EFFECTS OF MODALITY AND LINGUISTIC MATERIALS ON MEMORY IN YOUNGER AND OLDER ADULTS

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1 Introduction

Sensory factors can affect recall [1]. Visual tests are immune to hearing loss, but auditory tests are more ecologically relevant for evaluating speech understanding [2]. Previously, an auditory test was preferred to a visual test because it yielded a greater range of working memory scores [2]. The purpose of this study was to evaluate the relative effects on recall of auditory versus visual materials with simple versus complex linguistic properties.

2 Method

2.1 Participants

The 64 participants were native English speakers with good health and normal hearing (audiometric thresholds ≤ 25 dB HL at and below 3 kHz and no asymmetry ≥ 20 dB. The younger 32 participants (mean age = 19.9 years, *SD* = 1.8, range 18-26; 5 male, 27 female) received course credit for participating. The older 32 participants were recruited from a pool of research volunteers and received $12/hour (mean age = 71.9 years, *SD* = 5.6, range 60-83; 5 male, 27 female).

2.2 Procedures

Audiograms were obtained using standard clinical methods. Participants completed a survey to report years of education and levels of language fluency. All participants completed four test conditions which were counter-balanced (2 modalities x 2 linguistic levels): simple auditory, complex auditory, simple reading, complex reading. Participants repeated sentence-final target words. In simple conditions, each target word was preceded by the same carrier phrase; in complex conditions, each was preceded by a unique sentence. In each condition, 100 items were presented, with five trials in each of five setsizes (2, 3, 4, 5, 6 words to be recalled per set). The number of words correctly recognized, judged, and recalled was measured.

2.3 Materials and apparatus

The complex auditory and visual stimuli were sentences from the Revised Speech Perception in Noise (SPIN) Test [3]. The simple auditory and visual stimuli were from the Word Auditory Recognition and Recall Measure (WARRM) [4]. Auditory conditions were completed in quiet in a sound-booth. Visual conditions were presented on a computer screen and completed in a quiet office environment.

3 Results

3.1 Audiometry

Younger adults had clinically normal (≤ 25 dB HL) audiometric thresholds at all frequencies. Older adults had normal thresholds at frequencies ≤ 4 kHz and had typical age-related high-frequency hearing loss.

3.2 Younger adults

There were significant main effects of 1) linguistic complexity ($F(1,31) = 81.0$, $p < .001$, $\eta p^2 = .72$), with higher recall for simple than complex stimuli, 2) modality ($F(1,31) = 57.1$, $p < .001$, $\eta p^2 = .65$), with higher recall for auditory than visual stimuli; and 3) setsize ($F(4,124) = 336.5$, $p < .001$, $\eta p^2 = .92$), with recall decreasing with increasing setsize. There was a significant interaction between linguistic complexity and setsize ($F(4,124) = 9.3$, $p < .001$, $\eta p^2 = .23$) and modality and setsize ($F(4, 124) = 14.4$, $p < .001$, $\eta p^2 = .32$). As setsize increased, the differences in recall due to complexity and modality increased (Figure 1). There was no three-way interaction. Bonferroni corrected post-hoc tests of multiple comparisons revealed that recall scores in all setsizes were significantly different from each other. Collapsed across modality, recall was better for word-level than sentence-level materials by 8 percentage points. Collapsed across linguistic complexity, recall was better for auditory than for visual materials by 9 percentage points. For total scores, recall was better for word- than sentence-level materials by 9 percentage points and recall was better for auditory than visual materials by 11 percentage points.

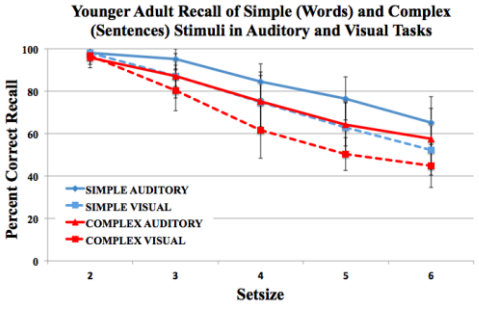

Figure 1: Percent correct recall by setsize for target words in word-level and sentence-level materials during listening and reading tests for younger adults. Error bars represent SDs.

