e-mail (nyborgstrand@nyborgstrand.dk).

Travel information
From Nyborg to Copenhagen airport by rail
One-way standard fare: DKK 234 (approx. EUR 31, USD 40, fare may vary depending on ticket type). For the return journey, direct trains run every hour (minute 00) between 8:00 am and 10:00 pm from Nyborg to CPH airport. Duration: 1h37m. More trains are available outside these times or with changes. Use www.journeyplanner.dk for timetable information and online ticket reservations.

From Nyborg to Copenhagen airport by road
Travel from Hotel Nyborg Strand to CPH airport by car takes about 1½ hour (134 km or 83 miles). Note a one-way toll charge of DKK 235 or EUR 33 per vehicle for crossing the Great Belt Bridge.

From Nyborg station to the hotel
Nyborg railway station is about a 5-minute drive from Hotel Nyborg Strand. Taxi: DKK 60 (approx. EUR 8, USD 10). If you like walking, there is a 15-minute "Nature Path" between the railway station and the hotel. Use www.journeyplanner.dk to assist your planning of local transportation.9

Planning ahead
On planning your return, prepare 2 hours for transport to Copenhagen Airport and another 2 hours for check-in and security check at the airport. The scientific programme will end on August 30 at 12:30 pm. Please plan your journey accordingly.

About the weather
See www.dmi.dk for the current forecast.

PRACTICAL INFORMATION

Posters
Hanging of posters:
Wed 28 Aug 08:30-10:00

Presenters of odd-numbered posters are encouraged to be present at their poster during the first dedicated poster session (Wed 17-19), presenters of even-numbered posters during the second dedicated poster session (Thu 17-19). Posters will remain on display throughout the symposium to allow further interaction outside these dedicated sessions.

Talks
Dedicated time with assistance for slide upload and technical tests in the auditorium:
Wed 28 Aug 09:00-09:45 and 17:00-17:15
Thu 29 Aug 17:00-17:15

Contributed oral presentations should not exceed 15 min. in length (or 30 min. for invited talks), in order to leave at least 5 min. after each talk for questions and discussion.

Manuscripts for ISAAR proceedings
Authors are encouraged to submit a manuscript for their ISAAR contribution. Manuscripts from both oral and poster presentations will be published in the proceedings book and distributed to all participants after the symposium.

Proceedings will also be accessible to all participants via the GN ReSound audiological library (www.audiological-library.gnresound.dk).

All manuscripts must be submitted electronically at www.isaar.eu. Authors are requested to follow the manuscript guidelines and to use the templates available at www.isaar.eu. Manuscripts are limited to a maximum length of 8 pages for contributed papers and 12 pages for invited papers.

The deadline for receipt of manuscripts is 30 August 2013.

Meals and drinks
The ISAAR registration fee includes all meals and social activities during the symposium and a copy of the symposium proceedings. Two glasses of wine will be served free of charge at dinner. Complimentary beer, wine, and soft drinks will also be available in the evenings in the poster area. Other drinks may be purchased at the hotel bar.

Contact information
For any questions concerning the programme or manuscripts, please contact: webmaster@isaar.eu

For registration or venue information, please contact Hotel Nyborg Strand directly at: nyborgstrand@nyborgstrand.dk

For general information about ISAAR, or to contact the scientific committee, please write to: isaar@isaar.eu

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Session 1:

BASIC PERCEPTUAL STUDIES OF TRAINING, LEARNING, AND GENERALIZATION

Chair: Torben Poulsen

Wed 28 Aug, 10:15-13:40

S1.1 – Wed 28 Aug, 10:15-10:50

Induction and prevention of auditory perceptual learning

Beverly A. Wright* - *Northwestern University, Evanston, IL, USA*

Performance on many perceptual tasks improves with practice even in adults, indicating that our sensory systems are not rigid but rather can be changed through experience. My coworkers and I have been investigating the factors that induce and those that prevent perceptual learning on auditory skills. For example, we have evidence that (1) for improvement to occur across days requires a sufficient amount of training per day, and that additional daily training can be superfluous, (2) a combination of practice with relevant auditory stimuli and additional stimulus exposures without practice can enhance learning, and (3) practice on more than one auditory task within a single session can either enhance or disrupt learning depending on how the training trials are distributed. Conclusions drawn from learning on fine-grained auditory discrimination tasks have held for visual and speech learning, suggesting that common principles are at play across multiple domains. Knowledge of these issues will lead to more effective training strategies to help restore perceptual skills in people with perceptual disorders as well as to enhance those skills in people with normal perception.

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S1.2 – Wed 28 Aug, 10:50-11:25

Studies of pitch mechanisms based on perceptual learning

Brian C. J. Moore* - *Department of Experimental Psychology, University of Cambridge, Cambridge, UK*
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Mechanisms of pitch perception were studied using perceptual learning. In one set of studies, subjects discriminated the fundamental frequency (F0) of a group B of harmonics embedded in a background of harmonics with fixed F0 (group A). The results were potentially affected by pitch discrimination interference (PDI) and by cues related to pitch pulse asynchrony (PPA) between groups A and B. Large learning effects occurred when PPA cues were available. Training was given using a stimulus with cosine-phase harmonics and high harmonics in Group B, under conditions where PPA was not useful. Learning occurred, and it transferred to other cosine-phase, but not to random-phase, tones. The learning may reflect improvements in the ability to overcome PDI. In a second set of studies, F0 discrimination was measured for tones with cosine- or random-phase harmonics, bandpass filtered with five harmonics within the passband and presented in threshold-equalizing noise. Groups trained with LOW, MID or MID-HIGH stimuli (harmonics 1-5, 11-15, or 14-18) showed training effects that transferred to other stimuli except HIGH (28-32). A group trained with HIGH stimuli showed no training effect, suggesting that a different mechanism was used for the HIGH stimuli than for the other stimuli. We propose that the LOW, MID and MID-HIGH stimuli were discriminated using temporal fine structure information.

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S1.3 – Wed 28 Aug, 11:25-12:00

Auditory learning: uncorking performance bottlenecks

Sygal Amitay*, Yu-Xuan Zhang, Pete R. Jones, and David R. Moore
- MRC Institute of Hearing Research, Nottingham, UK

Perceptual learning has traditionally been portrayed as a bottom-up phenomenon that affects the trained stimulus encoding or decoding. Cognitive skills such as attention and memory are thought to drive, guide and modulate learning, but are, with notable exceptions, not generally considered to undergo changes themselves as a result of training with simple perceptual tasks. Moreover, shifts in threshold are interpreted as shifts in perceptual sensitivity, with no consideration for non-sensory factors (such as response bias) that may contribute to these changes. Work from our lab shows that perceptual learning is a conglomeration of effects, with training-induced changes ranging from the lowest (noise reduction in the phase locking of auditory signals) to the highest (working memory capacity) level of processing, and includes contributions from non-sensory factors that affect decision making even on a “simple” auditory task such as frequency discrimination. I will discuss our emerging view of learning as a process that increases the signal-to-noise ratio associated with perceptual tasks by tackling noise sources that cause performance bottlenecks, and present some implications for training populations other than young, attentive, and well-paid college students.

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S1.4 – Wed 28 Aug, 13:00-13:20

Learning after brief exposure and intensive practice: the case of time-compressed speech

Karen Banai* - *University of Haifa, Haifa, Israel*
Yizhar Lavner - *Tel-Hai College, Tel-Hai, Israel*

Brief experience with distorted (e.g., time-compressed) speech, which is often incomprehensible to naïve listeners, yields both learning and generalization. On the other hand, prolonged training with other forms of distorted speech (e.g., speech-in-noise) appears to result in more specific learning. Because the outcomes of intensive training and brief exposure were rarely compared, it is not known whether the greater specificity observed after prolonged training is a generic feature of learning or a result of differences in the trained stimuli, tasks and listener population. To explore this issue, we trained listeners either briefly or intensively on a time-compressed speech task, and compared the patterns of learning and generalization following each regimen. Among native speakers of Hebrew (the language of the trained materials), both regimens yielded learning on the trained condition as well as generalization to untrained conditions with different sentences and speakers, but the magnitude of learning was larger after more intensive training. This however was not the case among non-native Hebrew speakers in which generalization after intensive training was more limited. Taken together, it seems that the specificity of learning should not necessarily change depending on the length of training and that listener-related factors might be one of the determinants of learning.

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S1.5 – Wed 28 Aug, 13:20-13:40

Auditory and working memory training: assessing the relative benefits to real-world listening abilities for people with hearing loss

Helen Henshaw* - *NIHR Nottingham Hearing Biomedical Research Unit, School of Clinical Sciences, University of Nottingham, Nottingham, UK.*
Melanie Ferguson - *NIHR Nottingham Hearing Biomedical Research Unit, Nottingham University Hospitals NHS Trust, Nottingham, UK.*

For home-based training interventions to benefit people with hearing loss (PHL), any task-specific learning needs to transfer to functional benefits in real-world listening. A randomised controlled trial (RCT) of n=44 adults with mild sensorineural hearing loss (SNHL) showed significant on-task learning for a phonetic-discrimination task ($p<.001$), and generalisation to improvements in self-reported hearing ($p<.05$), working memory ($p<.05$) and divided attention ($p<.01$). No improvements were shown for speech-in-noise. A follow-up study identified appropriate and sensitive outcome measures to assess training-related benefits. Participants (n=33 hearing aid (HA) users) trained on a phonetic-discrimination-in-noise task, and were assessed pre- and post-training on complex listening tasks with a cognitive-component. Significant on-task learning ($p<.001$) generalised to improvements in competing-speech ($p<.05$) and a dual-task of speech and memory ($p<.01$), with the greatest improvements in challenging listening conditions. Findings suggest that outcomes used to assess training-related benefits for PHL should be sensitive to the cognitive effects of training and set at an appropriately challenging level. An ongoing double-blind, placebo-controlled RCT aims to assess whether directly training working memory can offer increased benefit to n=54 HA users with mild-moderate SNHL.

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Session 2:

PHYSIOLOGICAL CORRELATES
OF AUDITORY PLASTICITY

Chair: Jakob Christensen-Dalsgaard

Wed 28 Aug, 14:00-17:00

S2.1 – Wed 28 Aug, 14:00-14:35

Formation of the mammalian cochlea: roles of Sonic hedgehog

Jinwoong Bok *- Department of Anatomy, Department of Otorhinolaryngology, BK21 Project for Medical Science, Yonsei University College of Medicine, Seoul, South Korea*
Colleen Zenczak, ChanHo Hwang, and Doris K. Wu* *- National Institute on Deafness and Other Communication Disorders, Rockville, MD, USA*

The mammalian inner ear is a structurally complex organ that relies on the surrounding tissues such as the hindbrain, neural crest, and otic mesenchyme for its positional cues and differentiation. Notably, the developing hindbrain secretes molecules such as Wnts and Sonic hedgehog (Shh) that are important for establishing the dorsal and ventral axes of the inner ear, respectively. The inner ears of Shh null mouse embryos lack ventral specification – absence of the utricle, saccule, and cochlea. Results from previous studies attributed this lack of ventral patterning to the loss of Shh signaling from the ventral hindbrain (floor plate) and the notochord beneath. However, there is an additional later source of Shh emanating from the spiral (auditory) ganglion, with an unknown role in cochlear development. In this presentation, preliminary results on the role of spiral ganglion source of Shh on cochlear development will be summarized. This ganglionic source of Shh regulates the growth of the cochlear duct, timing of cell cycle exit of cochlear hair cell precursors, and their subsequent differentiation.

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S2.2 – Wed 28 Aug, 14:35-15:10

Attention and auditory cortical plasticity

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Patrick Kanold - *Department of Biology, University of Maryland, College Park, MD, USA*
Shihab Shamma - *Institute for Systems Research, University of Maryland, College Park, MD, USA; Ecole Normale Supérieure, Paris, France*

Rapid task-related receptive field plasticity alters the tuning properties of A1 neurons in a task-specific fashion that may enhance their ability to encode the attended spectral and temporal features of the current task. We compared task-related plasticity in primary auditory cortex (A1) vs. secondary auditory cortical (AC) areas, in a simple task in which the animals learned to discriminate tonal targets from noisy background stimuli. In secondary AC areas, we found relatively heightened responses to targets vs. background stimuli during behavior, compared to responses observed in passive listening. The secondary AC is thus likely to play a key role in the transformations of sound from spectrotemporal pattern to recognized auditory object to behavioral meaning from A1 to PFC. We propose that the PFC controls the flow of sensory inputs via top-down feedback to sensory cortical areas during behavior, reflecting attentional focus and task objectives and rules. Stimulation of PFC, paired with pure tone presentation, elicits changes in A1 receptive fields that are similar to those observed in attention-driven behavior. These results support the idea that PFC and AC are part of a larger auditory attention network that uses neuromodulators and an array of plasticity mechanisms to enhance responses to attended foreground stimuli and suppress responses to background stimuli.

