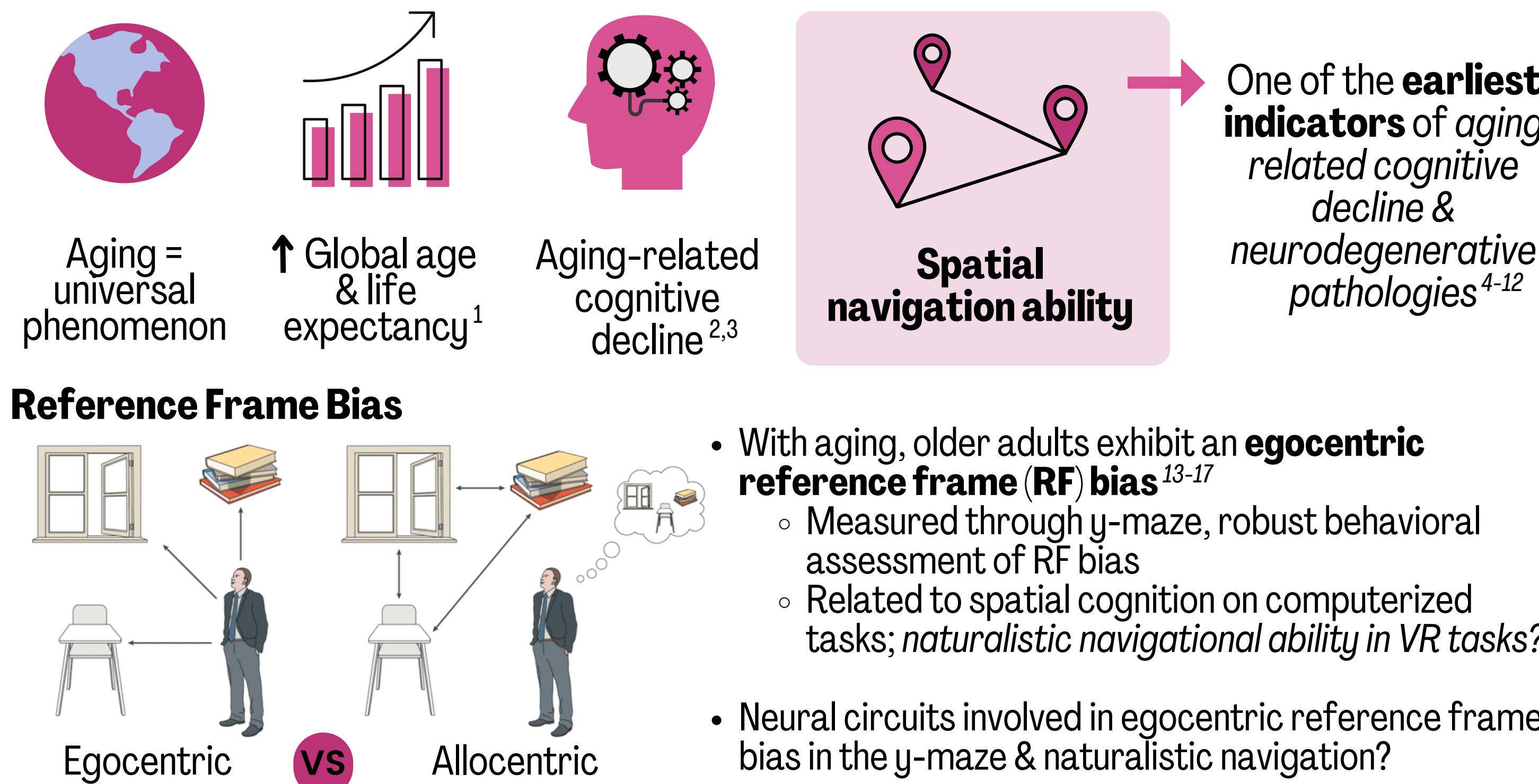


# Interactions between spatial navigation ability and cognitive function in the aging brain



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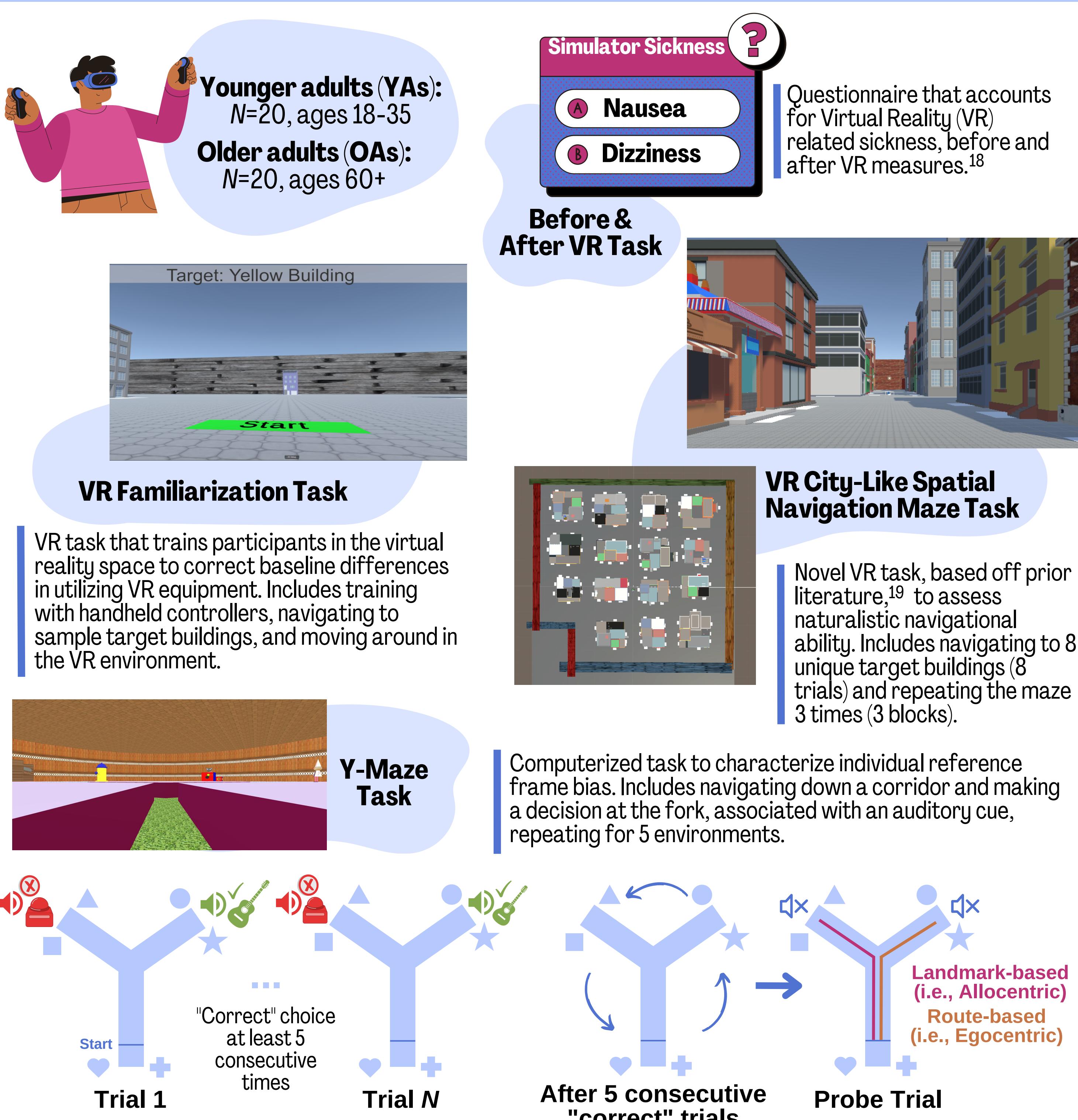
## Introduction



### Study Objectives:

- Determine aging effects on novel virtual reality maze to measure naturalistic navigational ability in lab environments.
- Characterize effects of aging-related egocentric bias on naturalistic navigational ability.
- Test circuit mechanisms of egocentric bias, utilizing concurrent TMS-fMRI to look at connectivity between the posterior parietal cortex, retrosplenial cortex, & hippocampus.

