Cognition and Hearing

Sweden has become an important international meeting place for research on hearing and cognition. This summer, experts and researchers from all over the world met for a three-day symposium about Cognitive Hearing Science on Communication.

Experts on cognitive hearing and communication from all over the world gathered in Linköping, Sweden in June this year. Linköping is in many ways a meeting place for researchers from all over the world who work with subjects that concern cognition and hearing, in conjunction with Linköping University and its Linnéus Centre HEAD (Hearing And Deafness). For the second time, the centre organized an International Conference on Cognitive Hearing Science and Communication.

Hearing and the brain

"Within cognitive hearing science we study the brain's role in hearing. So it's not just about the auditory functions of the ear as such, but what happens when the signal has left the cochlea and is on the way up to the cerebral cortex, and above all how the signal is handled by the central, 'higher' levels of the cerebral cortex," explained Jerker Hörnberg, chair of the Scientific Committee at the congress book.

"Age-related hearing loss can have several origins."

In addition to clinicians, audiologists and researchers, the industry was also present to learn about advances and research projects. The Second International Conference on Cognitive Hearing Science for Communication, CHS2013, will be followed by at least a third international conference (when the Linnéus Centre was founded in 2008, a budget for three international conferences, which are unique in this field, was set aside). This second conference was held on 16-19 June at Konserthuset and Kongress in Linköping.

The Talk:

While we cannot present all the speakers and every subject presented at the conference, we can focus more specifically on certain presentations.

Brett Edwards from Starkey Hearing Technologies in Berkeley, California spoke about "Assessing the cognitive benefits of hearing aid technology." Edwards presented the research goal of "understanding the impact of hearing loss and hearing aid technology..."
on: binaural and spatial perception, auditory scene analysis, cognitive load, attention switching and focusing. The approach used was to develop new outcome measures for characterizing the impact of hearing loss and hearing aids, in order to develop technology that will improve the performance on those said measures. Edwards presented the results of two studies, one about “Spatial release of cognitive load” (Xia and Kalluri) and one about “Switching attention” (Xia and Haftel). Edwards and Starkey were able to use the new measures to identify auditory processing challenges that people with hearing loss experience, and to identify whether hearing aid technology improves hearing.

In order to study this, they pioneered the use of a neural metric, the eABR – brainstem response to complex auditory stimulation such as speech syllables. They used eABR to observe slowed “neural timing and increased variability in the brain of older people compared to young adults”. With both software-based auditory brain training exercises and music they saw improvements in listening, processing and memory skills. They observed coincident changes in the neural function. The results point to neural mechanisms behind the aging process and provide us with an objective measure of short and long term training’s effect on the aging brain. Kraus talked about hearing health in adults with music as a model. The investigation she carried out with her colleagues shows that musicians hear speech more easily in a noisy environment than non-musicians. The participants in the study included older adult non-musicians, older adult musicians, and young adults. Results for neural response to noise showed that the musicians did better on all levels, but the difference was biggest for older adults. For speech recognition in noisy environments they did better too. In tests for neural timing, the older adult musicians’ results were closer to the young adults’ results than to older adult non-musicians. The same results were found in other tests, such as neural consistency and neural synchrony. Even if you stop playing music, the brain will continue to benefit. Age was also the subject of Arthur Wingfield’s presentation. Wingfield comes from the Department of Psychology and Volen National Center for Complex Systems, Brandeis University, USA, and his presentation was entitled “Age, Hearing Loss and the Cost of Effortful Listening”. Aging has a negative effect on many areas: perceptual and cognitive speed, declines in the capacity of the working memory, and usually some degree of hearing loss that makes it particularly hard to understand speech in noise. One could expect speech comprehension in older adults to be poorer than in others. Wingfield
has looked at work that illustrates "effective use of top-down support from preserved linguistic knowledge to aid speech recognition, but also age-related cognitive factors that limit this ability." There is a cognitive cost to successful, but effortful perception in the face of a degraded input. When aging, one is confronted with several problems: while speech is rapid — the processing speed is slower, it draws on working memory resources — while the working memory capacities are reduced, speech is often under-articulated but auditory processing declines at the same time. When one is able to recognize a degraded input, the perceptual effort that was needed to succeed comes at a cost to other activities.

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The Swedish Institute for Disability Research, Linnæus Centre and HEAD and HEAD Graduate School

In 2000 the universities of Linköping and Örebro cooperated on founding the Swedish Institute for Disability Research (SIDRI). In 2012, Linköping University also became a part of SIDRI. The disability research is interdisciplinary, including both medical, technical, behavioral and cultural perspectives. The aim is to "pursue excellence, adopt the perspective of the individual, promote collaboration with user organisations and industry and promote development of the International Classification of Functioning (ICF)." SIDRI has a graduate program, which is a leading European research program in disability. 86 doctoral theses have been successfully defended so far.

When Linköping University received a large 10-year grant from the Swedish Research Council in 2008 they created Linnæus Centre HEAD (Hearing And Decibels) — the field of research. The centre is a part of the Swedish Institute for Disability Research, and it holds a multidisciplinary research team, with senior scientists, postdoctoral researchers and collaborators from Sweden and the rest of the world.

The HEAD Graduate School is run in collaboration between Linköping and Örebro universities, within the framework of SIDRI, and is affiliated with Linnæus Centre HEAD, funded by the Swedish Research Council. The graduate school "promotes excellent research training and is open to doctoral students whose projects fall within the broad field of hearing and deafness research." Among the activities organized by the graduate school: courses, seminars, workshops, mobility incentives. It also develops links between researchers, clinicians, user organisations and the hearing industry. At the moment there are 41 doctoral students enrolled, and 8 have already obtained their PhDs.

Information about SIDRI: www.sidri.se
Information about Linnæus Centre HEAD: www.headcentre.se
Information about HEAD Graduate School: www.sidri.se/head

"Children with 2 CIs performed significantly better than their matched peers with only 1 CI."

Astrid van Wieringen from the Department of Neuroscience, KU Leuven, Belgium, presented a talk entitled "Understanding the causes of variability in spoken language outcome of children with cochlear implants." Even though children with cochlear implants have relatively good linguistic skills, there is a large variability in performance. There is a lack of insight in factors that predict language outcome after cochlear implantation in children, and this is a hindrance for efficient follow-up and rehabilitation. In order to investigate different factors underlying the causes of the variability in language outcome in children with CI, a multi-center project with 288 CI participants up to the age of 12 was set up. "Predictors in language skills were established, showing that age at cochlear implantation, contra-lateral stimulation, additional disabilities, multi-lingualism, parental involvement and communication mode were related to language performance and accounted for up to 50% of the variance. Moreover, a study on spoken language comprehension and production showed that children with 2 CIs performed significantly better than their matched peers with only 1 CI. A third study yielded spoken language profiles for children with cochlear implants compared to carefully matched normal-hearing peers. There was also an investigation of narrative skills from a cross-section of children with CI with a matched group of normal hearing children, at macro and micro-level. This was also done with children with two CIs. The studies showed that children with implants under the age of 2, with two CIs, no additional disabilities, and who spoke one language, had age-adequate vocabulary, morphology, syntax and narrative skills. Additional data about auditory, visual and visual-motor short-term memory skills and speech perception abilities in noise has been gathered, making it possible to "detect the contribution of memory and intelligibility to successful language acquisition in children with CIs." By understanding the causes of these variations, the clinicians can offer better prognoses to CI-candidates prior to the operation, helping both parents and therapists with the process after the implantation, for the best possible outcome for acquiring language.

Test: Mari Vold Alexander Photos: Marie-Louise Mattsson and Forskarskåret