DIFFERENCES IN LISTENING EFFORT AMONG COCHLEAR IMPLANT USERS COMPARED TO HEARING AID USERS

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Introduction

- Listening effort refers to the workload required to hear and understand speech (Hicks & Tharpe, 2002).
- More difficult listening conditions, as well as an impaired auditory system, are associated with increased listening effort (Howard, Munro, & Piaccia, 2010; Hicks & Tharpe, 2002).
- Increased listening effort may lead to more stress and mental fatigue for individuals with hearing loss.
- Emerging evidence suggests that the psychophysiological measures of heart rate variability (HRV) and skin conductance are sensitive to increased listening effort in normal hearing listeners and those with moderate hearing loss.
- Heart rate variability (HRV) and skin conductance responses have been used to assess listening effort in hearing and hearing impaired participants (Mackenzie & Convo, 2011; Mackenzie, MacPhee, & Heldt, 2015). In task conditions requiring more listening effort, high frequency (HF) HRV decreased and skin conductance increased for hearing impaired participants, suggesting increased effort and arousal.
- This study assesses differences in listening effort between cochlear implant users and hearing aid users to see if either device provides more benefit in terms of listening effort.

Research Question

Do individuals with cochlear implants expend more listening effort than individuals with hearing aids, independent of speech recognition performance?

Method

Participants: The sample consists of 30 participants with severe and profound hearing loss who either use cochlear implants (n=15) or hearing aids (n=15). Participants were students recruited from the National Institute for the Deaf at the RIT campus and were compensated $10 for their time. The mean age of the participants was 20.2 (SD = .89) years.

Measures:

Skin Conductance Level (SCL): Two Ag/AgCl electrodes attached to the non-dominant hand were used to collect electrodermal activity. Mean level change scores from pre-trial baseline were calculated for each condition and log-transformed.

Heart Rate Variability (HRV): HRV was derived from an electrocardiogram collected from a modified lead II electrode configuration in the program Kubios HRV 2.2 for each condition. The first two minutes of data from each task condition were used in the analysis. Log-transformed high frequency (0.15-0.4Hz) HRV power (ms²) was used for analysis.

Hearing in Noise Test (HINT): HINT scores were collected from pre-trial baseline to determine the baseline noise level for each condition. The order of the three conditions were Reading, HINT 37, 141-153.

Condition ANOVA.

Participants completed 3 tasks, the two HINT listening conditions and a sentence reading control condition. The order of the three conditions were counterbalanced across participants. A 2-minute quiet baseline occurred before each condition. Self-report ratings were made after each condition. The stimuli were presented in a sound attenuated chamber through calibrated speakers.

Data Analyses:

Total SCL and HRV power scores were analyzed with a t-test to compare groups. All other measures were analyzed in a repeated measures 2 Group x 3 Task Condition ANOVA.

Results

There were no significant differences between groups on self-reported perceived stress or fatigue experience in the past month. Perceived Stress Scale: t(28) = 1.14, p = .26. Iowa Fatigue Scale: t(27) = 0.44, p = .67.

DISCUSSION

- Individuals suffering from hearing loss are exposed to many situations where they must increase their listening effort which can lead to stress. Cochlear implants and hearing aids are used to help ameliorate the effects of hearing loss. Knowledge of whether use of one device over the other provides for decreased listening effort is important for making clinical decisions.
- In this study each group reported experiencing similar levels of perceived stress and fatigue in the past month.
- Reduced HF-HRV power has been associated with greater cognitive effort (Thayer et al., 2009). In this study HRV was lower for both listening conditions compared to the reading control condition suggesting that participants effort increased during the listening tasks compared to a reading out loud task. There were no group differences between cochlear implant users and hearing aid users, suggesting neither device provided an advantage in terms of listening effort.
- In contrast to the HRV data, the skin conductance data suggested that participants had an increased sympathetic response to the reading conditions. This may be due to differences in modality of the stimuli.
- Despite the HRV and SCL data indicating no differences during the HINT conditions self-report indicated that the quiet listening condition required less effort and this was reflected in the pattern of behavior performance on the two tasks. Again neither device provided a significant advantage over the other.
- Future studies should test varying signal to noise ratios (SNR) as one device may provide greater benefits at lower SNRs. It may be that the current SNR was not difficult enough to elicit differences between groups.
- Future studies should control for the differences in modality of stimuli between test and control conditions by including changing visual stimuli during the listening task.

References


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