Technical University of Denmark

NEWSLETTER

HEARING SYSTEMS IN PROFILE

September 2020

HEARING SYSTEMS

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Photo: Coulorbox

Attention decoded from brain activity of elderly hearing-impaired people

Researchers from Hearing Systems at DTU Health Tech have developed techniques to decode attention from brain activity of elderly hearing-impaired listeners. The results show promise for the development of future neuro-steered hearing instruments.

Hearing-impaired patients and hearing-aid users suffer from difficulties understanding speech in noisy environments with many talkers. Normal-hearing listeners can navigate complex acoustic environments by focusing their attention on one speaker and ignoring background sounds. To restore this ability for patients with hearing loss, the hearing instrument must know what sounds the listener is trying to attend to.

In a new paper, Søren A. Fuglsang and colleagues showed that attention can be decoded from only 10 seconds of EEG data recorded from the scalp of hearing-impaired listeners. Elderly listeners with hearing loss and normal-hearing controls were presented with competing talkers and asked to focus attention on one of them. By reconstructing the speech audio from the neural EEG recordings, the authors were able to identify an enhancement of the attended signals in both groups. The authors also report that hearing loss paradoxically enhances brain responses to sound, suggesting that the brain compensates for the loss of sensitivity at central stages of the auditory system.

Senior Researcher Jens Hjortkjær concludes: 'With these findings, we have increased our knowledge about the consequences of hearing loss in the brain, but also taken a step towards a potential new form of hearing-aid technology.' The results are published in the Journal of Neuroscience. Read the article here

News

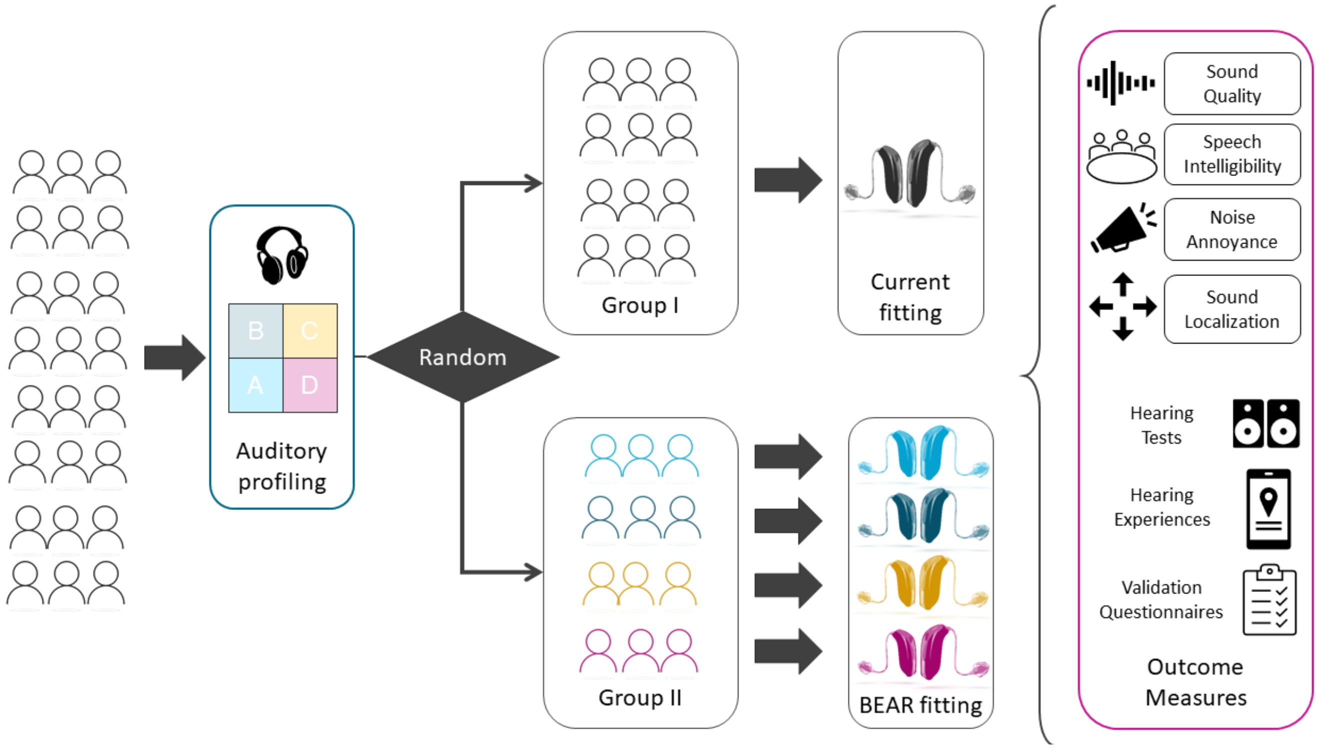


Illustration: Raul Sanchez-Lopez

Better Hearing Rehabilitation project (BEAR)

In August, the BEAR project moved into a new phase with a large-scale study at Odense University Hospital and Aalborg University Hospital. Two randomized groups of patients will participate in the study. One group will receive the standard treatment as it is applied in Danish audiology clinics today – the other group will go through the new BEAR fitting procedure and treatment.

