Hearing aid use may improve working memory

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Introduction

- Adult aging is associated with hearing loss[1], speech perception difficulties[2,3], and declines in episodic memory[4], processing speed[5], and working memory resources[6].
- Hearing loss is independently associated with accelerated cognitive decline in older adults[7].
- Hearing aids offer the potential to mitigate the effects of sensory loss, restoring some aspects of sensory functioning[8,9].
- Previous studies have investigated the effects of hearing aid use on cortical evoked potentials after a period of four[10] to twelve weeks[11]. The acclimatization effects and neural changes are still debated.

Objective

- **The connection between hearing loss and decreased higher level speech processing motivated us to examine whether increased audibility through the use of hearing aids can positively affect or offset cognitive declines.**

Goals

- To investigate the effects of HA use for six months on cognitive processing of older adults.
- To study whether HA use improves the neural functions that are affected by age-related hearing loss (ARHL) by cortical auditory evoked potentials (CAEPs).

Methods

Participants

- 32 older adults (60-84 years old, 72.3 ± 7 years; 21 F)
- Mild to severe symmetrical SNHL.
- No history of neurological disorders; no middle ear pathology
- Normal IQ (114.6 ± 15.55) on WASI [12]
- Screened for dementia (25.6 ± 2.00) using MOCA[13]

Hearing Aid Fitting

- Widex Dream BTE-RIC bilateral hearing aids
- Matched NAL-NL2 prescriptive targets for 55, 65, and 75 dB SPL inputs

Protocol

- All participants fit with HAs, tested in aided and unaided conditions at pre-test, and tested 6 months after pre-test.
  - ➢ Experimental group (n=18) wore HAs during acclimatization period and were tested in 4 additional testing sessions
  - ➢ Control group (n=14) was fit and tested with HAs but did not wear them during the intervening 6 months.

Pre- & Post-test sessions (24 weeks apart) included:

Cognitive Testing

- Cognitive- NIH Toolbox[14]
  - List Sorting Working Memory Test [15]
  - Flanker Inhibitory Control and Attention Test
  - Pattern Comparison Processing Speed Test

Electrophysiological Recording

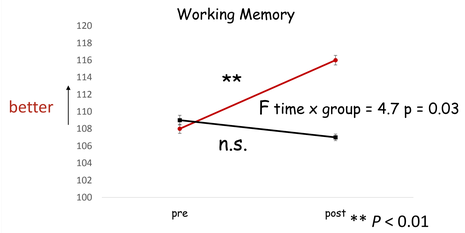
- 170 ms /ga/ presented in sound field with alternating polarities.
- Participants tested in aided and unaided conditions:
  Quiet (80 dB SPL) and Noise (+10 signal to noise ratio (SNR) six-talker babble noise)
  CAEP recorded with Biosemi acquisition system.

Data Analysis

- Conducted in Matlab
- The P1-N1- P2 complex was used
- Mean response amplitudes at the Cz electrode were calculated for the expected time regions for each of the prominent cortical peaks: P1 (35-75 ms), N1 (80-150 ms), and P2 (160-250 ms) in the quiet condition and P1 (35-75 ms), N1 (150-200 ms), and P2 (225-275 ms) in the noise condition.

Statistical Analysis

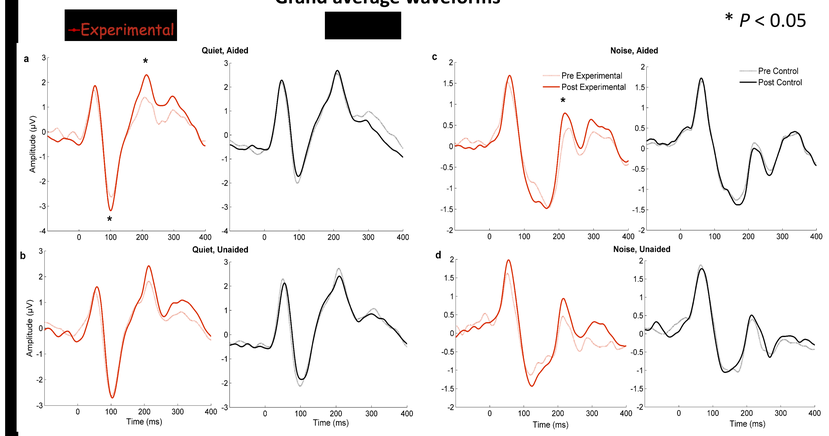
Cognitive: The use of HAs improves working memory



