Quantifying Flexibility in Thought: The Resiliency of Semantic Networks Differs Across the Lifespan

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Introduction

- Older adults show greater reserve of semantic knowledge, but their word retrieval abilities decline with age.1
- Recent advances in network science have investigated the effect of aging on semantic memory structure.2,3
- Percolation analysis provides a quantitative measure of the flexibility and robustness of a semantic network.4 It examines how a semantic memory network is resistant to "attacks", or breaking apart.

The effect of aging on semantic memory structure is still undetermined.

Present Study

Aims

- We used percolation analyses to examine how semantic networks of younger and older adults break apart.
- We examined the percolation integral, which measures how fast the network breaks apart into separate modules.

Predictions

- Younger adults’ semantic networks would be more efficient, more connected and less segregated compared to older adults.
- Older adults’ network would break apart more quickly (i.e., at lower thresholds) and have a smaller integral value and a steeper percolation slope than younger adults.

Methods

Across 3 Datasets

- 78 Younger, 78 Older Adults
- English monolinguals
- Mean Age(SD) of Younger Adults: 24.6 (5.3)
- Mean Age(SD) of Older Adults: 67.18 (5.41)

Semantic Network Analysis

Calculated at the group level from verbal fluency data and analyzed through graph theory measures of clustering coefficient (CC), average shortest path length (ASPL) and modularity (Q).

Percolation Analysis

Measures the robustness of complex networks under targeted or random attacks. Removes nodes (words) or links between nodes whose strength falls below an increasing threshold.5

Percolation Analysis: Across all 3 datasets, the percolation integrals of the younger adults were larger than older adults.

Older adults’ semantic networks are less robust and broke down faster than that of the younger adults’.

Older adults have diminished flexibility in their semantic network, despite the stability of semantic knowledge across the lifespan.

Conclusions

Semantic Network Analysis

- Across 3 datasets, younger adults had lower average shortest path lengths, and higher clustering coefficients. Older adults had higher modularity values compared to the younger groups.

- Dataset 3 showed that younger adults had higher modularity and path lengths while there was no difference in clustering.

Percolation Analysis

- Across all 3 datasets, the percolation integrals of the younger adults were larger than older adults.

- Older adults’ semantic networks were less robust and broke down faster than that of the younger adults.

- Older adults have diminished flexibility in their semantic network, despite the stability of semantic knowledge across the lifespan.

References:


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