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S2.3 – Wed 28 Aug, 15:10-15:30

Coding of higher-order units from individuals events: human EEG evidence for prediction-driven plasticity in audition

Alessandro Tavano* - *University of Leipzig, Leipzig, Germany*
Burkhard Maess - *Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany*
Erich Schröger - *University of Leipzig, Leipzig, Germany*

Do plastic changes underlie the emergence of higher-order (larger) units from sequences of individual stimuli? To answer this question, we turned to human EEG and used a pre-attentive, deviant repetition paradigm in which continuously varying pitch deviant tones were repeated either predictably or unpredictably. Refractoriness was controlled for by having the same amount of standards preceding first deviant tones across conditions. Occasionally, the repeated deviant was omitted (16.6%). Remarkably, the omission of predictable repetitions yielded a full ERP response at both frontal and mastoid sites which was statistically undistinguishable from the actual (suppressed) repetition response for about 200 ms from omission/repetition onset. Notably, higher-pitch but not lower-pitch omissions elicited a P3a-like component following repeated deviant N1 processing. The omission of unpredictable repetitions was noticed by the brain ~15-20 ms from its onset regardless of differences in pitch deviant magnitude. This suggests that the brain organized the detected higher-order regularity as a pre-determined and possibly pitch-specific neural pattern of activation around the onset of a first deviant “anchor”.

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S2.4 – Wed 28 Aug, 15:50-16:25

Are receptive fields fixed or fluid?

Jessica de Boer* - *MRC Institute of Hearing Research, Nottingham, UK*

Neural representations of sensory stimuli are affected by stimulus- and task context. These effects can be long term, such as observed after intensive training or sensory deprivation, or short term, for instance when stimuli are repeated or attended. Long-term effects are generally associated with changes in neural receptive fields, such as expanded representation of, and increased selectivity for, learned features after training, or cortical remapping after hearing loss. In contrast, short-term context effects are usually explained in terms of either suppressive (e.g., repetition suppression) or facilitatory (e.g., attentional facilitation) gain control, without any change in neural coding parameters. More recent models, however, propose that short-term effects, such as repetition suppression or attention, act not only through gain control of neuron populations, but also change the receptive fields of individual neurons. In this view, receptive fields are considered not as fixed, but rather as fluid and instantly adaptable. In this paper, I will present new data, based on non-invasive electrophysiological recordings in humans, which support the notion that short-term context effects cause rapid receptive field plasticity. I will discuss possible mechanisms, including the possibility of more peripheral origins, mediated by the efferent system.

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S2.5 – Wed 28 Aug, 16:25-17:00

The representation of surprise in auditory cortex

Israel Nelken* - *Edmond and Lily Safra Center for Brain Sciences and Department of Neurobiology, Hebrew University, Jerusalem, Israel*

A substantial number of neurons in the vertebrate auditory system are sensitive to the temporal context in which sounds are presented. We studied this context-dependence using stimulus-specific adaptation (SSA) – the reduction in the response to a commonly presented sound which is not generalized, or generalizes only partially, to other stimuli. I will demonstrate that SSA in cortex shows hyperacuity, and that it is sensitive not only to stimulus probability but also to the temporal regularity of the sequence. Furthermore, SSA is present also for broadband stimuli with identical long-term spectra. While SSA is already present in the non-lemniscal auditory pathway starting from the level of the inferior colliculus (IC), I will show that in the lemniscal pathway, SSA first occurs in primary auditory cortex (A1), and that SSA in IC and in A1 have subtly different properties. Finally, I will discuss our current understanding of the mechanisms underlying SSA in the midbrain and in auditory cortex, using both experiments and models.

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Session 3:
MODELING OF PLASTICITY

Chair: Torsten Dau

Thu 29 Aug, 08:30-11:05

S3.1 – Thu 29 Aug, 08:30-09:05

Classification and annotation of natural sounds

Klaus Obermayer* - *Neural Information Processing Group, Department of Software Engineering and Theoretical Computer Science, Berlin Institute of Technology, Berlin, Germany*

In my presentation I will show how methods from machine learning can be applied to classify and annotate everyday sounds. I will first explore an event-based representation using a so-called spike-based code. Then will also show that these methods can be used to not only assign physical but also perceptual attributes to sounds. Finally I will provide evidence that active learning techniques – where samples are selected based on their ”informativeness” for a given task – can considerably reduce the required number of training examples. This may have implications for the design of psychoacoustic experiments, where labelled data may be costly to obtain.

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S3.2 – Thu 29 Aug, 09:05-09:40

Critical periods for hearing loss and restoration: veering off the developmental path

Dan H. Sanes*, Todd N. Mowery, Anne E. Takesian, and Vibhakar C. Kotak *- Center for Neural Science, New York University, New York, NY, USA*

A general principle of development holds that sensory experience during finite periods of maturation, called critical periods (CP), influences CNS function, thereby shaping adult performance. Thus, early hearing loss is more disruptive to central processing than is adult-onset loss. Furthermore, the deficits that attend developmental loss are thought to be minimized when hearing is restored before CPs close. If so, then we would predict that neuron cellular properties would display an age-dependent vulnerability to hearing loss, yet recover fully if hearing were to be restored within a CP. To test this idea, we varied the age at which mild hearing loss was induced (bilateral earplugs) and the age at which hearing was restored (earplugs removed). By measuring auditory cortex neuron membrane and synaptic properties in a brain slice, we found that most properties failed to mature only when hearing loss was initiated within a brief time window. Furthermore, the window was property-specific. Perhaps more surprising, we found that some neuron properties did not recover, even when hearing loss lasted only 1-2 weeks, or when the recovery period extended to adulthood. These results suggest that even transient periods of mild hearing loss can derail central auditory maturation, and imply that perceptual deficits may persist long after peripheral transduction returns to normal.

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S3.3 – Thu 29 Aug, 09:40-10:00

A computational model of sound recognition used to analyze the capacity and adaptability in learning vowel classes

Jeffrey Spencer* - *University of Melbourne, Department of Electrical and Electronic Engineering, Melbourne, Australia*
Neil McLachlan - *University of Melbourne, Department of Psychological Sciences, Melbourne, Australia*
David Grayden - *University of Melbourne, Department of Electrical and Electronic Engineering, Melbourne, Australia*

Sound recognition is likely to initiate early in auditory processing and use stored representations (spectrotemporal templates) to compare against spectral information from auditory brainstem responses over time. A computational model of sound recognition was developed using neurobiologically plausible operations. The model has an adaptable template database in which incoming sounds are compared to the template database and either combined with a template, pruned from the database, or added to the database. In this paper the adaptability and number of templates required for the computational model to correctly recognize 10 Klatt-synthesized vowels across the male pitch range and the three formant ranges in Peterson and Barney (1952) was determined to be around 5000 templates. These data suggest that storage of auditory representations for speech at the spectrotemporal resolution of the auditory nerve does not require excessive memory resources to meet the constraints of biological plausibility or implementation on modern computer systems. The computational mechanisms developed in the model may inform how the brain adapts to learn language.

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S3.4 – Thu 29 Aug, 10:30-11:05

Is hearing aid signal processing ready for machine learning?

Bert de Vries* - *GN ReSound, Eindhoven, Netherlands*

In the hearing aids community, machine learning technology enjoys a reputation as a potential performance booster for signal processing issues such as environmental steering, personalization, offline optimization and speech detection. In particular in the area of hearing aid personalization, the promise is steep but clear success stories are still hard to come by. In this contribution, we analyze the “personalizability” of typical hearing aid signal processing circuits. Among some other issues, we discover that the lack of a probabilistic framework for signal processing hinders interaction with machine learning techniques. Finally, an approach and research plan towards personalizable hearing aid signal processing is presented.

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Session 4:

PLASTICITY AND AUDITORY DISORDERS

Chairs: Beverly Wright and Brian Moore

Thu 29 Aug, 11:05-17:00

S4.1 – Thu 29 Aug, 11:05-11:40

Tinnitus: maladaptive plasticity?

Jos J. Eggermont* - *University of Calgary, Calgary, AB, Canada*

Tinnitus is a symptom, not a disease. Tinnitus is often accompanied by hyperacusis as well as hearing loss. Tinnitus is foremost not an auditory disorder but a particular consequence of hearing loss, and then only in about 1/3 of the cases. Tinnitus can also result from insults such as whiplash, via somatic-auditory interaction in the dorsal cochlear nucleus. These are examples of bottom-up mechanisms that can underlie tinnitus. Much is known about necessary neural substrates of tinnitus, but much less about the sufficient ones. I will review proposals from animal research for these neural correlates, i.e., increased spontaneous firing rates, increased neural synchrony and reorganized cortical tonotopic maps. These can occur following noise trauma, but also following long-term exposure to non-traumatic (<70 dBA) sounds. Homeostatic plasticity may play a role. I will contrast these findings with what is known from human imaging and electrophysiology in tinnitus patients, and suggest that we are a long way from agreement between animal studies and human findings related to tinnitus.

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S4.2 – Thu 29 Aug, 11:40-12:00

Use of tinnitus masking functions to support or refute the presence or absence of auditory plasticity

Jose Luis Blanco *- Oticon Spain, Madrid, Spain*
Michael J. Nilsson* *- Oticon A/S, Smørum, Denmark*

Tinnitus, the perception of sounds that do not have a peripheral correlate, is often hypothesized to be associated with cortical reorganization that over-emphasizes baseline cortical activity and is perceived as these phantom signals. But there are several issues that suggest this explanation may not be universal (if the system is plastic, why can't tinnitus be eliminated by another plastic change?). A potential technique to distinguish tinnitus that may be correlated with auditory plasticity versus tinnitus associated directly with peripheral damage will be evaluated. Narrowbands of noise will be used to determine masking thresholds across frequencies. Thresholds will be plotted relative to the tinnitus pitch to determine whether the frequency of optimal masking is aligned with the frequency of tinnitus, which does not support plasticity, or with adjacent frequencies, supporting the existence of auditory plasticity. Subjects with tinnitus frequency less than 6 kHz will be recruited, and a test battery will be collected, including DPOAE, tinnitus frequency, TEN test to detect possible deadzones, as well as masking thresholds with narrow bands of noise around the tinnitus frequency. Case studies will be presented to demonstrate the threshold functions found in a small sampling of tinnitus patients. Implications for treatment will be discussed.

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S4.3 – Thu 29 Aug, 13:15-13:50

Brain plasticity-based training to improve human listening and language abilities

Michael M. Merzenich* - *Brain Plasticity Institute, San Francisco, CA, USA*

A large body of animal and human studies support the development and application of brain plasticity-based training to improve human listening and related language and cognitive abilities. We have developed and applied programs designed to improve listening and language usage in normal and impaired child and adult populations, and have conducted outcomes trials demonstrating performance improvements in multiple aspects of sound and speech reception and production. Sharp improvements have been recorded, as a rule, in indices of attention, memory, cognitive and social control, and speech production. We have applied special forms of this training in individuals with condition-specific neurological distortions in their auditory/aural language processing abilities, including individuals with phonemic reception/ phonologically processing deficits, hearing-related attention deficits, language impairments associated with pervasive developmental disorder or psychotic illness, speech reception deficits associated with hearing loss, age-associated impairments in speech reception and language usage with and without hearing, and tinnitus. Our approach to training and outcomes results from these clinical indications shall be briefly summarized.

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S4.4 – Thu 29 Aug, 13:50-14:25

Experience-related changes in the adult auditory system

Kevin J. Munro* - *University of Manchester, Manchester, UK*

Changes in the sensory environment, as a result of deprivation or stimulation, modify our sensory experience and may result in experience-related or learning-induced reorganisation within the central nervous system. Electrophysiological and imaging techniques have revealed reorganisation of the adult human auditory map, for example, after sudden unilateral hearing loss. In parallel to these studies, there is behavioural evidence that auditory function can be modified by changing the acoustic environment; for example, experience with amplification has consequences for long-term performance. Future studies could usefully unite these behavioural and advanced objective techniques in order to provide a direct link between changes in perception and reorganisation of the auditory system. This presentation will summarise our work investigating changes in perceptual and physiological measures, in adult humans, after the sensory environment has been modified by: i) unilateral amplification, ii) use of a unilateral earplug, and iii) sudden and severe unilateral deafness. The findings are consistent with the growing body of literature that shows that the mature central auditory system is malleable and is modified by experience.