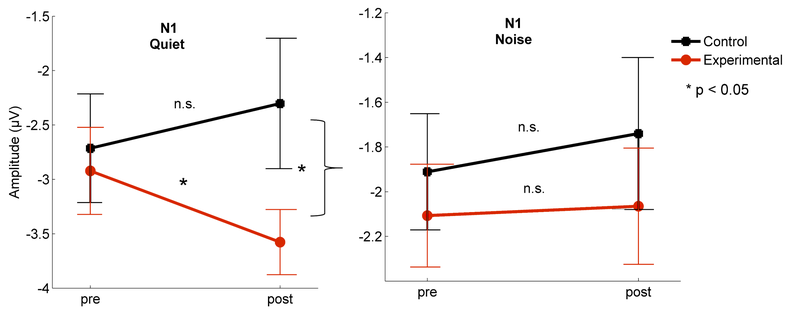
Experimental Control

Experimental group working memory improved significantly after the use of HAs for 6 months, while controls did not show any change.
No changes in Flanker and Pattern Comparison tests.

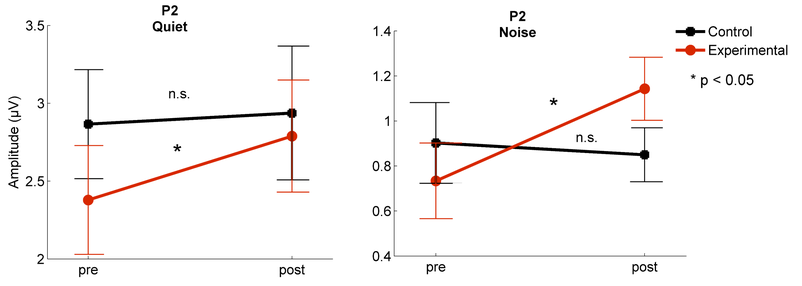
CAEPs: The use of HAs increases amplitude



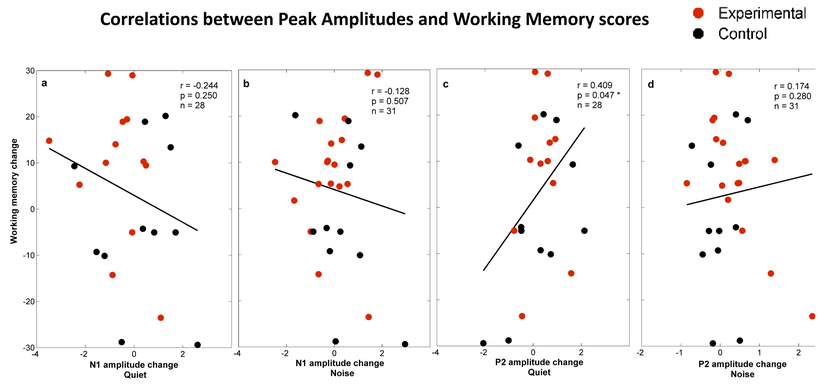
N2 amplitudes increased after the use of hearing aids



P2 amplitudes increased after the use of hearing aids



Working memory positively correlated with increases in cortical amplitudes



- Working memory improvement was related to higher P2 peak amplitudes in quiet
- N1 changes did not correlate with working memory changes.

Summary & Conclusions

- **There were significant HA-induced changes in cortical processing of speech stimuli and working memory in the experimental group.**
  - Increased auditory experience through hearing aid use gained during the 24-week period enabled increased attentional resources to the signal (reflected by N1).
  - P2 amplitudes were more robust after the use of hearing aids, and changes in amplitude were related to improvement in working memory.
  - P2 amplitudes may represent facilitation of implicit memory for an auditory object[16]
- **Therefore, a possible mechanistic association between auditory perception and working memory was demonstrated in the current study.**
  - HA amplification intervention can be used to lessen the amount of cognitive resources required for effective auditory communication.
  - Increasing audibility of the incoming signal could reduce the consumption of resources needed to achieve success on some listening tasks.

Our findings suggest that enhanced auditory experience enables better access to details in sensory representation (reflected by cortical response peaks), which in turn permits the correct identification of auditory objects and potentially improves projections to working memory sources.

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