All patients will be classified into one of four auditory profiles based on the results of the BEAR clinical test battery. These tests make it possible to characterize the hearing deficits in more detail than possible with the audiogram alone. After testing, patients from all four profile groups are randomly assigned to one of the two treatment groups. In the current treatment group, the hearing-aid fitting is almost entirely based on the pure-tone audiogram, whereas the patients in the BEAR group will receive a treatment that is adapted to their specific auditory profile. This fitting procedure goes beyond amplification and involves the adjustment of advance hearing features, such as directional filtering and noise reduction.

After the hearing-aid fitting, the aided performance of each patient will be evaluated with new techniques developed in BEAR. In the clinic, a test battery will be applied to measure the quality of the hearing-aid fitting with respect to speech intelligibility, sound quality, noise annoyance, and localization. Outside of the clinic, an online reporting system will be applied to capture the experiences of each patient. All patients will be encouraged to identify and regularly report the positive and negative experiences that they have in their daily life with their new hearing aids.

The BEAR project, supported by Denmark's Innovation Foundation and coordinated by Aalborg University (AAU), represents a close collaboration between AAU, Syddansk Universitet (SDU), DTU, the University Hospitals in Aalborg, Odense and Copenhagen, the industrial partners Oticon, GN Hearing and WS Audiology as well as Force Technology.

Read more about BEAR here.

News

The new North Wing at Rigshospitalet is opening up now for both patients and research activities in September. Photo: Adam Mørk.

Opening of Copenhagen Hearing and Balance Centre

On September 7, the Copenhagen Hearing and Balance Centre (CHBC) has opened up for audiology staff at Rigshospitalet, Copenhagen. The following week, on September 14, the center opens up for patients. The new center will be an international beacon in research and treatment of both hearing and balance loss. The center is located in entrance 8, where it will be distributed on the third and fourth floors.

CHBC is part of the Department of Ear, Nose and Throat (ENT) & Audiology Clinic at Rigshospitalet. The research collaboration between Hearing Systems and the hospital in connection to CHBC has already been started. New projects will be running when the new clinical research facilities are established. The center is placed in the North Wing, where the researchers will have their offices. The establishment of the center was initiated by Mads Klokker, Head of the Department of Ear, Nose and Throat & Audiology Clinic at Rigshospitalet and supported by, amongst others, a large donation from the William Demant Foundation of DKK 40 millions in connection with a new unique cross-sectional collaboration between the Capital Region of Denmark, the Faculty of Health Sciences at the University of Copenhagen, and DTU.

News

Since the middle of May, our lab facilities have gradually been opening up taking all nescessary precautions. Photo: Eva helena Andersen

Re-opening of the laboratories

Since middle of May, we have gradually been opening up our lab facilities for researchers and test subjects again, taking all precautions to keep everyone involved safe from COVID-19. For instance, we limit the number of people in the lab building, have procedures in place for keeping hands and equipment sanitized, and do not yet invite people who are in the risk group. Due to our focus on hearing loss, there is a particular interest in being able to invite older people again as soon as possible, but we will of course only do so when we can do it safely. We are keeping a close eye on government and university recommendations and regulations as they develop, and look forward to the day when we can be fully up to speed again.

ARCHES 2020

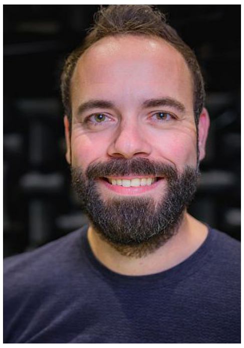
On December 1, members from the Audiological Research Cores in Europe, ARCHES, which is this year arranged by Hearing Systems researchers, will meet in Denmark. ARCHES is a European network of research groups focusing on hearing science, with the aim to stimulate networking, interaction, and scientific collaboration between researchers in the audiological field. There will be a backup plan to make this meeting happen online if the pandemic limits travelling.
More info at www.arches2020.dk .