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S4.5 – Thu 29 Aug, 14:25-14:45

Unilateral conductive hearing loss causes impaired auditory information processing in neurons in the central auditory system

Jennifer L. Thornton, Kelsey L. Anbuhl, and Daniel J. Tollin* -
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Temporary conductive hearing loss (CHL) during development and in adults can lead to hearing impairments that persist beyond the CHL. Despite decades of studies, there is little consensus on the mechanisms responsible. Here we introduced 6 weeks of unilateral CHL to adult chinchillas via foam earplug. Single-unit recordings from inferior colliculus (IC) neurons indicated that the CHL caused a decrease in the efficacy of inhibitory input to the IC contralateral to the earplug and an increase of inhibitory input ipsilateral to the earplug. The changes were seen after removal of the CHL. Sensitivity to interaural level difference (ILD) cues to location in IC neurons was shifted by ~10 dB relative to controls. In both ICs, the direction of the shift was consistent with a compensation of the altered ILDs due to the CHL. IC neuron responses carried ~33% less information (mutual information) about ILDs after CHL than in normals. Experiments examining cochlear anatomy and peripheral evoked responses confirmed that the results did not arise from damage to the periphery. The CHL-induced shifts of ILD sensitivity suggest a compensatory form of plasticity occurring by at least the level of the IC. The neurons were also impaired in their abilities to encode information about the spatial attributes of sound. How these physiological changes may lead to impaired hearing will be discussed.

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S4.6 – Thu 29 Aug, 15:30-16:05

Auditory plasticity in congenital deafness: sensitive periods in development and deprivation

Andrej Kral* - *Institute for Audio-Neurotechnology and Department of Experimental Otology, Hannover, Germany*

Cortical representation of an auditory stimulus is plastic: it changes with experience. Periods of high susceptibility for environmental modification are called sensitive periods (Kral, 2013, Neuroscience). Some of these cannot be compensated by later experience; an example is the cochlear implantation in prelingual (early) deafness in children, where only implantation in the first 3.5 years allows good recovery and adaptation to implant (Sharma et al., 2005, Hear. Res.). In the congenitally deaf cat, cortical reorganization to single-channel stimulation (expansion of the cortical active area) has been shown to depend on age of cochlear implantation (Kral and Sharma, 2012, TINS). Also, reorganization of aural preference with respect to stimulated ear shows a sensitive period that is even shorter than the one for expansion of the active area (Kral et al., 2013, Brain). We suggest that, to explain the critical nature of the sensitive period for cochlear implantation, several phenomena have to take place in combination: a developmental decrease in synaptic plasticity, alteration in cortical synaptic development, incomplete development of feature sensitivity in the auditory system, neuronal networks preventing neuronal regulatory processes for learning, and cross-modal reorganization of some auditory areas. Supported by DFG (Kr 3370/1-3 and Cluster of Excellence Hearing4all).

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S4.7 – Thu 29 Aug, 16:05-16:40

Cortical plasticity and reorganization in hearing loss

Anu Sharma*, Hannah Glick, and Lauren Durkee - *Department of Speech Language and Hearing, University of Colorado at Boulder, CO, USA*

Hearing impaired adults and children who receive intervention with hearing aids and cochlear implants provide a platform to examine the trajectories and characteristics of deprivation-induced and experience-dependent plasticity in the central auditory system. We review the evidence for sensitive periods for development of the central auditory pathways. A sensitive period in early childhood appears to coincide with the period of maximal synaptogenesis in auditory cortex. Implantation within this sensitive period provides the auditory experience needed for refinement of essential synaptic pathways. Cross-modal recruitment is another aspect of plasticity that is apparent in deaf children. In long-term congenital deafness, somatosensory and visual stimuli activate higher-order auditory areas. However, cross-modal plasticity and changes in neural resource allocation are also evident in adult-onset post-lingual hearing loss. Overall, it appears that the functional activation of cognitive circuitry resulting from cortical reorganization in deafness is predictive of outcomes after intervention with amplification or electrical stimulation. A better understanding of cortical development and reorganization in auditory deprivation has important clinical implications for optimal intervention and habilitation of these patients.

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S4.8 – Thu 29 Aug, 16:40-17:00

Electrophysiological signatures of plasticity in the visual and auditory cortex after cochlear implantation

Pascale Sandmann* - *Carl von Ossietzky University of Oldenburg, Oldenburg, Germany; Cluster of Excellence Hearing4all, University of Oldenburg, Germany*
Karsten Plotz and Rüdiger Schönfeld - *Evangelical Hospital Oldenburg, Oldenburg, Germany*
Stefan Debener - *Carl von Ossietzky University of Oldenburg, Oldenburg, Germany; Cluster of Excellence Hearing4all, University of Oldenburg, Germany; Research Center Neurosensory Science, University of Oldenburg, Germany*

Previous studies have shown that both sensory deprivation and cochlear implantation can induce cortical plasticity. However, it is not well understood how the deprivation-induced cortical reorganization affects the adaptation of the auditory cortex to the cochlear implant (CI) signal. Here we present a prospective longitudinal study which used electroencephalography (EEG) to examine post-lingually deafened CI users (N=11; mean age: 59±17 years) before as well as after implantation. A group of carefully matched normal-hearing listeners (N=12; mean age: 60±15 years) served as control. The two groups performed a discrimination task with different frequency-modulated tones (auditory condition) and patterns of coherent motion (visual condition). The results revealed an enhancement of auditory discrimination ability over the period of one year following cochlear implantation. At the same time, CI users showed an increase of the N1 event-related potential (ERP) for the auditory condition, whereas the P1 ERP for the visual condition was smaller in CI users compared with NH listeners. Importantly, the amplitude of the visual ERP was inversely related to the speech recognition ability with a CI. Our results demonstrate a rapid adaptation of the auditory cortex in elderly CI recipients and indicate associations between changes in the visual and auditory modality during CI rehabilitation.

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Session 5:

HEARING REHABILITATION WITH HEARING AIDS AND COCHLEAR IMPLANTS

Chairs: Morten Løve Jepsen and Iris Arweiler

Fri 30 Aug, 08:30-12:15

S5.1 – Fri 30 Aug, 08:30-09:05

Auditory training and challenges associated with participation and compliance

Robert Sweetow* - *University of California, San Francisco, CA, USA*

When individuals have hearing loss, physiological changes in their brain interact with relearning of sound patterns. Some individuals utilize compensatory strategies that may result in successful hearing aid use. Others, however, are not so fortunate. Modern hearing aids can provide audibility, but may not rectify spectral and temporal resolution, susceptibility to noise interference, or degradation of cognitive skills, such as declining auditory memory and slower speed of processing associated with aging. These deficits are not identified during a typical “hearing aid evaluation”. Aural rehabilitation has long been advocated to enhance communication but has not been considered time or cost-effective. Home-based, interactive adaptive computer therapy programs are available which are designed to engage the adult hearing impaired listener in the hearing aid fitting process, provide listening strategies, build confidence, and address cognitive changes. Despite the availability of these programs, many patients and professionals are reluctant to engage in and complete therapy. In this presentation reasons for the lack of compliance with therapeutic options will be identified and possible solutions to maximizing participation and adherence will be offered.

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S5.2 – Fri 30 Aug, 09:05-09:40

Cognitive aspects of auditory plasticity across the lifespan

Mary Rudner* - *Linneaus Centre HEAD, Department of Behavioural Sciences and Learning, Linköping University, Linköping, Sweden*
Thomas Lunner - *Linneaus Centre HEAD, Department of Behavioural Sciences and Learning, Linköping University, Linköping, Sweden; Eriksholm Research Centre, Oticon A/S, Snekkersten, Denmark*

This paper considers evidence of plasticity resulting from congenital and acquired hearing impairment as well as technical and language interventions. Speech communication is hindered by hearing loss. Individuals with normal hearing in childhood may experience hearing loss as they grow older and use technical and cognitive resources to maintain speech communication. The short- and medium-term effects of hearing aid interventions seem to be mediated by individual cognitive abilities and may be specific to listening conditions including speech content, type of background noise and type of hearing aid signal processing. Furthermore, some aspects of cognitive function may decline with age and there is evidence that age-related hearing impairment is associated with poorer long-term memory. It is not yet clear whether improving audition through hearing aid intervention can prevent cognitive decline. Profound deafness from an early age implicates a set of critical choices relating to possible restoration of the auditory signal through the use of prostheses including cochlear implants and hearing aids as well as to mode of communication, sign or speech. These choices have an influence on the organization of the developing brain. In particular, while the cortex may display sensory reorganization in response the linguistic modality of choice, cognitive organization seems to prevail.

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S5.3 – Fri 30 Aug, 09:40-10:00

A localization training program for hearing aid wearers

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The ability to localize a sound source depends on many variables such as the pinna shadow and the interaural level and time differences. However, even with compensation for these cues, localization skills in hearing impaired listeners can still be impaired. We reviewed the literature on how training on localization has been conducted and concluded that if the training protocol can be more adaptive and motivating, one may be able to train hearing impaired listeners to localize. We developed a home version and a laboratory version of such a training protocol and conducted a series of studies examining if training can be effective, and if so, what form of training (home or laboratory) may be more effective. We have also studied the efficacy of various new hearing aid features such as e2e and pinna compensation algorithm in enhancing localization. During the presentation, we will provide a review of the factors that affect localization, survey the hearing aid features that could help such performance, describe our localization training program, and report on the efficacy of such a training program.

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S5.4 – Fri 30 Aug, 10:40-11:15

Auditory training strategies for adult users of cochlear implants

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There has been growing interest recently in whether computer-based training can improve speech perception among users of cochlear implants (Fu et al., 2005; Oba et al., 2011; Ingvalson et al., 2013). This paper reports a series of experiments which first evaluated the effectiveness of different training strategies with normal-hearing participants who listened to noise-vocoded speech, before conducting a small-scale study with users of cochlear implants. Our vocoder studies revealed (1) that "High-Variability" training led to greater generalisation to new talkers than training with a single talker, and (2) that word- and sentence-based training materials led to greater improvements than an approach based on phonemes in nonsense syllables. Informed by these findings, we evaluated the effectiveness of a computer-based training package that included word- and sentence-based tasks, with materials recorded by 20 talkers. We found good compliance with the training protocol, with 8 out of the 11 participants completing 15 hours of training as instructed. Following training, there was a significant improvement on a consonant test, but in general the improvements were small, highly variable, and not statistically significant. A large-scale randomised controlled trial is needed before we can be confident that computer-based auditory training is worthwhile for users of cochlear implants.

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S5.5 – Fri 30 Aug, 11:15-11:35

Combining acoustic and electric hearing: challenges and approaches

Josef Chalupper*, Iris Arweiler, and Stefan Fredelake *- Advanced Bionics, Hannover, Germany*

Auditory plasticity plays a major role when combining electric and acoustic stimulation in the brain. Optimum design and parameterization of the signal processing in the cochlear implant (CI) and the hearing aid (HA) may facilitate the adaptation process and, thus, help users to get the maximum benefit from bimodal systems. The individual bimodal benefit, as reported in the literature, varies considerably. A potential reason for this is that a conventional bimodal fitting does not account for certain specific challenges of bimodal listening. Of particular importance are: low-frequency audibility, spectral overlap of electric and acoustic stimulation, loudness balance, inter-aural tonotopy, and (dynamic) synchronization of adaptive signal processing. In order to improve both effectiveness and efficiency of bimodal fitting, new approaches which specifically address these challenges are currently under investigation. First implementations and evaluations of new tools for individual diagnosis, prescriptive fitting and individual fine-tuning indicate that ensuring optimum audibility and consistent bimodal signal processing can improve the benefit for many users. For some, however, no increased benefit compared to conventional methods can be shown – possibly because of insufficient auditory plasticity.

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S5.6 – Fri 30 Aug, 11:35-11:55

Performance of the second CI in 109 sequentially implanted children

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From 2005 to 2009, 162 children were implanted with a second cochlear implant (CI2). The aim of this retrospective study was to investigate performance of CI2 with a focus on the plasticity of the auditory system to incorporate the sound from CI2. Performance of CI1 and CI2 is investigated, mainly with speech perceptions tests (closed Early Speech Perception test and open tests with monosyllables and sentences). Factors such as age at operation of CI1 and CI2 were studied. The results are based on prelingually implanted children (n=109) 4-8 years post CI2 implantation. The mean age at surgery of CI1 was 3.2 yrs (SD=1.6) and at CI2 8.6 yrs (SD=3.2). In March 2013, 61 were still all day users, 18 were part time users and 30 were non-users of their CI2. Non-use of CI2 was associated with a large difference in performance between CI1 and CI2. When CI2 was implanted within 5 years after CI1 the amount of CI2 non-users were about 10%. CI2 surgery 5 years after CI1 gave 40% non-users. Still a number of users have acceptable CI2 performance even if CI2 surgery took place long after CI1. A small group of well performing CI2 users chose not to use CI2 after some time. There are factors other than the performance of CI2 alone that can influence incorporation of bilateral CIs and individual decisions to use CI2.

