Multi-attribute Memory and Decision-Making Across the Lifespan: Neural Representations and Behavioral Dynamics

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Introduction

- Everyday consumer purchasing decisions, especially in the digital market space, require many cognitive processes including **memory.**
- However, very little is known about how memory affects **decision making**, especially across the **lifespan**
- Older Adults (65 <) often have difficulties in memory with normal aging; they struggle with more cognitively demanding tasks, as well as have a decrease in their **working and episodic memory.**[1,2]
- Several studies of memory and aging reveal **compensatory mechanisms**, both behaviorally and neurally, where older adults functionally adapt to maintain stable cognition.[3,4,5]
- Similarly, older adults may use strategies to help with decision making that requires high cognitive demand.
- Our study utilizes stimuli presentation that more accurately reflects everyday decision-making tasks – we show stimuli *simultaneously,* which mirrors our decision tasks such as financial investments where we have to juggle multiple pieces of information at once.

Research Questions

- How does memory affect decision making, and how does this change across the lifespan?
- Are older adults using strategies to compensate for their decline in cognitive capabilities?

Methods

Participants

N = 74 (20 younger adults (YA), 33 middle-aged adults (MA), 21 older adults(OA))

Task Design

Participants encoded attributes of various consumer goods and had to decide between pairs of competing products (e.g. two watches) in the scanner. Trials varied in (1) memory and (2) number of attribute rows.

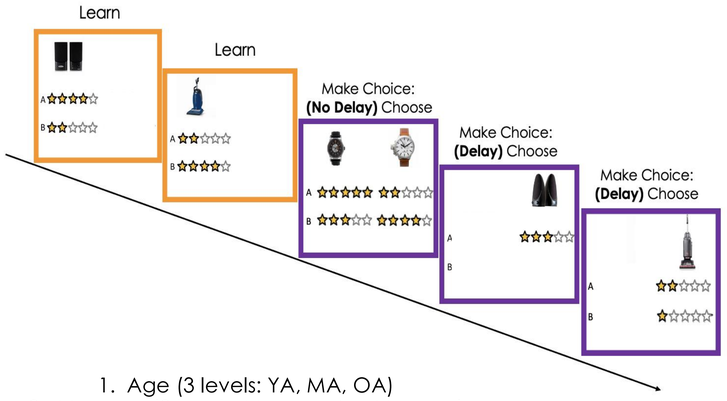
Variables

(1) Memory vs No memory: In no memory trials (no delay choose), participants made a decision while both items and their attributes were shown simultaneously on the screen. In memory trials, participants first *learned* product each products and their attributes separately, and then made a decision once the second product was shown (delay choose)

(2) Memory Load: Some products had 1 row of attributes, and some had 2 rows of attributes.

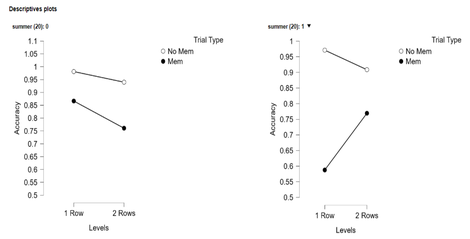
Methods & Results

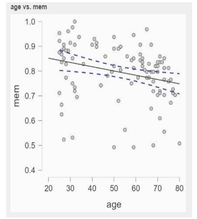
Experimental Design



1. Age (3 levels: YA, MA, OA)
2. Memory (2 levels: Memory, No Memory)
3. Memory Load (1 Row vs 2 Rows)

Behavioral Results



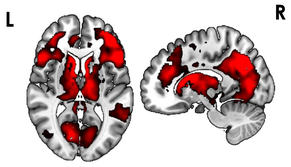


- There was a **negative correlation** with memory and age on memory trials
- **"Summers"** were participants who used a summation strategy to add together the 2 rows of attributes, rather than holding them separately in mind
- Most "summers" were OA - Strategy could compensate for the lower performance on mem trials, as it is only during 2-row mem trials that the summers' accuracy (the plot on the right) is closer to that of non-summers.
- Second independent samples T-Test: Summers are high performers on the inhibitory control task.

Results

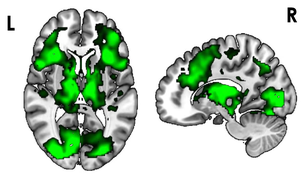
Main Effects

Memory > No Memory



Mid Occipital Gyrus, Default Mode Network, parahippacampal gyrus

2 Rows > 1 Row

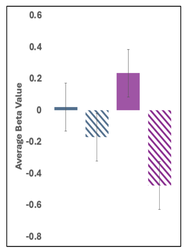


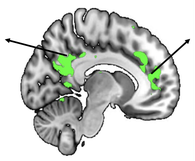
Default Mode Network, Precuenus, mPFC

Interaction Effects

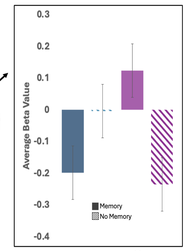
OA > YA in Mem > No mem

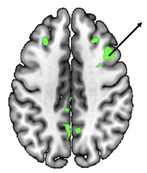
Precuneus



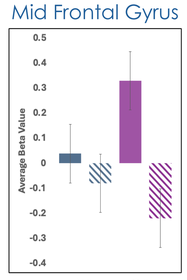


Anterior Cingulate



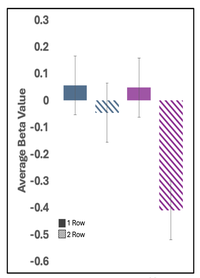


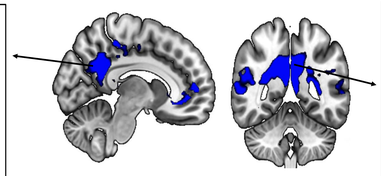
Mid Frontal Gyrus

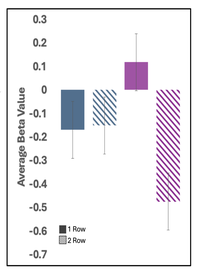


2 row Mem > 1 row mem

Precuneus/Posterior Cingulate



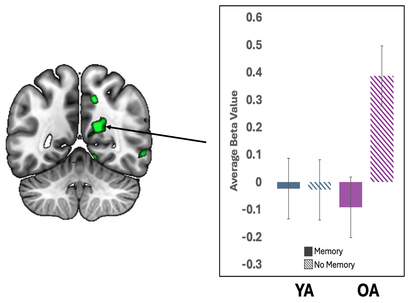




Results cont.

OA > YA in 2 row > 1 row

Cingulate



Discussion

- Older adults have worse memory when faced with cognitively heavy tasks relative to their younger adult counterparts.
- They showed *decreased* activation in regions related to the Default Mode Network (DMN) during memory tasks relative to younger adults, pointing to an increased effort needed for difficult tasks.
- This suggests that older adults adapt by recruiting different cognitive and neural resources to maintain performance. However, this increased reliance on the DMN may come at the cost of greater cognitive effort and neural resource allocation, which could make memory retrieval less efficient compared to younger adults.
- Increased task difficulty in the 2-row memory condition led to greater suppression (i.e., more negative activation) of Default Mode Network regions such as the precuneus and posterior cingulate cortex.
- This pattern reflects greater cognitive effort and attentional engagement, as the brain reduces internally focused processes to meet higher memory demands.
- The findings are consistent with previous findings that DMN activity decreases with increased cognitive load, supporting effective task-focused processing.

References

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