The dynamic interaction between narrative and gaze reinstatement across age groups

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Introduction

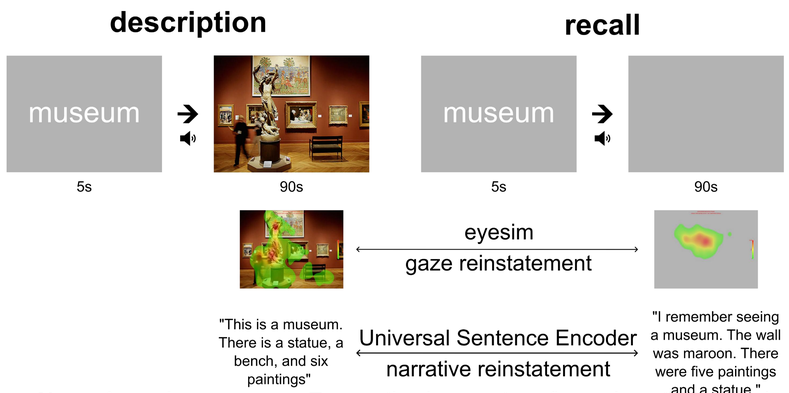
- Our memory of visual scenes includes both the eye movements we used to examine the scene, as well as our verbal description of what we saw
- Repeating eye movements made during encoding can facilitate the retrieval of other information, even when nothing is presented on the screen. As such, eye movements may scaffold the retrieval of verbal descriptions of a scene [1, 2]
- As of yet, this question has not been examined. Here, we investigated the temporal interactions between eye movements and verbal descriptions during recall, and whether this differs between younger and older adults

Do narrative and gaze reinstatement temporally interact during memory recall?

Given that aging affects both eye movements and memory, does aging change their temporal interaction?

Task

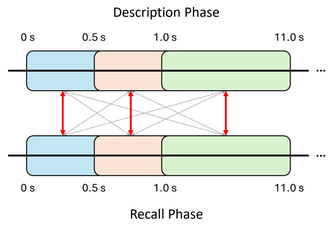
- 32 younger (M_{age} = 25.22) and 32 older adults (M_{age} = 73.44) described 10 photos for 90 seconds. These descriptions were subsequently recalled in response to a title cue associated with each photo.



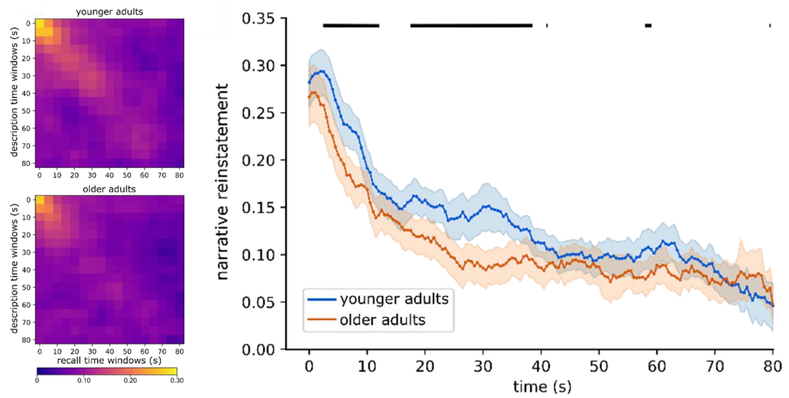
- **Narrative reinstatement**: Transcribed narratives from description and recall were converted to 512-dimension vectors using Universal Sentence Encoder. We calculated the cosine similarity between the two vectors to derive narrative reinstatement. [3]
- **Gaze reinstatement**: Eye fixation patterns during description and recall were converted into duration-weighted, smoothed fixation density maps. We calculated Fisher's z-transformed Pearson correlation between the two heatmaps to derive gaze reinstatement using eyesim. [4]

Sliding Window Analyses

- The entire narratives / eye movements were segmented into chunks by a moving window (size = 10s, step = 0.5s)
- We quantified narrative and gaze reinstatement over time by calculating similarity values between any two windows.