Staff news

New position at the University of Waterloo, Canada

Ewen MacDonald

After almost 9 years at DTU in Hearing Systems, Ewen MacDonald has moved to Canada to take a faculty position at the University of Waterloo. In addition to having the largest engineering school in Canada, the university also has an excellent international reputation for engineering and computer science. He has joined the Department of Systems Design Engineering, which recently started a biomedical engineering program and takes an interdisciplinary approach to research, including technical, environmental, socioeconomic, and political aspects into the engineering process. In addition to building a new lab and research into speech communication and hearing loss at the University of Waterloo, Ewen aims to continue to collaborate with the Hearing Systems Section.



Associate Professor in speech signal processing and hearing technology

Tobias May

In July 2020, Tobias May was appointed Associated Professor in speech signal processing and hearing technology. Tobias May's main focus is on signal processing strategies to improve the ability of people with hearing impaiment to communicate in challenging acoustic environments. His approach is to combine modern machine learning strategies with concepts from auditory signal processing and perception.

Staff news

Guest Researcher

Eline Borch Petersen

In October 2019, Eline Borch Petersen started as a part-time guest researcher at Hearing Systems. Eline is part of the Scientific Audiology Department at WS Audiology, where she primarily works with electrophysiology. At DTU she is involved in the co-supervision of several PhD and MSc projects.

New Postdoc position at Aalto University, Finland

Petteri Hyvärinen

In October 2019, Petteri Hyvärinen started a postdoc position at Aalto University, Department of Signal Processing and Acoustics, Finland.
From September 2020, he will start another three year position at Aalto. At DTU, Petteri is still a visiting researcher and involved in the Tinnitus Assessment Causes Treatments (TINACT) EU project and in supervision.

PhD defence

Photo: Antoine Richard

On August 14 2020, Raul Sanchez Lopez successfully defended his PhD project "Clinical auditory profiling and profile-based hearing-aid fitting", supported by the Innovation Foundation Denmark through the BEAR project.
The external examiners at the defense were:
Professor Judy R. Dubno, Medical University of South Carolina and Professor Pamela E. Souza, Northwestern University.
The chairman of the examiner committee was Associate Professor Jeremy Marozeau, DTU Health Tech.
Raul Sanchez Lopez started a postdoc position (80%) at Interacoustics Research Unit (IRU) where he is working on the "User-operated audiometry project" (UAud). He is also a part-time postdoc (20%) at DTU Health Tech.

New postdoc project

Augmented reality model of human hearing

Marina Kliuchko

In June, Marina Kliuchko joined Hearing Systems to work on the project "Augmented reality model of human hearing" supported by the William Demant Foundation. The project aims at gathering up-to-date scientific knowledge about the human hearing function and conveying this information to the general public. For that, the project will employ augmented reality technology to help with presenting complex information about hearing and the consequences of its impairment in a way that is easy to navigate and understand. This will help to foster an understanding of challenges faced by hearing-impaired listeners within their social environment and to promote hearing health. The project is supported by the William Demant Foundation.

New PhD projects

Scene-aware compensation strategies for hearing aids in adverse conditions

Niels Overby

Dynamic range compression in hearing aids ensures that quiet sounds are amplified without affecting the loud sounds. The speed of dynamic compression has been an ongoing research field for many years. Fast compression amplifies the quiet speech components, but also the quiet noise components. In the case of slow compression, the overall level is comfortable, but the quiet speech components might be inaudible. In this project, a dynamic range compression scheme is proposed that applies fast-acting compression only to estimated speech segments to increase their audibility and slow-acting to the estimated background sound segments to preserve overall listening comfort. The project is supported by Sonova.

Investigating novel pulse shapes through computational modeling of the neural-electrode interface and psychophysics

Sarantos Mantzagriotis

A major limitation in Cochlear Implantation (CI) is the spread of current excitation induced by each electrode, resulting in poor frequency resolution, dynamic range, and distortion of the original acoustical signal. It is hypothesized that currently used rectangular pulses are far from optimal for maximizing information transmission within the neural-electrode interface.
The project aims at improving musical perception in cochlear implant listeners by revisiting stimulation strategies and pulse shapes. It will investigate this by creating computational frameworks that model neural phenomena at the microsecond scale, collective neuronal behaviour in 3D spanning larger time scales combining psycho-acoustical experimentation for pitch recognition.
The project is supported by the William Demant Foundation.

Perceptual and neural consequences of hidden hearing loss.

