Auditory event-related potential outcomes with ReadMyQuips auditory training program

Aparna Rao[1], Dania Rishiq[2], Luodi Yu[1], Yang Zhang[1,3], Harvey Abrams[2]

[1] *Department of Speech-Language-Hearing Sciences, University of Minnesota, Minneapolis, MN 55455, USA.*
[2] *Starkey Hearing Technologies, Eden Prairie, MN*
[3] *Center for Neurobehavioral Development, University of Minnesota, Minneapolis, MN 55455, USA.*

Introduction

Individuals with hearing loss commonly suffer compromised speech perception, particularly in noisy group environments (Harkins & Tucker, 2007), leading to significant problems in verbal communication. Auditory training programs for adults harness the plasticity of the neural system to enhance this function in response to training. In this study, we focused on ReadMyQuips (RMQ: http://www.sensesynergy.com/readmyquips), a representative example of a structured auditory training program. RMQ implements an adaptive procedure to tailor the pace of auditory-visual speech perception training in noise to individual performance levels. A cognitive skill targeted by auditory training in noise is that of selective attention, the ability of listeners to focus on task-relevant sounds (targets) while suppressing task-irrelevant sounds (distractors). In the context of speech perception, targets are normally the words emitted by an identified speaker or speakers, whereas distractors are considered any other acoustic stimuli, spoken or unspoken, that interfere with speech detection and comprehension. Selective attention is known to modify cortical function (Fritz et al., 2007) and electrophysiological techniques are well suited to the non-invasive investigation of these changes (Luck, 2014). Here we present the effects of amplification and auditory training using RMQ on auditory selective attention. Electrophysiological and behavioral outcomes data are discussed.

Materials and Methods

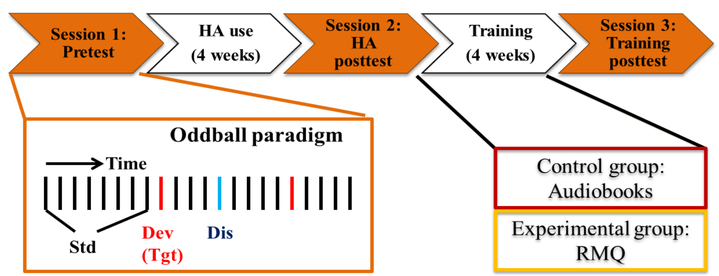
Participants

- Mild to moderate hearing loss
- First-time users of hearing aids (i.e., had not used hearing aids in the 12 months prior to beginning the experiment)
- Two groups: (1) experimental and (2) control
- Age range of participants: Experimental group: 60-85 years, control group: 49-85 years
- Gender: 5 males and 5 females in both groups
- Participants in the experimental group completed RMQ training
- Participants in the control group listened to audiobooks

ERP stimuli

- Standards (best ear or right ear): 1000 Hz
- Deviants (best ear or right ear): customized for each participant to achieve a d' of 2.5 (Ranged in frequency from 1008 Hz to 1036 Hz)
- Distractors (opposite ear): 1400 Hz
- All stimuli presented at approximately 60 dB SL re: threshold at 1000 Hz.

Schematic of timeline of ERP experiment



Materials and Methods

EEG data recording

- Advanced NeuroTechnology 64-channel EEG system and Waveguard Cap
- Sampling frequency: 512 Hz and Passband: 0.016 - 200 Hz

EEG data analysis

- Re-referenced to the average of left and right mastoids
- Artifact Rejection: trials with potential exceeding +/- 40 μV
- Lowpass filter at 40 Hz
- Epoch : 800 ms (with 100 ms prestimulus baseline)
- P3b and P3a analyzed for frontal, central and parietal sites
- P3b: 400~600 ms (time window 60 ms averaged)
- P3a: 200~380 ms (time window 60 ms averaged)

Results

Effects of amplification (N = 20)

Figure 1: Grand average waveforms of deviant (P3b) and distractor (P3a) from Session 1 to Session 2

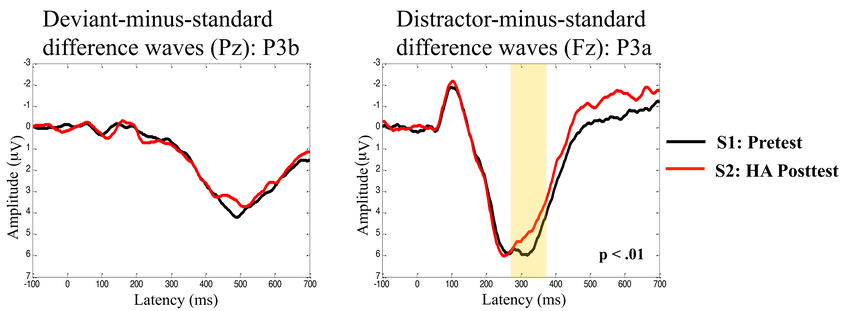


Figure 2: d' and criterion for Sessions 1 & 2

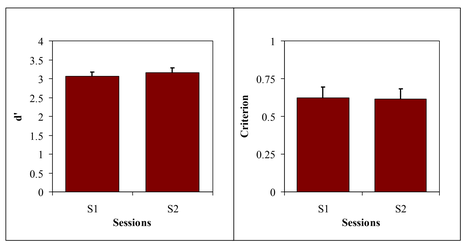
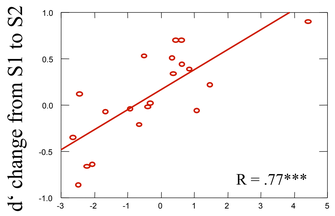


