Group Differences in Resting State EEG in Age-Related Hearing Loss

Jaya Ashrafi, Klaudia Sieczka, Teresa S. Warren

Aging and NeuroCognition Lab, Department of Speech and Hearing Science, College of Applied Health Sciences

INTRODUCTION

- Resting state electroencephalography (rs-EEG) can provide insights into the neurophysiological changes that occur in neurological and psychiatric disorders[1- 3]
- Previous studies have linked changes in rs-EEG cortical thinning to auditory processing issues in older adults with central hearing loss[4]
- However, no known studies have examined the differences in rs-EEG activity between older adults with mild, untreated age-related hearing loss (ARHL) and normal hearing (NH) controls

PURPOSE

- To examine rs-EEG differences between older adults with untreated ARHL and NH controls
- To examine the relationship between rs-EEG and peripheral hearing, measured by pure-tone average (PTA) in the better ear

METHODS

Participants

- 32 participants (ARHL: 16 and NH: 16)
  - ARHL: bilateral symmetric mild sensorineural age-related hearing loss
- **Inclusion criteria:** no hearing aid use, no other etiologies of hearing loss, no tinnitus, no history of major neurological or psychiatric disease, normal/corrected vision, right-handed, and native English speakers

METHODS (CONT.)

I. Audiological Evaluation

- Pure tone audiometry was done
- PTA (0.5, 1, 2, and 4 kHz) in the better ear was used as a measure of peripheral hearing[5- 6]
  - NH: ≤25 dB HL; ARHL: >25 dB HL

II. EEG Acquisition and Processing

- Neuroscan EEG system, with 64-electrode Quickcap
- Scan software used to process raw EEG data offline

III. Resting State EEG Analysis

- EEGLAB[9] and FieldTrip[10] toolboxes
- Absolute power: Fast Fourier Transformation-based spectral analysis at theta (4-7 Hz), alpha (8-12 Hz), and beta (13-30 Hz)
- Electrodes: Fz, FCz, Cz, CPz, and Pz

IV. Statistical Analysis

- R version 4.41
- Independent samples t-tests examined differences in rs-EEG absolute power between ARHL and NH groups
- Pearson's correlation coefficients examined the relationship between rs-EEG absolute power and PTA

RESULTS

I. Participant Demographics

Table 1. Participant Demographics

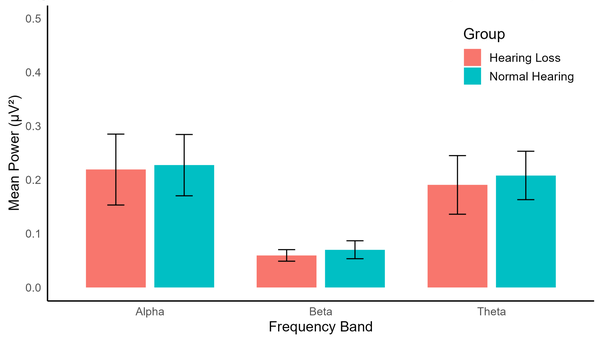
Group	n	Age (yrs)	Education (yrs)	PTA (dB HL)
ARHL	16	69.38 (6.46)	17.00 (2.31)	30.78 (3.19)
NH	16	69.68 (6.47)	17.31 (2.15)	16.56 (4.48)

Note: Each cell represents M (SD)

II. rs-EEG Group Differences between ARHL and NH

- No significant group differences were found in rs-EEG absolute power at theta, alpha, and beta frequency bands at the five electrodes analyzed ($p > .05$)

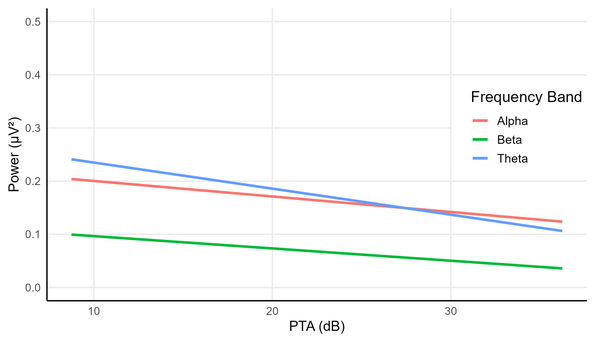
Figure 1. rs-EEG Absolute Power by Group