Sam Watson

UHEAL ('Uncovering hidden hearing loss') is a large scale collaborative project aiming to confirm the existence of and develop diagnostic tools for 'hidden hearing loss' in humans. While temporary hearing reductions caused by short-term loud noise exposure were not previously thought harmful, it is thought that lasting damage could be done to the afferent synapses connecting to the sensing hair cells; termed synaptopathy. Such consequences were observed in a landmark study in mice. This PhD project aims to aid UHEAL in evidencing synaptopathy in humans, but furthermore to scrutinise the possible neural, perceptual, and behavioural consequences this hidden hearing loss might have.
The project is supported by the Novo Nordisk Foundation.

Other research projects

Binaural speech segregation in noisy and reverberant environments using deep neural networks

Philippe Gonzalez

The recent success of deep neural networks (DNNs) has substantially elevated the performance of speech enhancement systems. Despite this success, the major challenge of learning-based approaches is the limited generalization to unseen acoustic conditions. The goal of this project is to develop a binaural DNN-based speech enhancement system and to systematically investigate the general applicability to unseen room reverberation, unseen interfering noise sources and arbitrary target speaker locations.

Quantitative modeling of subcortical auditory evoked potentials

Miguel Temboury

Computational models of the human peripheral auditory system based on animal physiology have shown potential for significant progress in hearing research. The simulated peripheral responses can be translated into auditory evoked potentials - EEG responses to acoustic stimuli that are measured non-invasively. The goal of this project is to develop a modeling framework that can accurately predict evoked potentials in normal-hearing and hearing-impaired listeners, which could benefit future hearing research and diagnosis of hearing impairment.

The project is supported by the William Demant Foundation.

Master projects

Teresa Maria Clausen-Gallo. Connection between synaptopathy and tinnitus in humans.
Supervisors: Pernille Holtegaard, Gerard Encina-Llamas, Bastian Epp (DTU)

Mercedes Christensen Duvig. Connection between synaptopathy and tinnitus in humans
Supervisor: Pernille Holtegaard, Gerard Encina-Llamas, Bastian Epp (DTU)

Stine Bech Petersen. Computational modelling of electrophysiological responses to speech in hearing impaired listeners.
Supervisors: Jens Hjortkjær, Jonatan Märcher-Rørsted (DTU)

Jan Louis Geerken. Perception of speech and music with individual and non-individual head-related transfer functions. Supervisor: Axel Ahrens (DTU)

Jesper Koch Jensen. The interaction between the tactile and auditory sense created by a bone-conduction actuato.
Supervisors: Maiike Van Eeckhoutte, Jeremy Marozeau (DTU)

Katarzyna Dragun. The effect of binaurally splitting the spectral content of sound on speech intelligibility an spatial perception.
Supervisors: Torsten Dau, Alan Wiinberg WS Audiology, Axel Ahrens (DTU)

Kristinna Højen Olsen. Auralization and virtual reality implementation of multi-talker scenarious with various acoustic reproduction thechniques. Supervisors: Cheol-Ho Jeong, Gerd Marbjerg, Axel Ahrens (DTU)

Michelle Herlufsen. Exploring New Musical Rules for Cochlear Implant Listeners. Supervisor: Jeremy Marozeau (DTU)

Philippe Gonzalez. Binaural speech segregation in noisy and reverberant environments using deep neural networks.
Supervisor: Tobias May (DTU)

Rémi Bernard Nordine Arnoult. Assessing the reproduction of nearby sound sources in virtual sound environments.
Supervisors: Marton Marschall (DTU), Ewen MacDonald (DTU) , Jens Cubick (WS Audiology)

Ingvi Örnólfsson. Localization in the presence of directional interference by humans and machines
Supervisors: Tobias May (DTU), Ning Ma (University of Sheffield), Torsten Dau (DTU)

Publications

(Since February 2020)

Journal papers

McCormack L, Pulkki V, Politis A, Scheuregger O, Marschall M (2020) Higher-order spatial impulse response rendering: Investigating the perceived effects of spherical order, dedicated diffuse rendering, and frequency resolution.
Journal of the Audio Engineering Society 68, 5, p. 338-354

Marozeau J, Gnansia, D, Ardoint, M, Poncet-Wallet, C, Lazard DS (2020) The sound sensation of a pure tone in cochlear implant recipients with single-sided deafness. PLOS ONE 15, 7, 21, e0235504.