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3.3 Older adults

There were significant effects of linguistic complexity ($F(1,31) = 89.72$, $p < .001$, $\eta p^2 = .74$), modality ($F(1,31) = 6.16$, $p = .02$, $\eta p^2 = .17$) and set size ($F(4,124) = 275.27$, $p < .001$, $\eta p^2 = .89$), with recall decreasing with increasing set size. There was an interaction of setsize and complexity, $F(4,124) = 6.56$, $p < .001$, $\eta p^2 = .18$. As setsize increased, the differences in recall due to complexity (blue vs. red lines) increased (Figure 2). There was a marginally significant two-way interaction between setsize and modality ($F(4,124) = 2.42$, $p = .052$, $\eta p^2 = .072$). As setsize increased, the differences in recall due to modality (solid vs. dashed lines) increased (Figure 2). There was no significant two-way interaction between modality and setsize or a three-way interaction. Bonferroni corrected post-hoc tests of multiple comparisons revealed that recall scores in all set sizes were significantly different from each other. Using the total scores, recall was better for word- than for sentence-level materials by 7 percentage points and recall was better for auditory than for visual materials by 4 percentage points.

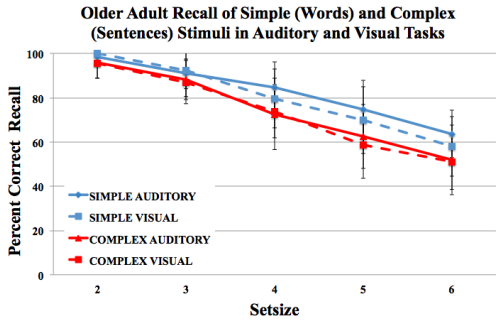

Figure 2: Percent correct recall by setsize for target words in word-level and sentence-level materials during listening and reading tests for older adults. Error bars represent SDs.

3.4 Age Comparisons

There was no effect of group on recall, $F(1,62)=1.343$, $p=.251$, $\eta p^2<0.021$, with an overall score of 72.9% for older and 70.1% for younger adults. There were main effects of setsize, modality, and linguistic complexity. Importantly, there was a significant interaction between age and modality $F(1,62) = 27.433$, $p < 0.001$, $np^2 = .307$), such that modality only mattered for the younger (Figure 3; striped bars), but not older group (Figure 3; solid bars). Younger and older adults scored similarly on the auditory tests but younger adults scored worse on visual compared to auditory tests.

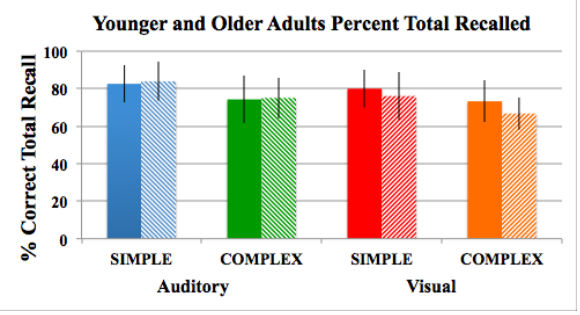

Figure 3: Percent correct total recall for target words in word-level and sentence-level materials during listening and reading tests. The solid coloured bars represent older adults and the striped bars represent younger adults. Error bars represent SDs.

4 Discussion

The current results for older adults differed from previous findings for younger adults. Notably, there was an effect of linguistic complexity for both age groups, but the older group did not demonstrate the modality effect that had been found for younger adults. The older adults performed similarly regardless of modality, with overall scores of 78.4% and 76.6% for auditory and visual tests, respectively. In contrast, the younger adults scored better on auditory (80.0%) than on visual (70.9%) tests. Notably, younger adults performed just as well as older adults on both auditory tests, whereas they performed worse on both visual tests (Figure 3). For younger adults, it is suggested that auditory recall is easier than visual recall because spoken stimuli have direct access to the phonological loop and therefore may require fewer cognitive resources to process than visually presented read stimuli, thus facilitating recall [5]. The younger adults in our study may be demonstrating this auditory advantage (or visual disadvantage), but the older adults did not. Perhaps younger adults found reading to be more challenging than listening, whereas reading and listening were similarly challenging for older adults. Older adults may be more expert readers than younger adults and have an advantage on the reading task; however, they may have sub-clinical declines in supra-threshold auditory processing which would put them at a disadvantage on listening. These findings may or may not apply to people with hearing or vision loss or to non-native speakers or those with low literacy. Further research will need to be conducted in order to generalize these findings to clinical or special populations and to explore if the listening memory test is sensitive to intra-individual differences in performance in various listening conditions (e.g., listening is aided vs. unaided or in quiet vs. in noise).

References

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