Path Integration using Eye & Hand Movements in Younger & Older Adults

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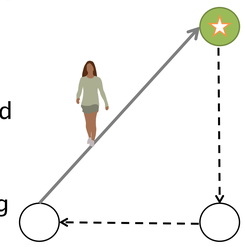
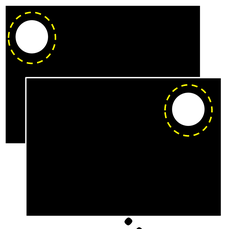
Background

- Path Integration (PI): Ability to track current position relative to the starting point in a route[1]
- Grid cells in the entorhinal cortex (ERC) support PI and in older adults, reduced grid cell representations are associated with greater PI errors[2,3]
- Activity in the ERC is modulated by running direction in navigable space and direction of eye movements in visual space[4-6]
- This suggests that the ERC performs similar computations on a variety of input (perceived body and eye movements)



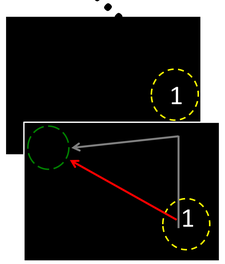
Are processes comparable to path integration used to update eye and hand position after movement?

Methods



Tablet Task

Eye-tracking Task



- Younger (n=23) & older adults (n=14) completed manual tablet and eye-tracking tasks in which they followed routes guided by auditory or visual cues, respectively. The eyes were closed during the tablet task
- At the end of a route, a cue (ex.1) prompted participants to revisit a previous location in the route

2 blocks:

1. Home-location block: Prompted to return to the starting point on each trial; i.e., only homing trials
2. Any-location block: Prompted to return to one of the locations presented on the route, except for the final location

Note: For subsequent analyses, only homing trials from both blocks were used

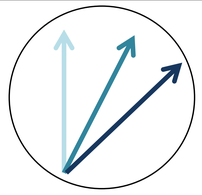
Latency: Time required to initiate movement after test prompt

Revisits: Number of mid-route locations revisited en route to the starting point of the route

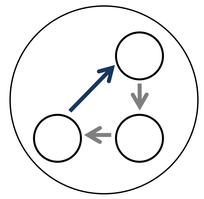
Latency and Revisits were modeled as a function of **age group, block, and the number of positions in a route**

Predictions

	Continuous Updating	Configural Updating
During the route	Vector updated continuously	Route representation is created
Vector computation	Online	Offline
Working memory load	Low	High
Response latency & Number of revisits	Do not vary with the number of positions in the route	↑ with the number of positions in the route

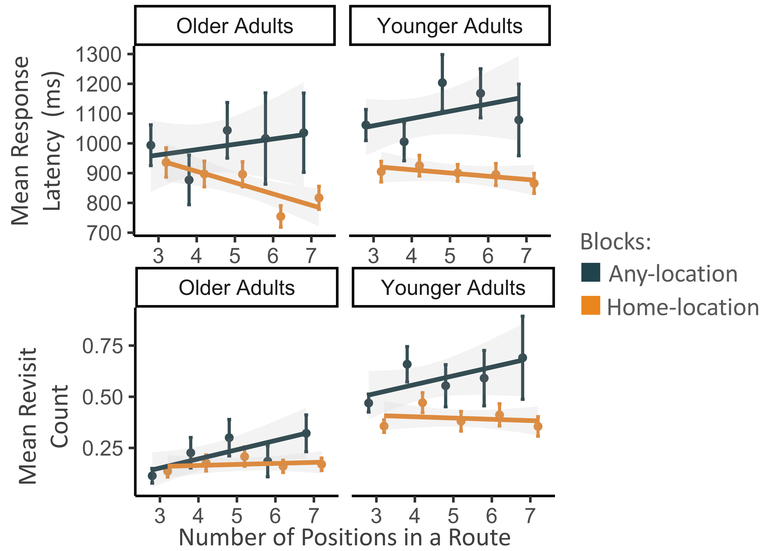


Continuous Updating



Configural Updating

Results: Tablet Task



- **Latency:** *Decreased* as the number of positions in a route increased in the home-location block, likely because the expectancy for the test prompt increased with number of positions which increased readiness and speed of response. Latency *did not change* as number of positions increased in any-location block which might reflect privileged access to the starting point
- **Revisits:** Younger adults (YAs) revisited more mid-route locations than older adults (OAs), more mid-route locations were revisited during the any-location than home-location block, and on average, revisits increased with the number of positions in a route

Results: Eye-tracking Task

- **Latency:** As in the tablet task, latency *decreased* as the number of positions increased in the home-location block, but *did not change* with number of positions in the any-location block
- **Revisits**: YAs revisited *more* mid-route locations compared to OAs. For YAs revisits generally increased with number of positions in both blocks, but for OAs, revisits increased with number of positions only in the any-location block

Conclusions

- We see similar patterns of results across modalities in this study. Differences in overall response latency across tasks may be attributed to smooth and continuous hand movements in the tablet in contrast to saccadic eye movements in the eye-tracking task
- In both tasks, younger adults represent and use the configural route representation more than the older adults, even in conditions in which position can be updated continuously
- As in previous studies with whole-body PI in humans[7], we see evidence for the use of different PI strategies to update position after hand or eye movement

Processes comparable to path integration reflect how eye and hand position is updated after movement.

References

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