Neural basis of the impact of multitasking on working memory performance in older adults

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Introduction
1) External interference negatively impacts working memory (WM) whether it is completely irrelevant (i.e., distractions), or a component of a concurrent, secondary task (i.e., interruptions, or multitasking) 1-3, 9. 2) We recently showed that interruption negatively impacts the WM performance of healthy older adults to a greater degree than younger adults 7, 8. 3) Our group recently found that the degree to which Interupters are processed correlates with reduced WM performance 6, 8. However, using electrophysiology techniques we did not find evidence to suggest that older adults process interrupting stimuli more so than younger adults 7. 4) This suggests that a unique mechanism underlies the negative impact of interruption on WM performance in aging.

Neural Hypotheses and Results
We posited three hypotheses for the neural basis of the aging interruption effect, which were systematically evaluated in the current fMRI study:

Hypothesis 1: Older adults direct more attention toward the interruption.
Younger adults suppress FFA activity when viewing the distractor-in-DS (compared to control). Older adults do not. Increased activity in response to interference predicts a WM performance decline, replicating EEG results.
In light of this, the FFA activity seen here for DS provides an explanation for the impact of distraction on WM performance in older adults.
Yet, age groups do not differ in FFA activity, so this does not help explain the impact of interruption on WM.

Hypothesis 2: Older adults fail to reestablish the functional connection of the WM maintenance network following interruption.
In young subjects (left panel), interruption causes a large drop in FFA-MFG functional connectivity, but they are able to restore the connection following interference (in Delay 2).
Older subjects (right panel) also experience a loss of FFA-MFG functional connectivity during interruption, but they are unable to reestablish the connection in Delay 2.
This represents the inability of older adults to reactivate the representation of the encoded stimulus.

Hypothesis 3: Older adults continue to process interruptions even after they are no longer present or relevant.

Behavioral Results
Comparing accuracy and RT between age groups:
• The impact of distraction on WM performance did not differ between age cohorts.
• Older subjects performed significantly worse than younger subjects during interruption (5).
• Importantly, indices between conditions (NI-DS, NI-OS) were significantly different between age groups. This means that, behaviorally, both distraction and interruption had a greater impact on older adults’ WM performance compared to no interference.

Methods
The paradigm was the same as performed by younger adults in a recent study. 4:

Conditions (tasks):
Interruption Stimulus (IS): During the interference period, subjects were instructed to respond to the interfering stimulus if the face was that of a man over 40 years of age.
Distractor Stimulus (DS): During the interference period, subjects were instructed that the interfering stimulus was entirely irrelevant.
The experiment also included two other conditions:
• Control (C): No interference stimulus was presented and the subjects were instructed to keep the face sex list.
• DS-200 (DS): A distractor stimulus was presented every 200 ms, and the subjects were instructed to ignore the stimulus.

Conclusions
• Multitasking (i.e., interruption) is associated with a disproportionate drop in working memory performance in older adults, compared to younger adults, replicating previous results.
• Neural data suggest that this aging effect is not mediated by an increase in attention directed toward interrupting stimuli.
• Whole-brain functional connectivity data suggest that older adults have a diminished ability to reactivate internal representations of the stored memories following interruption.
• Similarly, older adults appear to have difficulties disengaging from interrupting stimuli. This may be an underlying mechanism of the inhibition deficit of deletion in aging noted by Hasher et al. (1999).
• Multitasking leads to a more significant working memory disruption in older adults due to an inability to dynamically switch between functional neural network connections.

References

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