The impact of learning sequences in encouraging distinct memory representations to support associative inference in older adults:

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Introduction

- Associative inference is the ability to indirectly link two elements across related experiences based on their shared commonalities.[1]
- This ability has been shown to be supported both by distinct, pattern separated memories, or integrated memories. The order in which information is studied can bias whether learned episodes become integrated or separated.[1,2]
- Prior research shows that associative inference develops in adolescence and is linked to hippocampal structure, but little is known about how it changes as individuals enter older adulthood, a period marked by cognitive decline.[3,4]
- This study explores whether blocked learning sequences can support memory and associative inference in older adults by reducing interference and promoting memory integration.

Research Question

How do different learning sequences impact both direct memory and associative inference in older adults?

Data

Participants:

- 122 older adults, all right-handed (76 for blocked condition, 46 for interleaved)
- 117 younger adults, all right-handed (63 for blocked condition, 54 for interleaved)
- Recruited both in-person and online via Prolific

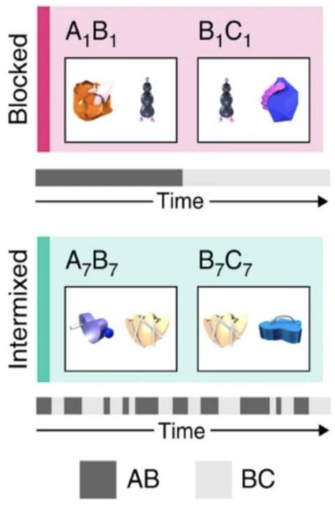
Task & Stimuli:

- Participants learned 12 ABC triads using 36 abstract 3D objects (Blender)
- Blocked: A–B pairs learned first, then B–C
- Interleaved: A–B and B–C mixed
- Final tests included direct memory and indirect A–C inference (forced choice)

Analysis:

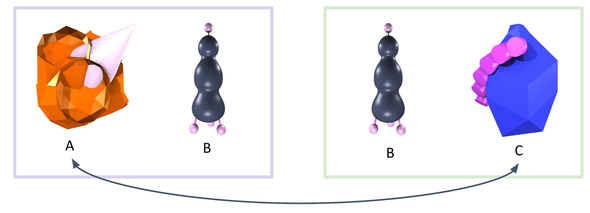
- Excluded trials with RTs <300ms or >10000ms
- Independent sample t-tests between schedule types
- Inference phase accuracy filtered by correctly learned A-B and B-C pairs.

Task Design

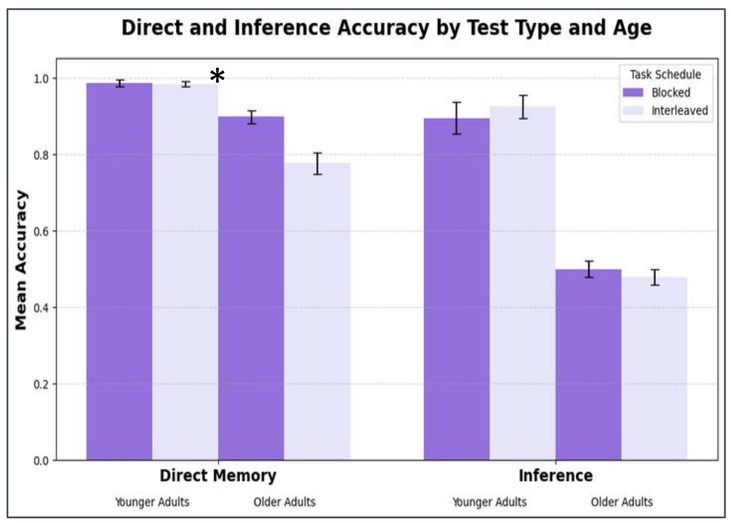


(Adapted from Schlichting et al., 2015)

Pattern Separation vs. Integration

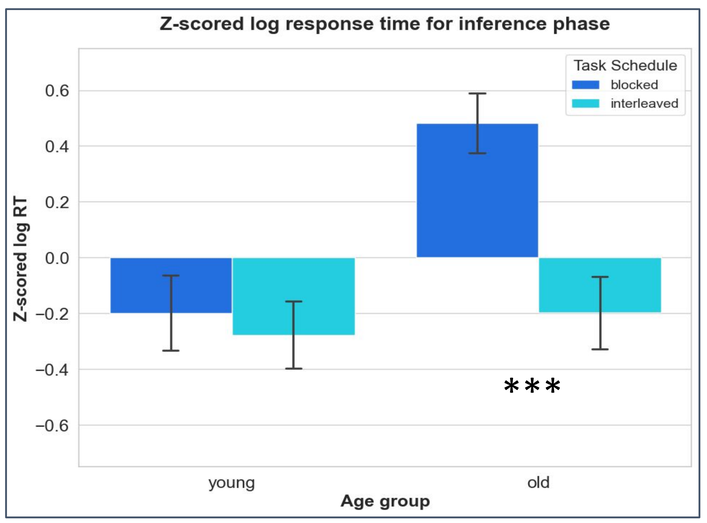


Older adults accuracy varies by test type



Interaction of Age:Direct Memory
***f*=6.7241 *p*=.01**

Blocked training increases deliberation



Paired sample t-test:
***t(100)*=4.025, *p*<.001**

Results

- Increased accuracy in the direct memory phase suggests successful learning of individual AB and BC pairs.
- In older adults, blocked training improves direct memory, but not associative inference.
- Older participants deliberate longer during blocked trials, relative to intermixed, a potential signature of using separated representations to perform inference on demand.

Discussion

Benefit of blocked learning in older adults

- The sequence in which information is presented during learning plays an important role in associative memory for older adults.
- Blocked learning improves memory in older adults, possibly by reducing memory interference between overlapping events.
- Trending response time differences may suggest that blocking and interleaving result in different memory representations: slower RTs after blocked learning may suggest that separate memories have to be retrieved and recombined at time of inference.

Limitations and future directions

- Use fMRI to evaluate whether neural representations supporting behavior are in fact integrated or separated.
- Evaluate "hybrid" learning schedules to see if benefits of blocking can be obtained without strong separation.
- Fit compression models to behavior and neural activity, determine process-level affordances that give rise to performance differences.

References

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Acknowledgements

Thank you to Eshika, Bryce and the UCI Computational Cognitive Neuroscience Lab for helping collect and score the data for this experiment.

Supplementary Material