Attention Allocation and Aging in a Dual Task Paradigm
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Background Information
Attention allocation is the ability to direct cognitive resources to a given task. In real life, however, attention is often divided among multiple tasks, also known as multitasking. The ability of individuals to allocate attention across multiple tasks depends on the complexity of the task and the individuals' cognitive capacity; more difficult tasks require greater cognitive effort to execute, leaving fewer additional resources to allocate to other tasks. Given that older adults tend to have smaller cognitive capacity than younger adults, we might expect that older adults have greater difficulty allocating attention than younger adults. Therefore, the purpose of this study was to test whether there are age-related changes in attention allocation while multitasking and whether these changes are exaggerated in complex listening environments.

Methods
Participants
Young adults (n = 21; 18-25 years old, mean = 20.1 years) and old adults (n = 14; 65-75 years old, mean = 64.9 years). All participants were native English speakers with normal hearing sensitivity, defined as behavioral thresholds less than or equal to 30 dB at 0.5, 1, 2, 3, 4, 6 kHz in both ears (normal high-frequency pure tone averages for YNH = 0.5-8 kHz as 15-25 dBHL). All testing procedures were approved by the Institutional Review Board at Northwestern University.

Test Measures:
Cognitive Measures
1. NIH Toolbox Flanker Inhibitory Control and Attention
2. NIH Toolbox Flanker Inhibitory Control and Attention
3. Digit Recall Test
5. Dual Task Priority Auditory Working Memory

Multitasking (Kuhlman, 1973). The two tasks in the paradigm consisted of speech recognition task and a digit recall task. The sequence went as follows:
1. Quiet
2. Noise

There were 20 trials of this, within each of the four test conditions.

Test Conditions
To test attention allocation abilities, participants performed the dual-task paradigm under two distinct priority conditions:
1) Prioritize Speech Recognition
2) Prioritize Digit Recall

To test the influence of the listening environment on attention allocation, participants performed the dual-task paradigm in two distinct listening conditions:
1) Quiet
2) Noise

Figure 1: Average results of the Woodcock-Johnson III (WJ III) Test of Cognitive Ability: Auditory Working Memory

Figure 2: This figure shows the average results of the NIH Toolbox Flanker Inhibitory Control and Attention Task for YNH (blue) and ONH (red). There was a significant difference in scores between YNH and ONH (33\% = 2.754, p < 0.05).

Figure 3: Baseline performance for speech recognition in quiet and ONH (red), and Digit recall for YNH (blue) and ONH (red) for each listening condition (i.e., quiet vs. noise) and priority condition (i.e., sentence priority [cross/hard task] vs. digit priority [old task]).

Speech Recognition and Digit Recall in Baseline & Dual Task Recall

Figure 4: Speech recognition (A) and digit recall (B) performance of YNH (blue) and ONH (red) for each listening condition (i.e., quiet vs. noise) and priority condition (i.e., sentence priority [cross/hard task] vs. digit priority [old task]). For speech recognition, a repeated measures ANOVA revealed a main effect of listening condition (F(1,33) = 77.41, p < 0.001). But failed to reveal a significant main effect of age group or priority condition. There were no significant interactions. For digit recall, a repeated measures ANOVA revealed a main effect of listening condition (F(1,33) = 57.36, p < 0.001) and priority condition (F(1,33) = 32.45, p < 0.001). But failed to reveal a main effect of age group. Additionally, there was no interaction between listening condition and priority condition. On the other hand, the main effect of the baseline condition was observed (F(1,33) = 11.22, p < 0.01). These results suggest that, regardless of task, the presence of background noise disrupted performance.

Figure 5: Significant correlations were observed between WJ III Score and digit recall for YNH (blue) and ONH (red) during the dual-task conditions (i.e., when participants were multitasking) for all listening conditions and priority conditions (WJ III recall = 0.38, p < 0.01) and (DR_SP_NH = 0.64, p < 0.01; DR_DP_Q = 0.623, p < 0.01; DR_DP_NH = 0.611, p < 0.001). No significant correlations were observed between WJ III Score and digit recall at baseline, speech recognition at baseline, or speech recognition during the dual-task conditions were observed regardless of the listening condition or priority condition.

Conclusion
Age-related differences in executive control related to performance on the speech recognition and digit recall tasks (Figure 1 & Figure 2). However, we failed to observe any significant main effects for age group on either measure of speech recognition and digit recall performance. These results suggest that older adults are able to maintain baseline digit recall performance when prioritizing the digit recall task during the dual-task conditions (Figure 3 & Figure 4). These results suggest that all participants exhibited dual-task impairments that were not able to maintain baseline digit recall performance, even when it was designated as the prioritized task. In contrast, their ability to maintain baseline performance on the speech recognition task, even when instructed to prioritize the digit recall task and even in the presence of the background noise, suggest that the task may have been too easy (Figure 3 & Figure 4).

Future Directions
The participants remained at baseline performance for the speech recognition task even when instructed to prioritize the digit recall task, suggesting that cognitive resources were required for the speech recognition task as compared to the digit recall task. Therefore, we replaced the four task masker with a two-talker masker at +2 dB SNR to make the speech recognition task more difficult. Participants were 2 YNH (YNH_1 = 20 years and YNH_2 = 20 years).

Figure 6: Individual data points of participant YNH_1 (purple) and YNH_2 (red) for speech recognition (A) and digit recall (B) performance of YNH (blue) and ONH (red) for each listening condition (i.e., quiet vs. noise) and priority condition (i.e., sentence priority [cross/hard task] vs. digit priority [old task]). The following predictions hold: there is a dual-task cost for digit recall, but not speech recognition.

References

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