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S5.7 – Fri 30 Aug, 11:55-12:15

Perception of music and speech in adolescents with cochlear implants: effects of intensive musical ear training

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Cochlear implants (CIs) have revolutionized the lives of persons with severe or profound hearing loss (HL) but auditory processing in general and music perception in particular are hampered in CI users. Nevertheless, there are examples of CI-users who seem to enjoy music after repeated listening, and some studies show significantly improved music discrimination after computer assisted training. While previous studies primarily examined implant outcome in adult CI-recipients with an acquired HL, perception of music and speech in the growing population of adolescent CI users with a congenital HL has not been thoroughly investigated. Recent studies, however, indicate that to keep pace with their normal hearing peers, supplementary measures of rehabilitation are in demand throughout adolescence. Music training may provide a strong, motivational and beneficial method of strengthening not only music perception but also linguistic skills, particularly the prosodic properties of speech. Using EEG brain recording methods and behavioral measures, this study examined brain processing of music and speech in adolescent CI-recipients, and evaluated the effect of an intensive music training program on their perception of music and speech.

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Poster Sessions I and II

POSTERS WILL REMAIN ON DISPLAY
THROUGHOUT THE SYMPOSIUM

Presenters will be at their posters:

Wed 28 Aug, 17:00-19:00 (odd-numbered posters)

Thu 29 Aug, 17:00-19:00 (even-numbered posters)

P.1 – Wed 28 Aug, 17:00-19:00

Effects of training with amplitude modulated (AM) tones on tone-vocoded speech perception

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Ediz Sohoglu - *University College London Ear Institute, London, UK*
Christian Füllgrabe - *MRC Institute of Hearing Research, Nottingham, UK*
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In vocoded speech, temporal-envelopes are extracted from broad frequency regions and used to modulate tone- or band-limited noise carriers. Such a manipulation removes temporal fine-structure and degrades spectral content whilst preserving temporal-envelope cues and, if a sufficient number of frequency channels are used (usually >5), retaining intelligibility. We asked here whether training on a task requiring the explicit use of temporal-envelope cues but no speech content will transfer to 4-channel vocoded speech, which is unintelligible when initially heard. Identification of vocoded vowel-consonant-vowel (VCV) stimuli was assessed before and after two sessions of training on amplitude-modulation (AM) tasks. During the training phase, one group practiced an AM-detection task, a second group practiced an AM-rate discrimination task, and a third group served as untrained Controls (N=18 in each group). Both AM-training groups (but not Controls) showed significant improvement (~4%) on vocoded VCV identification. However, the trained groups did not differ significantly from the Controls. Doubling the amount of training did not result in additional improvement in vocoded speech perception, suggesting training on temporal cues in non-speech sounds is of limited benefit to vocoded speech perception.

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P.2 – Thu 29 Aug, 17:00-19:00

Using limitations of auditory abilities associated with hearing loss to optimize hearing aid design

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Recent research has demonstrated that people with hearing impairment have limited ability to use temporal fine structure information. This means that they will not be able to fully utilize auditory cues, such as interaural time differences and detailed pitch perception, which are derived from such information. But this reduced ability can be taken advantage of to improve certain aspects of hearing aid functionality. One such area is feedback suppression. Many of the latest hearing aid introductions in the hearing aid industry feature feedback suppression algorithms which apply a slight frequency shift to de-correlate the hearing aid output from the input and thus minimize the risk of feedback. This presentation will review evidence on temporal fine-structure abilities of people with hearing impairment, present detailed findings of a study related to the specific topic and relate this to how hearing aid anti-feedback systems can be designed to achieve a dual goal: to optimize the perceived sound quality to the listener with hearing impairment, whilst minimizing the occurrence of feedback.

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P.3 – Wed 28 Aug, 17:00-19:00

Perceptual and acoustical evaluation of noise reduction in hearing aids

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Single-microphone noise reduction is a common feature in modern hearing aids. It should suppress the unwanted background noise without affecting the target speech. Unfortunately, hearing-aid noise reduction is commonly presented as a "black box", so that there are relatively large uncertainties about the actual implementation of noise-reduction algorithms in hearing aids, about their perceptual effects, and about fitting strategies. Given the broad application of noise reduction in hearing aids this is quite unexpected and unwanted. In order to gain insight in the "black box" of noise reduction we recorded the noise-reduction output from different hearing aids for perceptual and acoustical measurements. We evaluated the hearing-aid noise reduction both in isolated form and in combination with compression. Hearing-impaired subjects performed intelligibility tests and rated the annoyance of the background noise, the quality of speech and their overall preference. We will present the results of these perceptual measurements on noise reduction and discuss their relationship to objective outcomes from acoustical measurements.

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P.4 – Thu 29 Aug, 17:00-19:00

Musical instrument training and audition: specificity or generality of perceptual and cognitive enhancements?

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Experience plays a critical role in influencing the development of perceptual and cognitive abilities. In the present study, we compared violinists, pianists, and non-musicians (each n=24), using a battery of tasks to examine the role of specific musical training experience in shaping perceptual and cognitive abilities. We measured psychophysical thresholds for acoustic cues relevant to instrumental performance (AM depth, FM depth, and onset rise time), and for visual colour hues (control task). We also examined perception of instrument-specific musical tuning systems. Groups completed sustained auditory attention, environmental auditory scene analysis, and multi-modal sequencing tasks. Results showed auditory perceptual enhancements in musicians. Musicians had significantly reduced auditory but not visual psychophysical thresholds compared to non-musicians, with biases towards instrument-specific tuning systems. Generalisation of musical expertise to cognitive abilities was limited. Groups differed only marginally in sustained auditory attentional performance and did not differ on other tasks. Only sustained auditory attention showed significant relationships with auditory psychophysical performance across groups. Our findings suggest experience may enhance training-relevant perceptual abilities, with limited transfer to broader cognitive skills.

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P.5 – Wed 28 Aug, 17:00-19:00

Modeling potential distribution inside the cochlea caused by electrical stimulation

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During the last decades the average speech intelligibility of cochlear implant (CI) users has steadily been improved. Nevertheless, problems still occur especially in complex hearing situations. One reason for that is the inaccurate signal transmission between CI electrodes and stimulated nerve cells. To develop new methods overcoming this problem, models are required that provide insight into the processes of electrical stimulation inside the complex geometry of the cochlea. This paper presents a detailed model of the electrically stimulated cochlea. This model consists of a virtual three-dimensional representation of the most important structures of the human cochlea. It serves as a basis for the volume conductor model, which was developed using finite element method. It allows for the computation of the electrical potentials inside the modeled structures caused by current applied to the CI electrodes. The presented model was used to compare current spread for different electrode positions and configurations. The results show that the model can represent characteristic differences in spatial selectivity and hence be a help in realizing spatially more focused electrical stimulation.

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P.6 – Thu 29 Aug, 17:00-19:00

Attitudes, rewards, and MP3 listening habits in Danish youth

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In a survey of more than 1800 Danish teenagers, their habits and view of MP3 listening was explored. The questionnaire was registering self-reported sound exposure, listening behavior, perceived rewards of listening, and the effect and media of prophylactic information. A “risk group” of approx. 10% was defined, which is corresponding well to other recent studies. In general the risk group indicates more reasons for listening to loud music, however, the three most popular reasons for both groups are “I can better feel/enjoy music at a high level”, “I can lose myself in loud music”, and “I get energy of listening to loud music”. More than 30% of the risk group indicates “I relax better with loud music” and “I get a pleasant effect in the body by listening to loud music”. Not surprisingly the pattern of use reveals that the risk group uses their MP3 in more situations, and especially more in situations that possibly are longer lasting like reading, sleeping, and by the computer. Both groups indicates that information on potential hearing risk from MP3 listening preferably are brought to them by television and commercials or by nurses and doctors. The most effective examples are case stories, medical argumentations, or experiencing symptoms of hearing loss.

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P.7 – Wed 28 Aug, 17:00-19:00

Auditory training: speech and music

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The mapping of a sound pattern to a linguistic context is the base of acoustical communication. This process is taking place whenever language skills are acquired. However, sound cues might be changed or lost in amplification, thereby changing the sound pattern. Adaptation is required to reconnect sound with context. Focused training on this connection will speed up, and improve the process. The necessity of this training is evident where hearing is restored from deafness, but a training effect is also expected in rehabilitation of gradually emerging hearing loss. Programs training speech recognition and cognitive skills exist for English speakers. They are used with some success, however the criteria for who will benefit from training are unclear. From sensory perception evaluation, training the attention to sound details and developing a language about sound attributes is well known, but the use of non-speech stimuli in auditory training has not yet been given much attention. Looking at the hearing aid fitting process an improved fitting could be expected if sound description ability is improved within the framework of specialized training. Music as a part of an auditory training program may increase sound property awareness to the benefit of cognitive skills also related to speech perception. Adding music improves the fun and thus the motivation of the training sessions.

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P.8 – Thu 29 Aug, 17:00-19:00

Facial configuration and the McGurk illusion: a mismatch negativity study

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Tobias Andersen - *Cognitive Systems, DTU Compute, Tehnical University of Denmark, Lyngby, Denmark*

The sight of articulatory mouth movements (visual speech) influence auditory speech perception. This is demonstrated by the McGurk illusion in which incongruent visual speech alters the auditory phonetic percept. In behavioral studies, reversal of the vertical mouth direction has been reported to greatly reduce the McGurk illusion. Such findings support the idea that audiovisual integration in speech to some extent relies on information regarding facial configuration. Here we ask whether this behavioral effect is reflected in a difference in neural activity in the auditory cortex. Mismatch negativity (MMN) is a component in the auditory event-related potential (ERP) that is elicited by a change in the auditory percept. It has been shown that the McGurk illusion can induce a MMN. We conducted an experiment in which the MMN could be elicited by the McGurk Illusion induced by visual speech with either upright or reversed mouth area. In a preliminary analysis, we found a mismatch negativity component induced by the McGurk illusion at electrode Cz when the mouth area was upright. In comparison, these participants produced no mismatch negativity when the mouth was reversed. These findings mirrored behavioral findings in the same subjects of a strong McGurk response for normal audiovisual speech, which was greatly reduced for manipulated stimuli.

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P.9 – Wed 28 Aug, 17:00-19:00

Comparison between the equalization and cancellation model and state of the art beamforming techniques

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This paper investigates the performance of a selection of state of the art array signal processing techniques for the purpose of predicting the binaural listening experiments from the equalization and cancellation (EC) paper by Durlach written in 1963. Two different array signal processing techiques are analyzed, 1) filter and sum beamforming (FS) and 2) minimum variance distortionless response beamforming (MVDR). The theoretical properties of these beamformers for the specific situation of prediction of binaural masking level differences are analyzed in conjunction with the EC model. Also, the performance of the different beamformers on the data sets in the Durlach paper from 1963 is compared to the EC model. It is concluded that even if there are significant theoretical differences between the EC model and the beamformers, it seems as if the MVDR model is capable of accurately model the original data sets.

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P.10 – Thu 29 Aug, 17:00-19:00

Analyzing the effects on the internal signal-to-noise ratio for bilateral hearing aid systems configured for asymmetric processing

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This paper investigates bilateral hearing aid systems configured to perform asymmetric processing affect the internal signal-to-noise ratio (SNR) in the auditory system. An asymmetric hearing instrument (HI) system is characterized by that the instrument in one of the ears performs directional noise reduction whereas the contra-lateral device is adjusted to omni mode processing. The equalization and cancellation model is used to evaluate the internal SNR of the auditory system. Two reference conditions were also created, a system with directionality in both HI, and one with omni mode processing in both HI. A speaker was placed to the front, and a speaker was placed at the side. In the first experiment, the target was assumed to be to the front and the noise was assumed to the side. Here, it was shown that the asymmetric system provided the same SNR as the system with directionality in both HI. The noise and target positions were interchanged and the experiment was repeated. In this case, the asymmetric system provided similar SNR as the system with omni mode processing in both HI which for this test condition provided a better SNR than the system with directionality in both HI.

