

Abstract

Previous studies have shown a connection between hearing status, memory, and cognitive decline in older adults. The current exploratory study investigates the effects of unaided hearing loss on cognition and recall for auditory versus written expository text passages in normal hearing young adults, normal hearing older adults, and older adults with hearing loss. Although all participants performed better on the recall of auditory information regardless of group, hearing loss was associated with several cognitive measures. Findings indicate a need for continued collaborative research into sensory deficits and their effects on cognition and memory, in order to inform clinical practice.

Exploratory Study on Hearing, Cognition, and Memory in Aging

The older adult population is growing rapidly, along with age-related hearing loss and declines in memory, and cognition. Prevention and advocacy are part of the the American Speech-Language-Hearing Association's scope of practice for speech-language pathologists (ASHA, 2007) and audiologists (ASHA, 2004). Understanding the association between sensory, memory, and cognitive deficits in healthy aging will not only help guide clinicians in the prevention of neurogenic cognitive and communication disorders, but will also inform their evaluation and treatment of these individuals.

Hearing loss has been connected with memory decline and dementia (Gates, Anderson, Feeney, McCurry, & Larson, 2008; Lin et al., 2011; Ronnberg et al., 2011). Moreover, a relationship between age-related auditory processing and cognition has been well-supported in the literature (Arlinger, 2003; Baltes & Lindenberger, 1997; Lindenberger & Baltes, 1994; Nilsson et al., 1997). Together, studies suggest that hearing loss has a negative association with thinking and memory in older adults. One hypothesis, the "sensory-specific hypothesis" (Schneider, Daneman, & Pichora-Fuller, 2002), is that hearing declines contribute to subsequent memory and cognitive declines for information that is heard. Another hypothesis, the "common-cause hypothesis" (Baltes & Lindenberger, 1997), is that general neural degeneration is responsible for concomitant declines in hearing, memory, and cognitive function. The research to date has involved large correlation studies that have not directly tested the effects of hearing loss on recall of written versus auditory information. The current study examined the effects of unaided hearing loss on memory for expository text passages that participants either listened to under optimum listening conditions (loudness was adjusted for hearing loss), or read aloud. We compared older adults with hearing loss (HL OAs) to older adults without hearing loss (OAs) and young adults without hearing loss (YAs). We also tested all participants on measures of cognition, memory, and vocabulary, to explore whether or not there was an association with hearing loss.

We hypothesized that young adults would outperform both groups of older adults on both the reading and listening memory tasks. We were also interested in exploring whether HL OAs would perform differently from OAs on the auditory or written passage recall. The sensory-specific hypothesis would predict that older adults with hearing loss would have poorer performance on auditory but not written information. The "common-cause hypothesis would predict that HL OAs would have general cognitive decline as a result of hearing loss and would therefore have poorer performance on both auditory and written information. Finally, we hypothesized a correlational relationship between hearing loss and cognitive and passage recall measures.

Method

Participants

Participants included 6 HL OAs, 11 OAs and 16 YAs. All were right-handed native speakers of English with no conductive hearing loss, no hearing aids, no history of cognitive, speech, language, or memory impairments, or history of a learning disability.

Procedure

All participants took part in two sessions, one for hearing, and one for cognitive and memory testing, that lasted approximately 1.5 hours each on two separate days. The sessions for YAs were counterbalanced. All older adults participated in the hearing protocol first, so that appropriate hearing levels for the listening recall portion of cognitive testing could be determined.

Hearing Protocol:

The participants completed a hearing history form and received a full battery of diagnostic audiologic tests, including: 1) visual examination of the auditory canal and eardrum (otoscopy), 2) examination of the function of the ear drum and middle ear (tympanometry), 3) pure tone examination of the participant's hearing to help determine type, degree, and configuration of hearing loss, 4) measurement of speech recognition thresholds, and 5) examination of speech discrimination (the percentage of words understood correctly at a significantly audible level).

Memory Protocol: Two expository reading passages of unfamiliar animals matched on 15 different variables were used (Rogalski, Altmann, & Rosenbek, 2013). Participants read aloud then verbally recalled as much information as they could about the passage. Participants also listened to then verbally recalled as much information as they could about the passage. Passages were counter-balanced across tasks.

Cognitive Testing: Participants completed pencil and paper tests, which provided supplementary information about cognition and vocabulary, including: the Montreal Cognitive Assessment (MoCA) (a cognitive screener that tests attention, memory, visuospatial functioning and language); the Trail Making task and the Symbol Digit Coding (assessments of processing speed and attention); a vocabulary test; and the Digit Span Forward, Backward, and Ordering tests (tests of working memory).

Results

A (3) group (HLOAs, OAs, and YAs) by (2) task (listening recall, reading recall) repeated measures analysis of variance (ANOVA) was conducted. Significant results and effect sizes (partial eta squared) are reported. Results reveal a main effect of task [$F(1, 30) = 11.42, p = .002$, partial $\eta^2 = .28$], indicating all participants performed better on the listening task than on the reading task. The interaction [$F(2, 30) = .22, p = .81$, partial $\eta^2 = .01$] and the main effect of group [$F(2, 30) = .80, p = .46$, partial $\eta^2 = .05$] were not significant. Please see Figure 1 below.

