Measuring the fluency of processing continuous speech in CI users

Anita Wagner[1]

[1]University of Groningen, Groningen

Cochlear implant (CI) users need to readjust their processing of speech to a strongly degraded signal. Although most CI users are successful in this adaptation, speech perception outcomes vary greatly between individuals, and many CI users perceive speech comprehension as effortful. For normal hearing listeners (NH) speech comprehension is effortless because the perceptual system enables instantaneous progression of information through several levels of analysis, from auditory object formation to the integration of meaning within a conversation. We study individual differences amongst CI users in their fluency and in the effort involved when processing continuous speech.

For twelve experienced CI users, we created profiles of their speech processing fluency based on cortical and behavioral measures that capture speech processing at various levels. These profiles were then compared to age-matched controls based on the measures: (1) cortical processing, measured as cortico-acoustic coherence in EEG recordings when listening to continuous speech; (2) the time course of lexical access captured in gaze fixations in a visual world paradigm; (3) the mental effort involved while processing speech, as measured in pupil dilation.

NH listeners show a uniform pattern in how they use acoustic information and their attentional resources during lexical access, as well as in their cortico-acoustic coherence, which we find in the delta (>4Hz) and theta (4-8 Hz) ranges. For the CI users, individual variation in the mental effort involved when processing speech was related to their processing fluency, i.e. to their ability to timely integrate acoustic and contextual information to resolve ambiguities during lexical access. Also, while all CI users showed increased cortico-acoustic coherence in the theta range, only listeners with high processing fluency showed increased coherence in the delta range. This data suggests a link between the mental effort involved in processing speech and different stages of lexical processing. The patterns found could support individualized estimation of the integrity of the speech perception system to enhance hearing rehabilitation, and complement the prognosis for implantation candidacy.