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Background

- There is a reciprocal relationship between memory and viewing^{1,2,3,4}
- Memory representations are constructed as visual information is sampled; these representations can exert a top-down influence and can continuously guide viewing on a *moment-to-moment* basis⁵
- Memory-related viewing behavior is diminished in healthy and pathological aging, which are associated with reduced integrity of the medial temporal lobe (MTL), including the hippocampus, a region critical for memory functions^{2,6}
- Mild cognitive impairment is a clinical diagnosis which often progresses to dementia and is associated with MTL volume declines (specifically the hippocampus). Thus, this group may provide a key understanding of how eye movements are perturbed due to pathological aging

How is moment-to-moment visual exploration influenced by varying degrees of MTL atrophy in the absence of any explicit memory demands?

Methods – Novel Scene Viewing Task

- Younger adults (YA, n = 38), healthy older adults (OA, n = 49), and individuals with mild cognitive impairment (MCI, n = 14) viewed novel images as their eye movements were monitored
- 120 novel scenes from a variety of categories (ex. art, outdoor, indoor, social) were viewed for 5 secs/scene
- OAs completed the Montreal Cognitive Assessment (MoCA), a cognitive screening tool used to detect clinically undiagnosed MCI
- Eye movement metrics were used to quantify visual exploration of scenes in terms of the:
 - Amount**: fixation count, fixation duration (ms), and saccade count
 - Extent**: saccade amplitude and area of exploration (RMSD⁷)
 - Manner**: number of gaze fixation clusters, entropy (or randomness) of gaze pattern⁸
- A multivariate analysis, partial least squares correlation (PLSC), was used to assess which scene exploration metrics differentiated between YA, OA, and MCI (Task PLS)
- Behavioural PLS was used to assess how the pattern of scene exploration varied with MoCA scores in OAs



Summary of Exploration Metrics

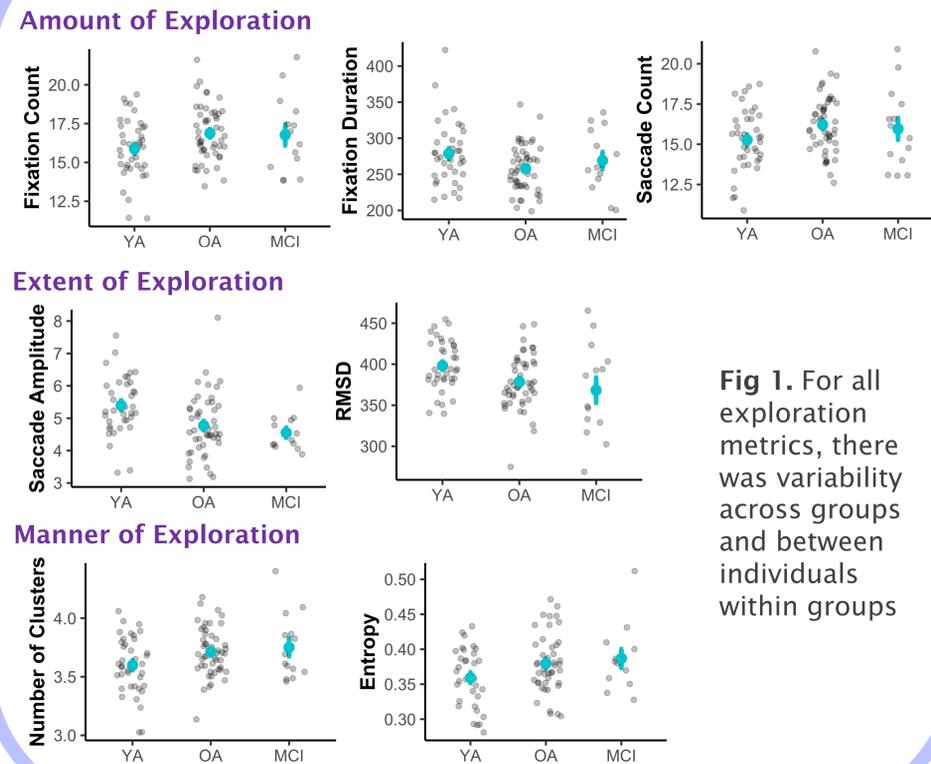
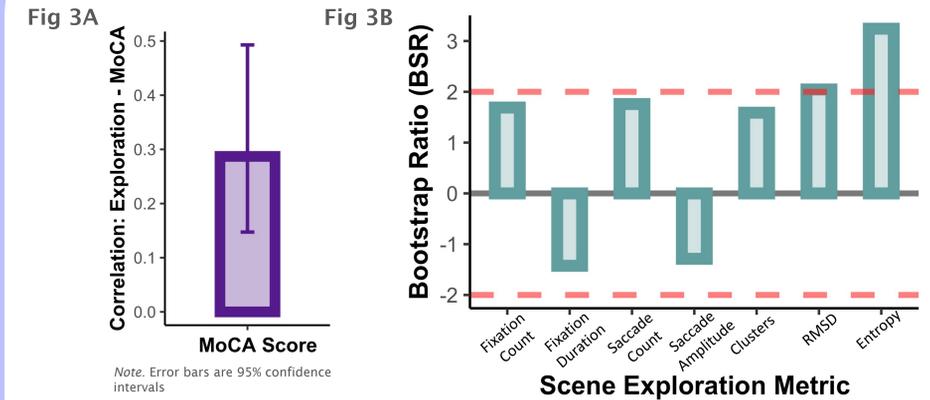