Figure 3: Correlation P3b- d' change from Session 1 to Session 2



Effects of auditory training

Figure 4: Grand average waveforms of P3b for experimental (N = 10) and control groups (N = 10)

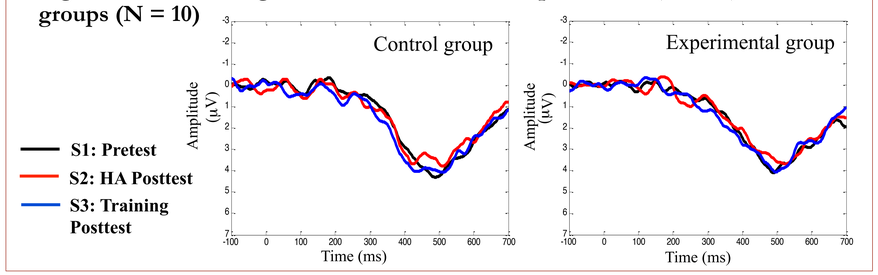


Figure 5: Grand average waveforms of P3a for experimental and control groups

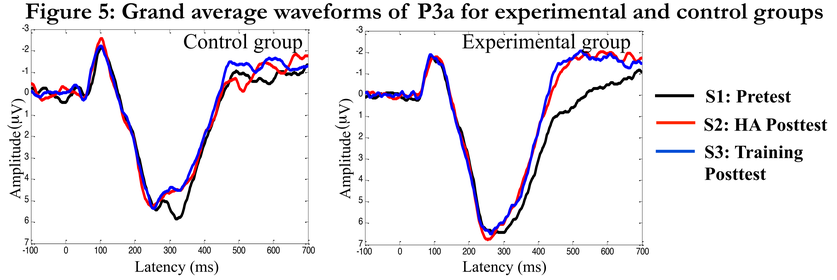


Figure 6: d' and criterion for Sessions 1, 2 & 3

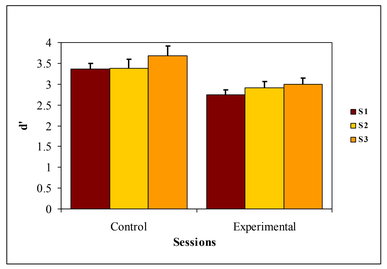
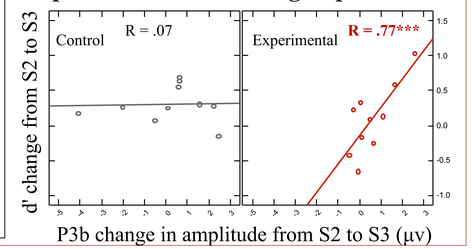


Figure 7: Correlation P3b- d' change from Session 2 to Session 3 for experimental and control groups



Discussion and Conclusions

Effects of amplification (session 1 to session 2)

- Although behavioral changes were not seen after 4 weeks of hearing aid use, changes were noted in ERPs, highlighting neurophysiological and cognitive underpinnings of amplification use.
- Reduced P3a after amplification use reflects suppression of involuntary orienting to distractors.
- Target processing as measured using P3b was not affected after amplification possibly due to variability in P3b across participants. The significant correlation found between changes in d' and P3b amplitude reflects this variability.

Effects of amplification and auditory training (session 2 to session 3)

- For the experimental group, the link between changes in d' and in P3b from session 2 to session 3 suggests a relationship between listening performance and task-relevant attentional allocation strengthened by RMQ training. This correlation was not found for participants in the control group.

Conclusions

- Our data set reflects the variability seen across participants after amplification use (Dawes et al., 2014) and auditory training (Olson, Preminger, & Shinn, 2013).
- Benefit of speech perception training is noted in a subset of participants. Further research is needed on optimal training protocols to enhance function in individuals with hearing loss.

References

- Harkins, J., & Tucker, P. (2007). *Trends in Amplification, 11*(2), 91-100.
- Fritz, J. B., Elhilali, M., David, S. V., & Shamma, S. A. (2007). Curr Opin Neurobiol, 17(4), 437-455.
- Luck, S. J. (2014). An introduction to the event-related potential technique: MIT press.
- Dawes, P., Munro, K. J., Kalluri, S., & Edwards, B. (2014). J Acoust Soc Am, 135(6), 3560.
- Olson, A. D., Preminger, J. E., & Shinn, J. B. (2013). J Am Acad Audiol, 24(3), 214-230.

This work is funded by Starkey Hearing Technologies. For further information, please contact Aparna Rao (raoxx098@umn.edu) or Dania Rishiq (Dania_Rishiq@Starkey.com).