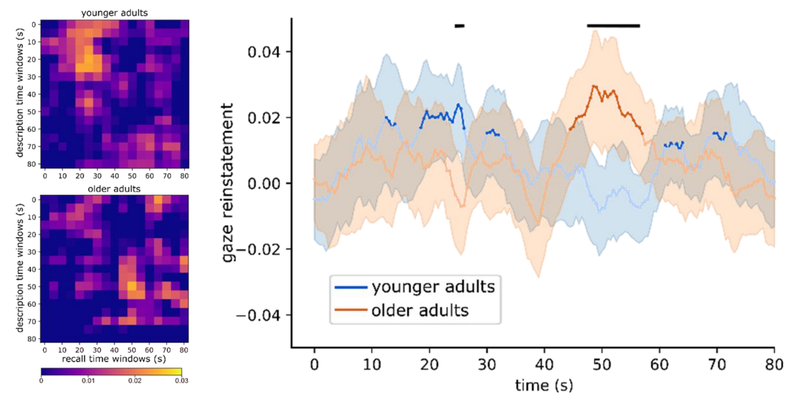


Narrative Reinstatement



- Narrative reinstatement was higher along the diagonal of the similarity matrix, indicating preserved narrative structure
- Narrative reinstatement decreased over time, but consistently above 0
- Younger adults showed higher narrative reinstatement than older adults in the earlier half of the trial

Gaze Reinstatement

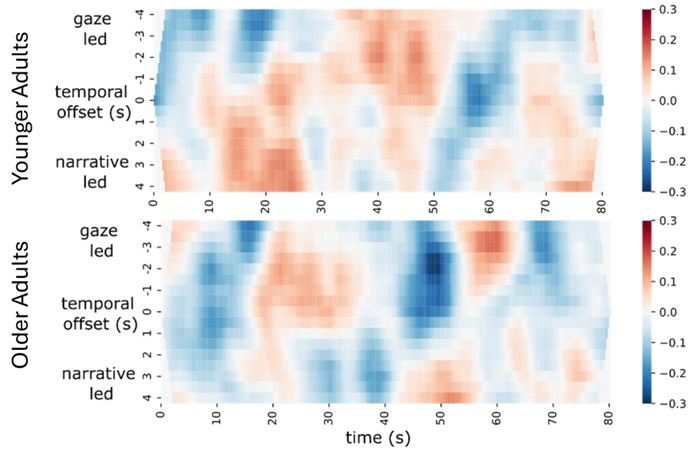


- Younger adults showed above-zero gaze reinstatement earlier (~10-30 s) than older adults (~40-60 s).
- Significant age differences in favour of younger adults earlier, and in favour of older adults later, in the trial.

- We used a longer step size of 5 seconds in the similarity matrix heatmaps to ease computation
- The shaded area indicates the 95% confidence interval at each time window for each age group derived by bootstrapping.
- When the lower bound of the confidence interval at a time point is above zero, its corresponding dot and connecting lines are highlighted in darker shades.
- Time windows with a significant age difference are marked by black lines (Bonferroni-adjusted $p < .05$)

Narrative-Gaze Correlations

- We used correlation map analysis (CMA) to visualize the time-dependent relationship between narrative and gaze reinstatement
- CMA calculates the instantaneous correlation between the narrative and gaze reinstatement time series at various temporal offsets [5]



- Both age groups showed correlations between narrative and gaze reinstatement at various temporal offsets, suggesting a close relationship between them.
- In younger adults, narrative preceded gaze reinstatement at the beginning of the trial; subsequently, gaze preceded narrative reinstatement before this switched again.
- This alternating pattern was also present in older adults, albeit at different times of the trial and with weaker strength.
- For both groups, the times during the trial when gaze reinstatement was significantly above zero temporally corresponded with time points in the CMA when narrative preceded gaze reinstatement.

Take-home Messages

- Results suggest an iterative feedback loop between narrative and gaze reinstatement, whereby narratives may set predictions to guide eye movements to informative regions, and gaze facilitates the retrieval of associated details in verbal narratives
- Age-related differences exist in the temporal profile of narrative reinstatement, gaze reinstatement, and the iterative feedback loop between them. Such differences may arise from age-related changes in the nature of memory representations, and/or the interaction between eye movements and memory.

References

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