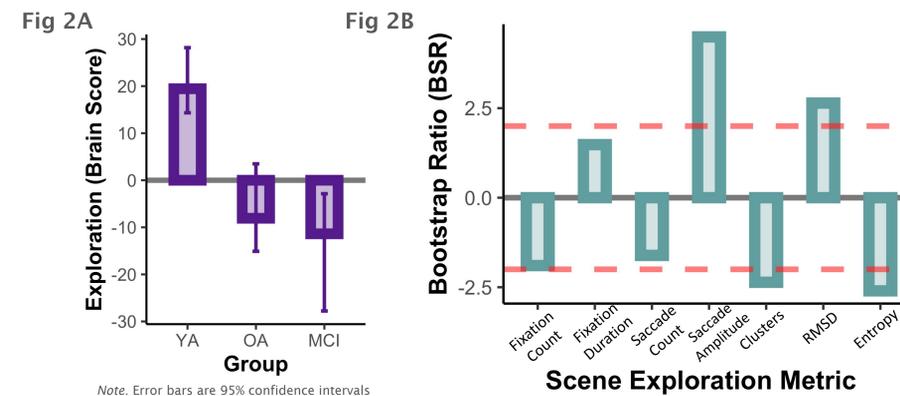
Fig 1. For all exploration metrics, there was variability across groups and between individuals within groups

Association between exploration and cognitive function in older adults



- MoCA scores in OAs: $M = 27$, $SD = 2.14$, range = 22 – 30
- There was a significant correlation ($r = .29$, $p = .034$, Fig 3A) between the scene exploration metrics and MoCA scores in OAs. As MoCA scores increased, there was a robust increase (BSR > 2) in the area of exploration (RMSD) and in entropy
- OAs with higher MoCA scores showed a shift in the pattern of scene exploration compared to YAs (note bars flipped from Fig 2B to Fig 3B) whereas OAs with lower MoCA scores showed a similar pattern to that of YAs

Group Differences in Exploration



- YAs reliably expressed (LV1 in Fig 2A, $p = .004$, 84% covariance) the pattern seen in Fig 2B—they had fewer gaze fixations, larger saccade amplitudes, fewer fixation clusters, yet a greater area of the scene was sampled by the eyes (RMSD), with less randomness (entropy) (BSR > 2)
- OAs and (more robustly) MCI adults expressed the reverse (negative bars in Fig 2A) visual exploration pattern (Fig 2B) compared to YAs
- OA & MCI groups had more gaze fixations, smaller saccade amplitudes, more fixation clusters, yet a smaller area of the scene was sampled by the eyes (RMSD), with more randomness (entropy)

Conclusions

- The amount, extent, and manner of scene exploration differed across groups with presumed varying MTL integrity. Despite increased visual sampling, OAs and (more prominently) the MCI group, explored scenes to a lesser extent and did so in an altered manner compared to YAs. This finding suggests that memory representations are constructed online and guide viewing in the moment
- Unlike OAs with lower MoCA scores, OAs with higher MoCA scores can shift the pattern of scene exploration, likely to compensate for age-related functional decline in the MTL
- Even in the absence of any explicit memory demands, eye movements during free viewing can be used to identify MTL decline in normal and pathological aging

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This work was supported by funding from NSERC and CIHR awarded to A.K. and J.D.R.

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