III. Correlation between rs-EEG and PTA

- No significant correlations between rs-EEG theta, alpha, and beta absolute at the five electrodes and PTA were observed ($p > .05$)

Figure 2. Correlations between rs-EEG Absolute Power and PTA



DISCUSSION

- The lack of differences in rs-EEG between groups may indicate that mild, untreated hearing loss does not result in neurophysiological alterations
- PTA was not significantly associated with rs-EEG power, suggesting no clear link between hearing sensitivity in the normal and mild range and spontaneous neural activity
- Future research should explore rs-EEG across a broader spectrum of ARHL severity, from mild to severe, to clarify if neurophysiological changes emerge at varying levels of hearing loss

ACKNOWLEDGEMENTS

We would like to thank Drs. Raksha and Shraddha Shende, and the START program for their guidance and support. This research was funded by the CHAD Pilot grant and ASHFoundation.

REFERENCES

1. Meghdadi, A. H., Stevanović Karić, M., McConnell, M., Rupp, G., Richard, C., Hamilton, J., Salat, D., & Berka, C. (2021). Resting state EEG biomarkers of cognitive decline associated with Alzheimer's disease and mild cognitive impairment. PloS one, 16(2), e0244180. https://doi.org/10.1371/journal.pone.0244180
2. Meghdadi, A. H., Stevanović Karić, M., McConnell, M., Rupp, G., Richard, C., Hamilton, J., Salat, D., & Berka, C. (2021). Resting state EEG biomarkers of cognitive decline associated with Alzheimer's disease and mild cognitive impairment. PloS one, 16(2), e0244180. https://doi.org/10.1371/journal.pone.0244180
3. Ma, H. L., Zeng, T. A., Jiang, L., Zhang, M., Li, H., Su, R., Wang, Z. X., Chen, D. M., Xu, M., Xie, W. T., Dang, P., Bu, X. O., Zhang, T., & Wang, T. Z. (2023). Altered resting-state network connectivity patterns for predicting attentional function in deaf individuals: An EEG study. Hearing research, 429, 108696. https://doi.org/10.1016/j.heares.2023.108696
4. Giroud N, Hirsiger S, Muri R, Kegel A, Dillier N, Meyer M. Neuroanatomical and resting state EEG power correlates of central hearing loss in older adults. Brain Struct Funct. 2018 Jan;223(1):145-163. doi: 10.1007/s00429-017-1477-0. Epub 2017 Jul 22. PMID: 28735495.
5. Lin, F.R.; Ferrucci, L.; Metter, E.J.; An, Y.; Zonderman, A.B.; Resnick, S.M. Hearing Loss and Cognition in the Baltimore Longitudinal Study of Aging. Neuropsychology 2011, 25, 763–770. https://doi.org/10.1037/a0024238
6. Lin, F.R.; Yaffe, K.; Xia, J.; Xue, Q.L.; Harris, T.B.; Purchase-Helzner, E.; Satterfield, S.; Ayonayon, H.N.; Ferrucci, L.; Si-monsick, E.M.; et al. Hearing Loss and Cognitive Decline in Older Adults. JAMA Intern. Med. 2013, 173, 293. doi:10.1001/jamainternmed.2013.1868
7. ANSI Specification for Audiometers; American National Standards Institute: New York, NY, USA, 2010.
8. Carhart, R.; Jerger, J. Preferred method for clinical determination of pure-tone thresholds. J. Speech Hear. Disord. 1959, 24, 330–345. https://doi.org/10.1044/jshd.2404.330
9. Delorme, A., & Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. Journal of Neuroscience Methods, 134(1), 9–21.
10. Oostenveld, R., Fries, P., Maris, E., & Schoffelen, J. M. (2011). FieldTrip: Open source software for advanced analysis of MEG, EEG, and invasive electrophysiological data. Computational intelligence and neuroscience, 2011, 156869. https://doi.org/10.1155/2011/156869
11. Shende, S. A., Nguyen, L. T., Lydon, E. A., Husain, F. T., & Mudar, R. A. (2021). Cognitive Flexibility and Inhibition in Individuals with Age-Related Hearing Loss. Geriatrics (Basel, Switzerland), 6(1), 22. https://doi.org/10.3390/geriatrics6010022