Sørensen PM, Epp B, May T (2020) A depthwise separable convolutional neural network for keyword spotting on an embedded system. Eurasip Journal on Audio, Speech, and Music Processing 2020 1, 14 p 10

Kowalewski B, Dau T, May T (2020) Perceptual Evaluation of Signal-to-Noise-Ratio-Aware Dynamic Range Compression in Hearing Aids Trends in Hearing 24, 14

Lamping W, Goehring T,Marozeau J, Carlyon RP (2020) The effect of a coding strategy that removes temporally masked pulses on speech perception by cochlear implant users. Hearing Research. 391, 12 p 107969

Ahrens A, Marschall M, Dau, T (2020) The effect of spatial energy spread on sound image size and speech intelligibility. Journal of the Acoustical Society of America. 147, 3, p 1368-1378

Kowalewski B, Fereczkowski M, Strelcyk O, MacDonald E, Dau T (2020) Assessing the effects of hearing-aid compression on auditory spectral and temporal resolution using an auditory modeling framework . Acoustical Science and Technology. 41, 1, p 214-222

Fuglsang S, Märcher-Rørsted J, Dau T, Hjortkjær J (2020) Effects of sensorineural hearing loss on cortical synchronization to competing speech during selective attention. Journal of neuroscience 40, 12, p 2562–2572

Navntoft CA, Marozeau J, Barkat TR (2020) Ramped pulse shapes are more efficient for cochlear implant stimulation in an animal model. Scientific Reports 10, 1, 17 p 3288

Reveles Jensen KH, Navntoft CA, Hjortdal Sindahl C, Cayé-Thomasen P, Jørgensen MB (2020) Cochlear Implant Should not be Absolute Contraindication for Electroconvulsive Therapy and Transcranial Magnetic Stimulation. Brain Stimulation doi.org/10.1016/j.brs.2020.08.007

Koiek S, Nielsen JB, Kjærbæk L, Gormsen MB, Neher T (2020) A Danish Sentence Corpus for Assessing Speech Recognition in Noise in School-Age Children. Trends in Hearing. doi.org/10.1177/2331216520942392

Lund K, Ordoñez R, Nielsen JB, Hammershøi D (2020) Sentence-based experience logging in new hearing aid users.
American Journal of Audiology, 29(3S) p 631–637

Conference papers

Sørensen LM, Bysted PL, Epp B (2020) Clustering in an array of nonlinear and active oscillators as a model of spontaneous otoacoustic emissions. Presented at the "46. Jahrestagung der Akustik" p 110-113

Wu M, Sanchez Lopez R, El-Haj-Ali M, Nielsen SG, Fereczkowski M, Dau T, Santurette S, Neher T (2020) Perceptual evaluation of six hearing-aid processing strategies from the perspective of auditory profiling: Insights from the BEAR project.
Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 265-272

Fereczkowski M, Dau T, MacDonald E (2020) Comparison of clinical feasibility of behavioural and physiological estimates of peripheral compression. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 429-436

Huisman T, Piechowiak T, Dau T, MacDonald E (2020) Audio-visual sound localization in virtual reality. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 349-356

Hyvärinen P, Fereczkowski M, MacDonald E (2020) Evaluation of a notched-noise test on a mobile phone. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 125-132

Lund KD, Ahrens A, Dau T (2020) A method for evaluating audio-visual scene analysis in multi-talker environments. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 357-364

Bachmann FL, MacDonald E, Hjortkjær J (2020) A comparison of two measures of subcortical responses to ongoing speech: Preliminary results. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 461-468

Sanchez Lopez R, Fereczkowski M, Neher T, Santurette S, Dau T (2020) Robust auditory profiling: Improved data-driven method and profile definitions for better hearing rehabilitation. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 281-288

Sørensen AJM, Fereczkowski M, MacDonald E (2020) Effects of noise and L2 on the timing of turn taking in conversation. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 86-92

Watson S, Sørensen AJM, MacDonald E (2020) The effect of conversational task on turn taking in dialogue. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 61-68

Sørensen AJM, MacDonald E, Lunner T (2020) Timing of turn taking between normal-hearing and hearing-impaired interlocutors.
Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 37-44

Sanchez Lopez R, Dau T, Jepsen ML (2020) Hearing-aid settings in connection to supra-threshold auditory processing deficits. Presented at the 7th International Symposium on Auditory and Audiological Research 2019, 7 p 221-228

PhD Thesis

Raul Sanchez Lopez (2020) Clinical auditory profiling and profile-based hearing-aid fitting

Book Chapter

May T, Kowalewski B, Dau T (2020) Scene-Aware Dynamic-Range Compression in Hearing Aids.
The Technology of Binaural Understanding. Springer, p 763-799