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P.11 – Wed 28 Aug, 17:00-19:00

The benefit of cochlear implant users' head orientation to speech intelligibility in noise

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Speech reception thresholds (SRTs) in noise improve when the speech and noise sources are spatially separated. This spatial release from masking (SRM) is usually investigated in fixed-head situations. We studied free-head situations in audio and audio-visual conditions. We compared normally hearing (NH) and cochlear implant (CI) users' spontaneous and directed head orientation strategies when attending to speech in noise with a progressively declining signal-to-noise ratio. SRM-model predictions suggested benefits of head orientation away from the target speech that we hypothesized would motivate head rotation. As signal-to-noise ratio declined, observed head tracks differed greatly between listeners. Audio-visual presentation reduced the amount of head rotation. When directed, listeners made more effective use of head rotation. Audio and audio-visual SRTs were acquired at fixed, 0 and 30 deg head orientations with respect to the target speech. At the most favourable 30-deg head orientation, SRM reached 8 and 6 dB for NH listeners and CI users respectively. Lip-reading yielded improvements of 3 and 5 dB on average across conditions. CI users confirmed that training in optimizing both their position and head orientation with respect to target speaker and noise source position in a social setting was both currently missing and likely valuable.

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P.12 – Thu 29 Aug, 17:00-19:00

Interaural bimodal pitch matching with two-formant vowels

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For bimodal patients, with a hearing aid (HA) in one ear and a cochlear implant (CI) in the opposite ear, usually a default frequency-to-electrode map is used in the CI. This assumes that the human brain can adapt to interaural place-pitch mismatches. This "one-size-fits-all" method might be partly responsible for the large variability of individual bimodal benefit. Therefore, knowledge about the location of the electrode array is an important prerequisite for optimum fitting. Theoretically, the electrode location can be determined from CT-scans. However, these are often not available in audiological practice. Behavioral pitch matching between the two ears has also been suggested, but has been shown to be tedious and unreliable. Here, an alternative method using two-formant vowels was developed and tested with a vocoder system simulating different CI insertion depths. The hypothesis was that patients may more easily identify vowels than perform a classical pitch-matching task. A spectral shift is inferred by comparing vowel spaces, measured by presenting the first formant in the HA and the second either in the HA or the CI. Preliminary results suggest that pitch mismatches can be derived from such vowel spaces. In order to take auditory adaptation in individual patients into account, the method will be tested with CI patients with contralateral residual hearing.

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P.13 – Wed 28 Aug, 17:00-19:00

Do perceptual consequences of spontaneous otoacoustic emissions reflect a central plasticity effect?

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Frequency difference limens (FDLs) have been found to improve in the vicinity of spontaneous otoacoustic emissions (SOAEs). This effect has been observed ipsilaterally and contralaterally to the emission ear, suggesting that prolonged ongoing stimulation of nerve cells tuned to the SOAE frequency lead to a central oversensitivity to that frequency (Norena et al., 2002, Hear. Res.). However, it is known that a tone close to an SOAE frequency can "entrain" the emission to oscillate at the tone frequency (Long and Tubis, 1988, Hear. Res.), thus FDLs near SOAEs might also be affected by this peripheral process. An alternative hypothesis explaining FDL performance in terms of peripheral entrainment and beating between external tones and SOAEs is proposed here. SOAE entrainment patterns were obtained in seven subjects with an ipsilateral SOAE and no neighboring contralateral SOAE. Ipsi- and contralateral FDLs were measured at frequencies covering the individual entrainment and beating regions. Ipsilateral FDLs were lowest in the entrainment region and worsened significantly when beating occurred. However, no changes in contralateral FDLs were found. Contralateral FDLs also remained unaffected by continuous ipsilateral presentation of a pure tone aimed at emulating an SOAE. These findings suggest a peripheral rather than central plasticity origin for perceptual consequences of SOAEs.

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P.14 – Thu 29 Aug, 17:00-19:00

Making use of auditory models for better mimicking of normal hearing processes with cochlear implants: first results with the SAM coding strategy

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Stimulation based on auditory modeling (SAM) is a new speech processing strategy for cochlear implants (CI) that we developed recently at the Fraunhofer IDMT. SAM incorporates active cochlear filtering (basilar membrane and outer hair cells) along with the mechanoelectrical transduction of the inner hair cells, so that several psychoacoustic phenomena are accounted for inherently. At ISAAR 2011 we showed the outline of the algorithm along with first simulation results concerning speech reception thresholds and horizontal-plane localization abilities using SAM. We also presented a real-time visualization of the strategy and a vocoder algorithm making SAM stimuli audible. In the meantime, SAM was tested with a group of five CI users. We investigated speech perception in quiet and in the presence of noise or reverberation, pitch discrimination abilities (for pure tones and sung vowels), and consonant discrimination. We also asked for subjective quality rating for speech and music snippets. Tests were repeated with the everyday strategy (ACE: advanced combination encoder) of the implantees and results were compared. This paper presents the test results in detail and compares outcomes with those of the previously published simulation studies. Results are encouraging, although only a fragment of them is statistically significant because of the small number of study participants.

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P.15 – Wed 28 Aug, 17:00-19:00

Investigating the relationship between simultaneously recorded cortical evoked responses and a behavioural AM detection task

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Recently there has been significant interest in the clinical applications of auditory evoked potentials originating from the cortex, as they can assess central auditory function in the neural encoding of perceptually relevant stimuli such as speech. One of the primary limitations of using evoked responses is a fundamental lack of understanding between the subjective perception of a sound and the objective response due to the neural encoding of the physical stimuli. The relationship is highly complex and nonlinear, and the current methods used to compare the two are far too crude. This study investigates the relationship between simultaneously recorded cortical evoked responses and a behavioural AM detection task, by using mutual information (MI) to analyse, compare and quantify the nonlinear relationship between the two. MI has been widely used in the neuroscience community as it can measure how tightly neural responses correspond to stimuli. It is also emerging as a powerful tool for use in non-invasive electrophysiology as well. Advances in quantifying the relationship between electrophysiological and behavioural tests could prove useful for new clinical tests and the diagnosis/management of hearing impairment in pre-lingual children.

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P.16 – Thu 29 Aug, 17:00-19:00

Task-modulated encoding of auditory objects in human auditory cortex

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Tanja Kassuba - *Princeton Neuroscience Institute, Princeton University, Princeton, NJ, USA*
Kristoffer H. Madsen, Hartwig R. Siebner, and Martin Skov - *Danish Research Centre for Magnetic Resonance, Copenhagen University Hospital, Hvidovre, Denmark*

We used functional magnetic resonance imaging to measure BOLD responses in the human brain during categorization of natural sound events. Normal hearing listeners were asked to categorize recorded impact sounds either with respect to the perceived material (wood, glass, metal) or action (drop, strike, rattle) in the same set of sounds. Using a multivoxel pattern classification approach, we found that neural activity patterns in the auditory cortex and in the inferior frontal gyrus predicted the presented sound category, but only when the category was the focus of the cognitive task. Although acoustically identical, task-irrelevant objects were not encoded. The results show that cortical representations of natural auditory objects are expressed in a highly flexible fashion favouring representations that are relevant in ongoing behavior.

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P.17 – Wed 28 Aug, 17:00-19:00

Plasticity in auditory perception: exposure to the speech nature of sine-wave stimuli modifies brain activity

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Sine-wave speech (SWS), in which speech formants are replaced by 3 tones, can be perceived either as speech or non-speech, depending on listeners' expectations on the nature of the sound. Auditory evoked potentials (AEPs) were recorded in two sessions, during active discrimination of SWS stimulus pairs using spectral (ubu/udu) or temporal (ubu/upu) cues. In the first, "non-speech", session, subjects discriminated between SWS stimuli, unaware of their speech-like nature. In the second, "speech", session, the same subjects performed the same discrimination task after learning to perceive the SWS as speech. Electrophysiological responses to the first stimulus in the pairs were analyzed and sLORETA current density source estimation was carried out. Perceiving the very same stimuli as speech or non-speech was associated with significant voltage differences around the main scalp recorded AEPs peaks. Source estimation revealed higher current density in auditory cortices to "speech" stimuli during early (around 230 ms) processing, and higher current density to "non-speech" stimuli at later processing (340-500 ms) times. Differences were prominent mainly within the right superior temporal cortex and the right prieto-temporal junction. Our data provide evidence for changes in distribution of processing non-speech sounds in the brain following a single exposure to their speech nature.

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P.18 – Thu 29 Aug, 17:00-19:00

Profiling hearing-aid sound

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Assessment of audio quality has a strong tradition within concert hall acoustics, music reproduction, and telecommunication, and some methods have recently been applied to hearing aid sound. Many assessment methods have been developed and evaluated and one of the most valuable methods is the use of assessment panels with trained listeners. Considerations about sound quality are an integral part of hearing-aid development as hearing-aid gain strategies and processing modify the sound by applying, e.g., frequency-dependent gain and dynamic-range compression, in order to compensate for consequences of hearing impairment. Hearing-aid manufacturers use different processing principles and different signal-processing technology to obtain this compensation. In the present study, the aim was to obtain the sound attribute profile for Widex devices and compare it to profiles of devices from other manufacturers, as well as an older Widex device. The listening panel comprised listeners with hearing impairment and was provided by DELTA SenseLab. The sound preference of the listening panel was also measured in a variety of acoustic scenarios focusing on speech and music conditions. It was found that the sound profiles of the different manufacturer devices were different and that this may be explained by differences in processing principles and technology.

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P.19 – Wed 28 Aug, 17:00-19:00

Separating the effects of energetic, modulation, and informational masking on speech intelligibility

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Speech intelligibility in noisy environments has traditionally been explained in terms of energetic masking of the speech by the interferer in the different critical bands. In the case of a speech interferer, intelligibility can be worse than in the case of an equal-energy noise interferer, which, thus, cannot be accounted for by differences in energetic masking. The remaining masking component has often been considered as “informational masking” (Brungart, 2001), presumably taking place at a more “central” level in the auditory system. However, recent work has shown that the detrimental effect of an interferer can strongly depend on its modulation content suggesting modulation masking effects to be involved in speech intelligibility. The present study attempts to disentangle the effects of energetic, modulation, and informational masking on speech intelligibility in monaural conditions. Predictions from the speech-based envelope power spectrum model (sEPSM; Jørgensen and Dau, 2011; Jørgensen et al., 2013) are compared to experimental data from the literature obtained in various conditions with single and multiple noise or speech interferers. While the sEPSM accounts for effects of energetic and modulation masking in speech intelligibility, the remaining “unexplored” effect in some of the conditions may be attributed to, and defined as, informational masking.

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P.20 – Thu 29 Aug, 17:00-19:00

Influence of memory effects in speech intelligibility tasks

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Testing speech reception thresholds of hearing impaired patients is a common task in clinical routine and research. Tests consist of grammatically correct sentences containing different grammatical classes. It is expected that due to primacy and recency memory effects error rates of the first and last word are minimal. In addition, from a linguistic point of view, not only the position of a word but also its grammatical class causes different cognitive effort. This study analyses the effect of different conditions on the comprehended words belonging to different grammatical classes. So far, 5 normal hearing subjects were measured via headphones with a German speech intelligibility test with different kinds of noise and different binaural conditions. The results do not only show the expected memory effects for the noun at the first and last position of the sentences. Also significant differences for the comprehension of sentence-centered numerals were found. This is impressive because in the middle, normally the attention of a listener is minimal, therefore one would expect larger error rates. In contrast, the verbs, cognitively more complex, show neither significant in- nor decreasing understanding. In summary, we conclude that careful analysis of speech reception tests provides also information of more cognitive aspects involved in speech understanding like memory capacity.

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The benefit of temporal fine structure for spatial release from masking for older hearing-impaired listeners

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Tone-vocoding (TVC) speech limits the benefit from (artificial) spatial separation, possibly due to disruption of monaural and binaural temporal fine structure (TFS) cues (Andersen et al., 2010; 2012). Andersen et al. (2010, 2012) used generic head-related transfer functions to place the target and masker talkers. In this study, we have tested if this lack of benefit occurs with real spatial separation using a loudspeaker array and binaural master hearing aids to implement real-time TVC at each ear. Spatial release from masking in a speech-on-speech task was measured for 20 older listeners (aged 64 to 86) with bilateral, gently-sloping hearing loss. The hearing aids were used to apply linear amplification (CAMEQ) only (TFS intact) or amplification and TVC (TFS disrupted). A modified Dantale II corpus was used with multiple female talkers for both target and masker sentences. Preliminary analysis suggests spatial release from masking was greater with intact TFS than with disrupted TFS. We also measured interaural phase difference discrimination thresholds for pure tones and thresholds of discrimination of harmonic frequency shifts and inharmonic frequency shifts for monaural complex tones. We want to determine how well performance in these tasks predicts the individual differences in SRM deficits observed with TVC.