Correlation results for hearing, passage memory, and cognition are found in Table 1. Hearing was strongly negatively correlated with the MoCA [$r = -.58, p < .0001$] and Coding [$r = -.63, p < .0001$] that is, higher PTA in better ear scores (poorer hearing) were related to lower MoCA and Coding scores. Hearing was also strongly positively correlated with Trail Making A [$r = .68, p < .0001$] and Trail Making B [$r = .67, p < .0001$]. Essentially, poorer hearing was associated with longer times to complete the Trail Making Tasks. Listening and reading recall

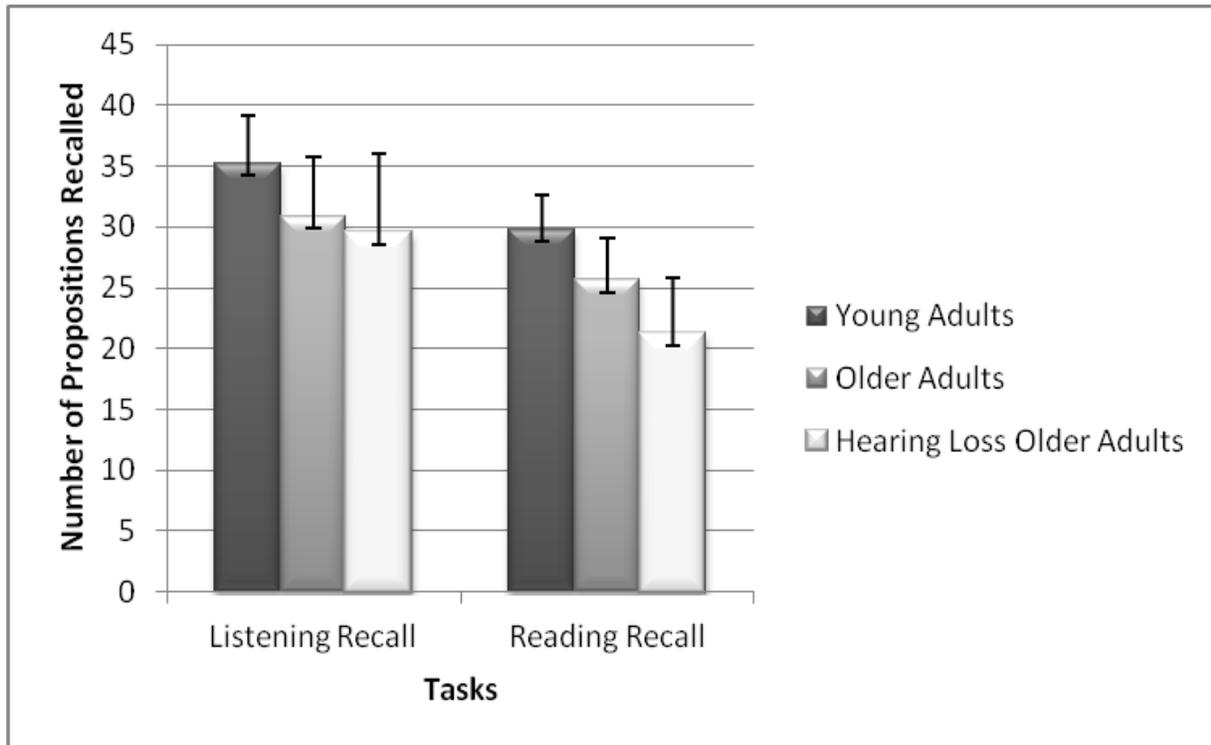
were strongly positively correlated with each other [$r = .78, p < .0001$] and both were strongly positively correlated with vocabulary: reading [$r = .49, p = .004$], listening [$r = .45, p = .009$]. Only reading recall was associated with cognitive measures. Moderate negative correlations between reading recall and Trail Making B [$r = -.41, p = .019$] indicate that better reading recall was associated with faster times to complete Trail Making B and weak positive correlations between reading recall and Digit Span Backward [$r = .35, p = .049$] indicate that better reading recall was associated with better Digit Span Backward scores.

Discussion

Hypotheses for differences between older adults and young adults were not supported, possibly due to the high education level of our older adults. The finding that listening recall performance was greater than reading recall performance across groups was unexpected, although some research supports this (Kim, 2006). Of most importance is that hearing loss was associated with a cognitive screening test and tests of processing speed and attention. These findings are consistent with previous research (Arlinger, 2003; Baltes & Lindenberger, 1997; Lindenberger & Baltes, 1994; Nilsson, et al., 1997) and support the need for more research into the area of hearing, cognition, and memory, in order to inform clinical practice. Future studies should draw from a larger sample size where education level is more consistent across groups.

Figure 1

Comparison of young and older adults on listening and reading recall tasks



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Table 1

Correlations among hearing, passage memory, and cognitive variables

Variable	2	3	4	5	6	7	8	9	10	11
1. PTA ^a Better Ear	-.21	-.16	-.58**	.68**	.67**	-.05	-.63**	-.17	.03	-.30
2. Reading Recall		.78**	.14	-.27	-.41*	.49**	.28	.24	.35*	.31
3. Listening Recall			.17	-.16	-.29	.45**	-.05	.26	.19	.24
4. MoCA ^b				-.53**	-.59**	.33**	.45**	.43*	.28	.48**
5. Trail Making A					.51*	-.23	-.63**	-.20	-.20	-.30
6. Trail Making B						-.37*	-.63**	-.28	-.15	-.48**
7. Vocabulary							-.05	.23	.26	.52**
8. Symbol Digit Coding								.40*	.24	.39*
9. Digit Span Forward									.68**	.32
10. Digit Span Backward										.43*
11. Letter/Number Sequencing										

Note. Correlation is significant at: * $p \leq .05$; ** $p \leq .01$

^aPTA = Pure Tone Average

^bMoCA = Montreal Cognitive Assessment

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