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P.22 – Thu 29 Aug, 17:00-19:00

Listening effort and speech quality as independent measures

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Bluetooth mobile-phone accessories are available from many hearing-aid manufacturers. The accessories pair with Bluetooth-enabled phones to provide two main benefits for the hearing-aid user. First, the accessories stream audio to the user's hearing aids, providing clear phone calls for the user. Second, the accessories enable the users to make hands-free phone calls, much like with ordinary Bluetooth headsets. Whereas the quality of the audio heard by the hearing-aid user relies greatly on the phone used by the user's conversational partner, the user's Bluetooth accessory itself is a large contributor to the sound quality that is sent to the conversational partner. To investigate the latter, a comparison was made of the audio quality received by the conversational partner for two Bluetooth hearing-aid accessories. Twenty-one test subjects compared recordings from the devices via paired comparisons. The stimuli were recorded in both quiet and in the presence of background noise, with both male and female talkers. Test subjects evaluated the quality of the speech as well as the listening effort required to follow the speech. The results of the speech quality evaluations as well as those for listening effort were significantly different. This suggests that speech quality and listening effort appear to be independent measures of the overall sound quality of the signals.

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Optimizing hearing-aid directional patterns using binaural directionality

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Hearing-aid users typically prefer omnidirectional microphones for providing comfort, but directional microphones for better speech intelligibility. One solution to this conflict is to fit bilateral hearing aids with asynchronous directional patterns: one side in a directional mode and the other side in omnidirectional mode. Such a configuration has been shown to provide the speech-intelligibility benefits of directional algorithms along with the comfort benefits of omnidirectional microphones. This configuration is an excellent balance, but Hornsby and Ricketts (2007) showed that there are two conditions in which fixed, asynchronous directional patterns are not optimal for speech intelligibility. However, until recently, it was not possible to take advantage of this knowledge, as directional modes are typically locked at the time of hearing-aid fitting. Device-to-device communication in ReSound's hearing aids has now made it possible to solve this dilemma. Thirty-nine test subjects participated in speech intelligibility tests comparing a binaurally-switching directional algorithm to a fixed, asynchronous directional mode. The results show that the binaurally-switching algorithm yields better speech intelligibility than the fixed mode. The results of Hornsby & Ricketts (2007) are therefore confirmed for ReSound's binaural, real-time directional switching implementation.

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P.24 – Thu 29 Aug, 17:00-19:00

HRTF adaptation and pattern learning

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The human ability of spatial hearing is based on the anthropometric characteristics of the pinnae, head, and torso. These characteristics are changing slowly over the years and therefore it is obvious that the hearing system must be adaptable to some degree. Researchers were already able to measure this effect, but still there are many open questions like the influence of training time and stimuli, level of immersion, type of feedback, and inter-subject variances. With head related transfer function (HRTF) adaptation it might also be possible to increase the plausibility of acoustical scenes over time. When measuring adaptation effects in a spatial hearing test it is important to distinguish between conscious pattern learning and perceptive adaptation. To increase the quality of virtual auditory display the amount of perceptive adaptation is of major interest. In a foregone spatial listening test high training effects could be observed within a short period of training. To investigate the different types of training a second listening test is conducted. The remembering of timbre leads to pattern learning and is therefore altered HRTF independently in the second test. The results are compared to the previous findings and give further insights into the topic of perceptive adaption of HRTFs.

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P.25 – Wed 28 Aug, 17:00-19:00

Horizontal localization with pinna compensation algorithm and inter-ear coordinated dynamic-range compression

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Hearing aid users can demonstrate poorer aided than unaided localization performance even when audibility is accounted for. One source of potential disruption of aided localization include time varying hearing aid processing at the two ears, which can compromise the interaural level difference (ILD) cues used for left-right localization. The natural ILD cues can be restored by coordinating the gain between the two hearing aids wirelessly. Another potential source of disrupted localization include the absence of pinna-shadow when using behind-the-ear (BTE) hearing aids with an omnidirectional microphone. A pinna shadow compensation feature that restores the natural attenuation for sounds originating from behind was developed. This study examined the localization performance of hearing impaired listeners in the horizontal plane when using a BTE hearing aid incorporating inter-ear coordinated compression and a pinna-shadow compensation algorithm. Fifteen participants were provided with a regimen of computerized take-home and in-laboratory localization training. The data demonstrated that the use of pinna-shadow compensation algorithm improved the localization accuracy over a BTE hearing aid with an omnidirectional microphone. A modest improvement in localization performance was measured for some listeners when using the coordinated inter-ear compression.

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P.26 – Thu 29 Aug, 17:00-19:00

Assessment, modeling, and compensation of inner and outer hair cell damage

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Reduced temporal fine structure (TFS) sensitivity is proposed to accompany cochlear hearing loss even if audibility and loudness perception are compensated for by hearing aids, or can be present elderly listeners with unremarkable audiometric thresholds. In both cases, inner hair cell (IHC) damage or neuronal degeneration of subsequent stages can be assumed to play a role. To investigate psychoacoustic measures for assessment of IHC loss, random frequency modulation (FM) detection thresholds in quiet and in background noise were collected for six young NH listeners, six older NH listeners, and eleven HI listeners. Two possible detection mechanisms based on phase-locking and amplitude modulation (AM) were assessed in a probabilistic, "spiking" auditory model [Meddis, J Acoust Soc Am 119, 406 (2006)]. IHC and outer hair cell (OHC) damage were incorporated and adapted to predict the psychoacoustic data. The resulting hearing impaired (HI) model was then used to simulate the auditory nerve (AN) response in aided conditions with an improved model-based dynamic compression algorithm [based on Ewert and Grimm, ISAAR, 393 (2011)]. Comparison to simulated normal-hearing AN responses revealed partial compensation of OHC damage while IHC damage resulted in supra-threshold "internal noise" which might contribute to the limited benefit from compensation strategies in hearing aids.

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P.27 – Wed 28 Aug, 17:00-19:00

Validation of a spatial speech-in-speech test that takes signal-to-noise ratio (SNR) confounds into account

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Adaptive speech-reception threshold (SRT) measures are popular, but the unbounded nature of the SNR at which the SRT is achieved often leads to a wide spread in SRT. This has the possibility of causing SNR confounds which may lead to faulty conclusions. In this study, a test protocol based on the Danish hearing in noise test (HINT) was devised including "SRT manipulators" (word/sentence scoring, female/male masker talkers, target-masker spatial separation), with the purpose of shifting individual SRTs towards a chosen target. The test also optionally includes target location uncertainty as a means of increasing the ecological validity of the test. For the validation, a within-subject comparison was made between two hearing-aid settings: linear and fast-acting compression limiting. This was chosen because compression is known to either increase or decrease SNR at the output of the hearing aid, depending on the input SNR – a clear SNR confound. 26 hearing-impaired listeners took part. Depending on performance in a common baseline condition, listeners were assigned to either a low or a high SRT target group. Adequate SRT manipulators were then individually selected and testing was completed with both adaptive-SRT and fixed-SNR paradigms. The results of this experiment will be presented and the validity and reliability of the proposed test will be evaluated.

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P.28 – Thu 29 Aug, 17:00-19:00

Yes they can! Hearing aids' induced plasticity in the elderly

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We tested whether a few weeks of hearing aids use in elderly hearing impaired subjects may induce plastic changes in the auditory nervous system. 36 hearing impaired elderly subjects (ages 64-88) were fitted with bilateral hearing aids, either simultaneously or sequentially. Unaided performance was evaluated in dichotic listening and speech in noise at pre-test and after 4, 8 and 14 weeks of hearing aids use. In addition 10 controls were similarly evaluated but were not fitted with hearing aids. In the study group, the dichotic listening scores improved significantly in the non-dominant ear by 8 weeks and onwards. Significant improvements were also observed for speech perception in noise with some gains apparent after 4 weeks of hearing-aids use. There were no significant differences between the effects of the fitting protocols nor was there a time by group interaction in either task. No gains were observed in the control group. These findings suggest that hearing aids use can induce changes in the way elderly people process auditory inputs in binaural tasks such as speech perception in noise and dichotic listening. We propose that these changes indicate behaviorally relevant neuronal plasticity in the elderly central auditory system.

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Evaluation of a frequency lowering hearing instrument algorithm using a non-inferiority test

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The primary goal of hearing instrument verification is to demonstrate an improvement on a relevant outcome. It is not prudent to implement an algorithm that improves one outcome while simultaneously degrading another. A traditional test typically uses a superiority hypothesis – H0: New=Conventional and H1: New≠Conventional. The absence of statistical significance may be interpreted incorrectly as an absence of clinically relevant differences. An alternative is to start the test with a non-inferiority hypothesis – H0: New<Conventional and H1: New≥Conventional. Cross-over designs are often employed because treatment differences are frequently measured within a subject rather than between subjects. Each test period should be long enough for the subject to become acclimatized to each processing change. With these conditions, it is possible to estimate, with the same test, the overall effect of the developed feature and also the period effect. The method of using a cross over design with a non-inferiority analysis was applied in the testing of a new frequency lowering algorithm. Improved high frequency functional gain and fricative discrimination was observed. Significant non-inferior SSQ scores between the processing on and off were seen while no period effect was found. These results provide a good approximation of “real world” acceptance.

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A simplified measurement method of TMTF for hearing-impaired listeners

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To measure the ability of temporal resolution with hearing-impaired listeners, a simplified method of temporal modulation transfer function (S-TMTF) was proposed. Usually, peak sensitivity and 3 dB cutoff frequency of TMTF are calculated from first-order Butterworth filter with several psychophysical data. On the one hand, S-TMTF can derive peak sensitivity and 3 dB cutoff frequency with two psychophysical data which are threshold of modulation index (dB) at 8 Hz (MI8) and threshold of modulation frequency (Hz) at half of MI8 (dB). To investigate the accuracy of S-TMTF, two indexes were compared with TMTF with normal and hearing impaired subjects. Result showed that (1) two index using S-TMTF were significantly correlated with TMTF on normal and hearing impaired subjects, (2) peak sensitivity of S-TMTF tended to be higher than TMTF because threshold of modulation index at 8 Hz was highest among other thresholds up to 16 Hz on TMTF on most of normal and hearing impaired subjects, in spite of previous report which showed that there were little difference among each thresholds at up to 16 Hz, and (3) measurement time of S-TMTF was 10 minutes and could be shortened to 1/4 times that of TMTF on normal and hearing impaired subjects. S-TMTF would be applied to the clinical diagnosis of hearing impairment.

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P.31 – Wed 28 Aug, 17:00-19:00

Prosody perception by postlingually-deafened cochlear implant recipients: perhaps plastic but not fantastic

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Due to the inherent device limitations of cochlear implants (CI) and to auditory perception via an electrical-neural interface the ability of CI listeners to perceive prosody is often reported as being worse than that of normal hearing listeners. We tested the perceptual ability of post-lingually deafened adult CI listeners with stimuli where prosodic features signaled distinctive semantic contrasts. These contrasts were tested with a Danish (n=18) and a Swedish (n=20) cohort in quiet and in noise. We also tested other auditory perceptual abilities that could influence prosody perception. These included sentence perception in noise with the Danish HINT, vowel identification within the constricted Danish vowel space, and discrimination thresholds for voice pitch, intensity, duration and vowel quality. A separate study investigated the perception of stress via modifications of intensity and voice pitch. Regression analyses showed that the discrimination threshold for intensity and the speech in noise results were linked to prosodic identification. The performance relationships between the tasks investigated in these studies contribute to an understanding of the receptive communication ability of CI recipients and the results provide language-specific data.

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Model-based loudness compensation for broad- and narrow-band signals

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Loudness is a fundamental percept that can be assigned to any stimulus and is one of the key factors related to overall satisfaction with hearing aids. About 20% of the hearing-aid users still mention to be dissatisfied particularly with loud sounds. A fundamental problem when attempting to restore loudness perception in hearing impaired listeners are differences in the loudness perception of narrow- and broadband sounds when compared to normal-hearing listeners. Here, a multi-band dynamic compression algorithm is presented that considers different target gains per band required for narrow- and broad-band signals. The goal is to restore loudness perception independent of signal bandwidth, accounting for absent or residual spectral loudness summation. The algorithm applies the desired gain according to the signal-to-masking ratio (SMR) which measures the masking effect of other bands on the current band. The SMR can be used as a measure of the bandwidth of the signal. Loudness perception was assessed by categorical loudness scaling for different signal bandwidths. The proposed algorithm was compared to classical gain prescription rules for a variety of narrow- and broad-band signals (noise and speech) and hearing losses, using a recent loudness model [Chen et al., Hear. Res. 282, 69 (2011)]. The algorithm shows advantages in conditions with different signal bandwidths.

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P.33 – Wed 28 Aug, 17:00-19:00

The neurocognitive development of speech perception after cochlear implantation: a longitudinal EEG study

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We monitored the development of speech perception in postlingually deafened patients after CI implantation. Behavioral measures and EEG recordings were performed 5 times from immediately after CI activation to 6 months later. A linear improvement of speech perception indicated by behavioral tests was seen across sessions. EEG components as the N1 and the mismatch negativity (MMN) were present from right after CI activation. The N1 was generated in frontal and bilateral temporal regions. An increase of activity over time was seen in areas encompassing left inferior-frontal and superior-temporal regions. The MMN was generated bilaterally in frontal and temporal areas as well as right hemispheric occipital regions. Other than in the N1, its strength increased during the first 4 weeks and decreased until 6 months later. Four weeks after CI activation speech perception correlated with high cross-modal co-activation of visual and auditory regions. This changed 5 months later when better speech perception was seen in those patients showing stronger activity in auditory regions. Overall the N1 was a better indicator of speech perception than the MMN during very early phases of rehabilitation. While high cross-modal co-activation seems important during the very early phases of rehabilitation, successful regaining of speech perception is marked by pure auditory activity.

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Examination of the learning effect with the Dantale II speech material

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This study examines the learning effect when using the Danish speech material Dantale II to determine the speech reception threshold (SRT) in noise under different test conditions. The learning effect is shown by an improvement of the test result, i.e., by a decrease in the value of SRT at repeated measurements until a certain number of measurements had been made. A listening test was performed with 24 normal-hearing subjects. The purpose of the test was to investigate the influence of the target level on the learning effect in an open-set test format, where the subject's task is to orally repeat as much as possible of the sentence just presented. The target level was set to 50% and 80% correctly understood words, respectively. Furthermore, it was investigated whether using a closed-set test format affects the learning effect. In the closed-set test format the subject had, for each word presented, to select a response from ten alternative words. Statistical analysis of the test results showed no significant difference in the learning effect between either the two target levels or the different test formats.

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P.35 – Wed 28 Aug, 17:00-19:00

Informational masking in speech intelligibly tests

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It is often challenging to separate speech from a noise – especially for hearing-impaired listeners. A particular difficult listening situation is when speech is obscured by speech from one or more simultaneous talkers. The purpose of this study is to investigate the effect of informational masking on the speech reception threshold (SRT) and to compare the obtained SRT values with subjective data from the SSQ questionnaire. A listening test was performed with 20 normal-hearing and 20 hearing-impaired subjects. The subjects were presented to the sentences from the Danish speech material Dantale II in four different speech-shaped interfering noises. The noise signals represented i) an almost stationary noise, ii) more simultaneous talkers, iii) two simultaneous talkers, and iv) a single talker. The listening test shows that the three noise signals representing one or more talkers perform better than the almost stationary noise signal, when the task is to distinguish between subjects with different abilities to understand speech in noise. The test-retest reliability was found to be the same for the four noise signals. The SRT values for the four noise signals did not correlate with data for specific questions from the SSQ questionnaire.

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Articulation place, voicing, and setting affect the spatiotemporal distribution of speech processing

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Speech discrimination is based on both spectral and temporal acoustic cues. Processing of consonants discriminated by spectral and temporal cues was compared in humans in different settings, using scalp-recorded brain potentials and their estimated source distributions. Subjects were presented with pairs of vowel-consonant-vowel utterances (VCV) along a temporal or spectral continuum. Brain potentials included onset- and consonant-evoked components P50, N100, P200 with an overlapping sustained negativity. While responses to the onset vowel were the same across discriminations and settings, the consonant-evoked latencies, mostly P1cv and N1cv, were sensitive to voice-onset time and experimental settings. Spatiotemporal distributions of brain activity to consonants varied between spectral and temporal discriminations, and depended on the context in which discrimination was performed, i.e., in temporal, spectral, or mixed settings. The highest magnitude of activity was in the auditory areas. P1cv was sensitive to place of articulation (spectral changes), voicing (temporal changes), and setting. N1cv to the very same acoustics (e.g., /ubu/) was larger in spectral than in temporal discrimination and largest in the mixed setting. Processing of VCV is sensitive to the type of acoustic cues and is associated with different brain distributions that are modulated by listening circumstances.

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Factors behind the “cleaning” of the auditory pathway in late implantation of prelingual oral deaf adults

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Pre- and peri-lingually deaf adults are benefiting from late cochlear implantation. While much has been written about the emotional experiences, we review auditory plasticity based on 16 months of CI usage by the first author. We suggest that the goal of speech discrimination in quiet via bimodal hearing may accrue from some or all of the following: 1) amplification of low frequency sounds since infancy, 2) usage of residual hearing via parent-child interaction in auditory training, 3) improved synaptic contact via spike activity from high stimulation rates fused with natural firing from residual hair cells, 4) exposure to singing and music as infants, 5) top-down linguistic processing, 6) reduced cognitive loading, 7) episodes of sleep-induced tinnitus-like symptoms after a period of intense auditory exposure, 8) auditory exposure throughout the day, 9) based on inference of imaging scans of 5 oral deaf adults, the distribution of the gray matter cortical thickness of Heschl’s gyrus (HG) as well as the spatial topography of the acoustic radiation white matter tract from the thalamus to the HG appear to be maintained, and 10) auditory training for bottom-up phoneme processing and auditory working memory. On the last issue, we discuss concerns about the lack of support from insurance companies and regulatory bodies in the US and UK respectively.

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Modeling auditory evoked brainstem responses to speech syllables: Can variations in cochlear tuning explain argued brainstem plasticity?

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Hornickel et al. (2009) and Skoe et al. (2011) measured and analyzed auditory brainstem responses (ABRs) to the synthetically created syllable-stimuli /ba/, /da/ and /ga/, in normal and learning-impaired children. They reported a co-variation between the differences in average phase lag between the three syllable-evoked responses (called average phase-shifts), and speech-intelligibility performance (used as a predictor for learning-impairment). Due to the reported normal peripheral hearing of both groups it was argued that this co-variation was evidence for neural differences in the brainstem, arising from neural plasticity. Thus it was argued that the brainstem can be influenced by cortical structures that would increase the difference between syllable responses. This study further developed an ABR model capable of simulating responses to a variety of stimuli. The model was used to investigate whether the variations in the auditory periphery could be another possible explanation for the decreased average phase shifts observed for the learning-impaired children. Specifically, by changing the cochlear tuning of the model and evaluating the simulations based on models with broad versus sharp tuning (yet keeping tuning estimates and wave-V latencies within “normal” bounds), it was observed that broader tuning systematically leads to smaller phase-shifts between the syllable-evoked ABRs.

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P.39 – Wed 28 Aug, 17:00-19:00

Population coding of auditory space is modulated by attention in human cortex

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Sound source location is represented in the auditory cortex with a population code. This code is implemented by two opponent populations of neurons, one tuned to the left and the other to the right hemifield of auditory space. The spatial tuning curves of these neurons are wide and the steepest slope of the curves coincide with sound source locations directly in front. This slope is believed to provide the best discrimination between locations in front. The goal of the present study was to find out whether the population code is modulated by spatial attention. We performed magnetoencephalography (MEG) recordings during which subjects directed their attention to sounds either in a lateral or in a central location. Spatial selectivity of the auditory cortex was evaluated with a stimulus-specific adaptation paradigm. We found that spatial attention influenced neural selectivity when attention was directed to a lateral location but not when attention was directed to front. Our results could be explained by the wide tuning curves shifting so that the steepest slope would fall nearer to the lateral direction of attention. However, when attention is directed to front no change would take place as the slope providing the best discrimination is already targeted there.

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P.40 – Thu 29 Aug, 17:00-19:00

Effects of NAL-R on consonant-vowel perception

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Two consonant vowel (CV) identification experiments in masking noise (4 SNRs) with 16 hearing impaired (HI) subjects and two different gain conditions were administered. In the flat-gain (FG) experiment listeners were able to adjust a uniform gain to their most comfortable listening level (MCL). In the other experiment also using MCL, a spectral emphasis according to the subject's hearing loss based on the revised prescriptive procedure of the National Acoustic Laboratory Australia (NAL-R) was given. MCL testing is contrary to the common approach of adjusting the level depending on the pure tone (PT) thresholds and the long term average speech spectrum (LTASS). The data, however, provide an argument that our MCL-approach is justified. It is further justified because firstly the LTASS is irrelevant for CV perception. CV cues are found to be bursts, whereas the LTASS is dominated by formant energy. Lastly, CV perception is binary, either the cue can be heard or not, PTs cannot characterize the audibility of the cues. Further, the effectiveness of NAL-R for CV perception is investigated. The average error went down from 20.1% (SD=3.7) to 16.3% (SD=2.8). However, a more detailed analysis revealed that in 19% of the cases NAL-R increased the error. In 18% of the cases it increased the entropy. In order to evaluate statistically more significant effects of NAL-R, the confusion matrix data was clustered. 6% of the time subjects change from the zero error cluster to a higher error cluster. Their confusions were studied in detail and compared to confusions of other HI and normal hearing subjects under various degraded conditions.

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P.41 – Wed 28 Aug, 17:00-19:00

Sound exposure of opera choir singers

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Professional opera choir singers as well as symphony orchestra musicians are exposed to loud sounds which can lead to hearing loss. Opera choir singers are dependent on auditory neural feedback from their own voice and the exposure from own voice is significantly different from the exposure from other neighbour voices. It is known that exposure from music may lead to hearing loss but the effects on hearing from own voice and other voice exposure is largely unknown. The purpose was to investigate the binaural sound exposure of different opera choir voices (soprano, alto, tenor, and bass) during the performances Mahler symphony No. 8 and Britten War Requiem. Total airborne exposure (LAeq) during performances varied from 94.3 dB (tenor) – 98.1 dB (soprano) during Mahler No. 8 and from 89.8 dB (bas) – 96.0 dB (soprano) during Britten War Requiem. Sound exposure of opera choir singers is high and may be harmful to hearing. A substantial amount of the exposure is singers own voice. However, no study has shown if own voice exposure actually can lead to hearing loss.

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P.42 – Thu 29 Aug, 17:00-19:00

Relationship of frequency-pattern training to speech perception

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Past work shows that discrimination of frequency contours improves with training with ability relating to speech perception. Training regimens typically utilize simple repetition of the discrimination or identification trials. In the current work, the training protocol was based on interactive pattern reconstruction, increasing memory demands to accentuate learning. With either four- or five-tone patterns, the task was to assemble the constituent tones in the correct order. Tones were randomly selected from logarithmically scaled distributions (frequency: 400-1750 Hz, duration: 75-600 ms). In training but not test sessions, listeners were allowed multiple repetitions of the intact pattern to self-correct their interim response. To assess relationship to speech abilities, the same task was used in pre- and post-training measures with the tonal pattern replaced by samples of sinewave speech. Despite training with only tonal patterns, results showed significant improvement in pattern reconstruction for both tonal and sinewave speech stimuli. This finding contrasts with previous training results in which benefits are largely restricted to the training stimulus class. Trends were obtained for improvement in sinewave speech intelligibility between pre and post training with greater relationship between results from intelligibility and pattern-reconstruction conditions post training.

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P.43 – Wed 28 Aug, 17:00-19:00

Adaptation to modified interaural time differences shifts spatial tuning in human auditory cortex

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The auditory system infers the location of sound sources from the processing of different acoustic cues. Recent studies on humans have shown that the auditory system can adapt to altered acoustic cues, but little is known about the mechanism of this adaptation. We equipped 20 participants with binaural digital earplugs that allow us to delay the input to one ear, and thus modify the main cue for horizontal sound localization, interaural time differences. Participants were asked to wear the earplugs during all waking hours for 7 days, while engaged in day-to-day activities. Their ability to localize sounds with the earplugs was tested every day. High resolution fMRI scans centered on the auditory cortex were performed before and after each participant wore the digital plugs. Results show that our participants rapidly adapt to the perceptual shift induced by the earplugs and indicate that a change in spatial tuning of portions of auditory cortex has occurred during the adaptation period.

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P.44 – Thu 29 Aug, 17:00-19:00

Systematic groupings in hearing impaired consonant perception

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Auditory training programs are currently being explored as a method of improving hearing impaired (HI) speech perception; precise knowledge of a patient's individual differences in speech perception allows one to more accurately diagnose how a training program should be implemented. Re-mapping or variations in the weighting of acoustic cues, due to auditory plasticity, can be examined with the detailed confusion analyses that we have developed at UIUC. We show an analysis of the responses of 17 ears with sensorineural hearing loss to consonant-vowel stimuli, composed of 14 English consonants followed by the vowel /a/, presented in quiet and speech-shaped noise. Although the tested tokens are noise-robust and unambiguous for normal-hearing listeners, the subtle natural variations in signal properties can lead to systematic differences for HI listeners. Specifically, our recent findings have shown token-dependent individual variability and concentrated errors in HI consonant perception. A clustering analysis of the confusion data shows that HI listeners fall into specific groups. Many of the confusions that define these groups can also be observed for normal-hearing listeners, under higher noise levels or filtering conditions. These HI-listener groups correspond to different acoustic-cue weighting schemes and indicate where auditory correction or training may be useful.

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P.45 – Wed 28 Aug, 17:00-19:00

Degradation of spatial sound by the hearing aid

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It is well known that the hearing aid distorts the spatial cues used to localize sound sources and this has severe consequences for sound localization and for listening in noise. However, it is not clear how the different components in the hearing aid contribute to the degradation of spatial sound. In this study we investigate how the spatial sound is degraded by four hearing aid components: 1) the microphone location, 2) the directionality (beamforming), 3) the compressor, 4) the real ear measurement. Head-related impulse responses from an artificial KEMAR head are convolved with appropriate excitation sounds and processed through the respective hearing aid algorithm. The performance metrics under investigation are: 1) interaural level difference (ILD), 2) interaural time difference (ITD), 3) monaural spectral cues. It is found that the main source for ILD degradation is the position of the microphone around the pinna which distorts the ILD by up to 30 dB. It is also found that the real ear measurement compensation severely affects the monaural spectral cues.

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P.46 – Thu 29 Aug, 17:00-19:00

Influence of noise reduction on listening effort, measured with response time to digits in noise

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Hearing aid features can be experienced as beneficial even if they do not have a measurable effect on speech intelligibility scores. For example, single-channel noise reduction is often preferred by hearing-aid wearers, while it does not improve speech scores. We hypothesized that this is caused by an improvement in listening effort. The purpose of the current study is to measure the effect of noise reduction on listening effort, using response times to digits in noise at SNRs where speech intelligibility has reached ceiling. We added various amounts of stationary noise to spoken digit triplets to obtain four different SNRs, and processed those stimuli with two noise reduction schemes: ideal binary masking and a minimum mean square error estimator. All stimuli were used in a response time experiment with two different tasks. In the first task, participants had to quickly identify the last digit of a triplet ("identification"). In the second task they had to quickly add the first and the last digit ("arithmetic"). Twelve normal-hearing subjects participated in this study. In the arithmetic task, at all SNRs, both noise reduction algorithms reduce the response time. In the identification task, no or less effect of noise reduction is found. Using the more complex task, it might be possible to investigate the influence of noise reduction on listening effort.

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P.47 – Wed 28 Aug, 17:00-19:00

Central auditory processing in older adults: age and temporal resolution

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Auditory temporal resolution refers to the ability of an individual to detect differences in the duration of auditory stimuli and in the time intervals between auditory stimuli over time. Temporal resolution is one of the underlying components of central auditory processing (CAP) capabilities. The purpose of the present study was to evaluate the effects of advancing age on 2 components of CAP: temporal resolution and speech understanding in noise. Temporal resolution was investigated using the gaps in noise (GIN) test. Results of the GIN test were compared with the ability to understand monosyllables in a stationary noise (NVA). Young and older adults were tested. Results demonstrated that the older adults have significantly worse temporal resolution scores compared to the younger. The older adults also showed to have significantly more difficulty understanding monosyllables in noise. Results from the GIN test did not correlate with the results of the speech recognition in noise test. The present study shows declining effects of age on both temporal resolution and speech understanding in noise. But results show that declining temporal resolution with age is not clearly reflected in the ability to understand speech in stationary noise. Using modulated noise might be a better way to show the decline, because in modulated noise deteriorated temporal resolution is more prominent.

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P.48 – Thu 29 Aug, 17:00-19:00

What can can we learn from children with cochlear implants on sensitive periods for language?

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This study examined lexical retrieval processes as a possible underlying language mechanism responsible for language deficits in some children with cochlear implants (CIs). Lexical retrieval processing was examined using phonological and semantic verbal fluency (VF) naming tasks. In the VF tasks, children were given one minute to generate as many words as they can that begin with a given sound (/t/, /l/, /f/) or that belong to a certain semantic category (animals, food). Twenty children with CIs and twenty age- and IQ-matched normal hearing children aged 7-10 participated in this study. Children with CIs generated fewer words on the VF tasks. In addition, qualitative differences were found in the performance of the two groups on these tasks. Children with CIs seem to process words at a slower rate compared to NH children. Age at implantation was significantly correlated with performance on the semantic part of the VF task. Younger implanted children performed better (named more words) on the semantic VF task. These correlations might suggest that early implantation is advantageous for certain aspects of lexical performance. Taken together the data support recent work suggesting that the development of certain aspects of language may have an earlier sensitive period than other linguistic skills.

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P.49 – Wed 28 Aug, 17:00-19:00

Effects on perception of auditory illusions

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It has always been a goal to produce acoustic systems that create perfect auditory illusion. Great progress has been made in the development of audio systems such as ambisonics, wave field synthesis, and binaural reproduction. This contribution introduces context dependent quality elements, which have significant influence on perception. Binaural synthesis of an acoustic scene via personalized headphone system is used. The investigated elements are divergent between synthesized scene and listening room, visibility of the scene, and personalization of the system. Two rooms with different acoustic parameters are used as recording and listening room. The test persons listen either to the same room as the listening room or to the other room. The plausibility of the perceived auditory scene is described by the probands with the help of the parameters angle of incidence and perceived externality of the sound event. Because it is unknown if the relevant quality elements are acoustically or visually based two groups of test persons are used. The first group has no visual cues (dark room), while the second group sees the synthesized source positions and listening room. We have found significant differences in localization and perceived externality depending on the synthesized and listening room, on the two groups, and on personalization of the system.

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P.50 – Thu 29 Aug, 17:00-19:00

Generalization resulting from training on a SAM-detection task to a SAM-rate discrimination task with different depths

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Information is carried in speech and sounds both in subtle amplitude and frequency variations over time. Hearing impaired people have a reduced ability to detect these cues, particularly in challenging auditory environments. Any improvements in these perceptual tasks, through for example auditory training, could help to alleviate some of these difficulties. It is known that practice can improve the detection threshold for amplitude modulation (AM) in sound stimuli. A recent study (Fitzgerald and Wright, 2011) demonstrated such training to detect sinusoidal amplitude modulation on a narrow band carrier. In particular, they looked at how training in one condition can generalise to other stimulus conditions or across psychophysical tasks – i.e., from AM detection to AM rate-discrimination. The training in rate detection was shown to generalise to improve detection thresholds with untrained rates, but not to generalise to detection with different carriers or to rate discrimination with the trained rate and carrier spectrum. This present study hypothesises that the lack of generalisation from AM detection to rate-discrimination, was due to the use of 100% AM depth in the rate discrimination task. This present study aims to investigate if it is possible to improve the generalization of AM detection to rate discrimination by using lower AM depths in the discrimination task.

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P.51 – Wed 28 Aug, 17:00-19:00

Across-electrode processing in CI users: a strongly etiology dependent task

Stefan Zirn*, John-Martin Hempel, and Maria Schuster *- Department of Otolaryngology (ENT)/ Head and Neck Surgery, University Medical Center of the Ludwig-Maximilians-University Munich, München, Germany*
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To investigate across-electrode processing in cochlear implant (CI) users, we established an experimental setup that allows measuring comodulation masking release (CMR) using controlled electrical stimulation of auditory nerve fibers. In a recent publication (Zirn et al., 2013) we presented results concerning a CMR flanking band type of experiment with uncorrelated (UC) vs. comodulated (CM) masker components. In this investigation we extended the test setup and compare a narrow-band (NB) versus a wideband (WB) electrode setup. Results of eight test subjects revealed a slight decline of CMR(UC-CM) in the NB (3.2 dB±4) compared to the WB condition (2.8 dB±3). However, the decline was not significant (Wilcoxon signed-rank test: p=0.6). CMR magnitudes varied strongly across test subjects. Whereas five CI users showed no or small CMR, three exhibited considerable magnitudes. The largest individual CMR(UC-CM) was 8.7 dB (NB) and 7.7 dB (WB). Interestingly, in the three CI users exhibiting considerable CMR magnitudes, no systematic decline of the effect from NB to WB was observed. As already pointed out in our former publication, pre-implantation etiology was again a good indicator for remaining individual CMR capabilities. [Zirn et al. (2013). Comodulation masking release induced by controlled electrical stimulation of auditory nerve fibers. Hear Res, 296, 60-66.]

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ISAAR 2013

"Auditory plasticity – Listening with the brain"

Programme addendum

Programme changes

Abstract P.15 is withdrawn.

The following posters are added to the programme:

P.15 – Wed 28 Aug, 17:00-19:00

Music enjoyment and listening habits in Danish adult cochlear implant users

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Cochlear implant (CI) users differ significantly from their normal hearing peers when it comes to perception of music. Several studies have shown that structural features – such as rhythm, timbre, and pitch – are transmitted less accurately through an implant. However, we cannot predict personal enjoyment of music solely as a function of accuracy of perception. But can music be pleasant with a cochlear implant at all? Our aim here was to gather information of both music enjoyment and listening habits before the onset of hearing loss and post-operation from a large, representative sample of Danish recipients. 163 adult CI users (101 females, 62 males) completed a survey containing questions about musical background, listening habits, and music enjoyment. The results indicate a wide range of success with music, but in general, the results show that the respondents enjoy music less post-implantation than prior to their hearing loss. 19% of the CI users indicated only little satisfaction in music listening after implantation. However, a large majority of the sample were optimistic, indicating that hearing music through a cochlear implant, although not perfect, was preferable to not hearing music at all (37%) or even as or more pleasant than before (44%).

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P.52 – Thu 29 Aug, 17:00-19:00

The amount of neurons, rather than the strength of the response, accounts for a noise-induced imbalance between excitation and inhibition in the inferior colliculus

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Excessive noise exposure is known to produce an auditory threshold shift, which can be permanent or transient in nature. Recent studies show that temporary threshold shifts are associated with permanent peripheral pathologies, such as degeneration of the cochlear nerve. This suggests that central auditory processing may also be abnormal, despite normal auditory thresholds. We recorded changes in stimulus-driven activity in the inferior colliculus at several time points following exposure to an 11-kHz pure tone of 124 dB SPL. Hearing thresholds were elevated immediately following overexposure, but recovered within one week. Despite rapid normalization of auditory thresholds, the balance between the amount of excitatory and inhibitory responses to a range of pure tones remained abnormal up to two weeks. Rate differences during both excitation and inhibition changed with a similar magnitude following overexposure. Therefore, the amount of units, rather than the strength of the response, accounted for a noise-induced imbalance between excitation and inhibition. Our findings may be associated with neural mechanisms of temporary tinnitus and hyperacusis after noise-induced transient threshold shifts.

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P.53 – Wed 30 Aug, 17:00-19:00

The effects of transcutaneous vagus nerve stimulation on alpha activity in tinnitus patients and controls

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It has been suggested that vagus nerve stimulation (VNS) could induce plasticity of the auditory system and reverse symptoms related to tinnitus. Studies involving electro- and magnetoencephalography (EEG, MEG) have revealed a connection between tinnitus and reduced alpha activity (8-12 Hz) over the temporal and frontal areas. Analyzing ongoing brain activity in the presence of simultaneous electrical stimulation is challenging due to interference caused by the stimulator. We examined the effects of transcutaneous VNS (tVNS) on ongoing brain activity from artifact-corrected MEG data in tinnitus patients (N=8) and normal-hearing control subjects (N=8). Normalized power spectra were calculated for different brain regions and the relative alpha band power was compared between 'tVNS on' and 'tVNS off' conditions. TVNS was applied continuously for 6 minutes at 25 Hz to the subject's left tragus. The tVNS-related artifact was removed from the MEG data with the spatiotemporal signal space separation (tSSS) algorithm. The results showed a decrease in the alpha activity over the right frontal area in the control group and a tendency towards a decrease in alpha activity over the left frontal area in the tinnitus group. Frontal areas have been linked to the emotional aspects of tinnitus and using tVNS to modulate frontal activity could provide a way for intefering with this part of the tinnitus network.

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