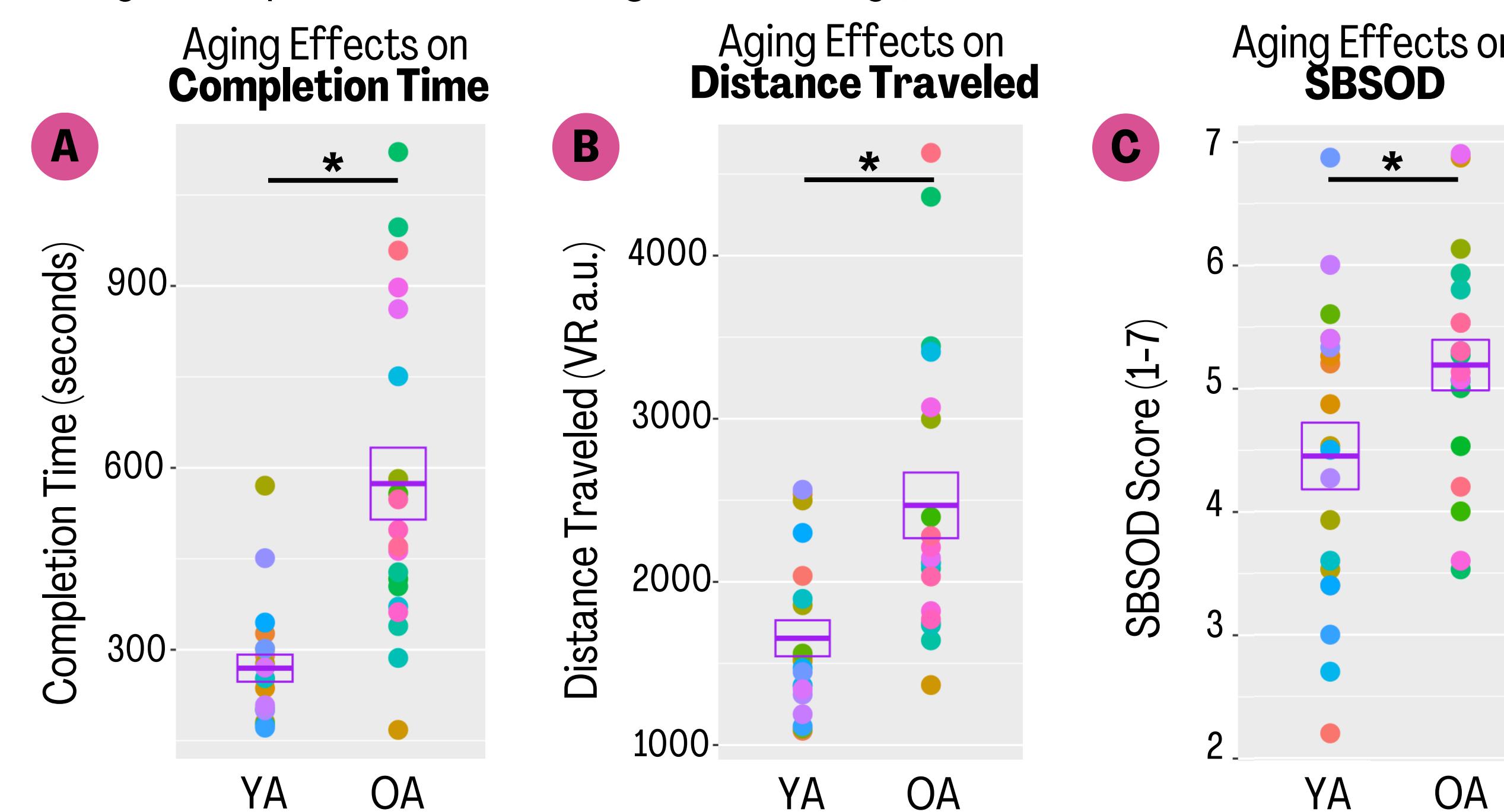
## Methods



## Results

### 1. OAs exhibit lower naturalistic navigational ability, compared to YAs.

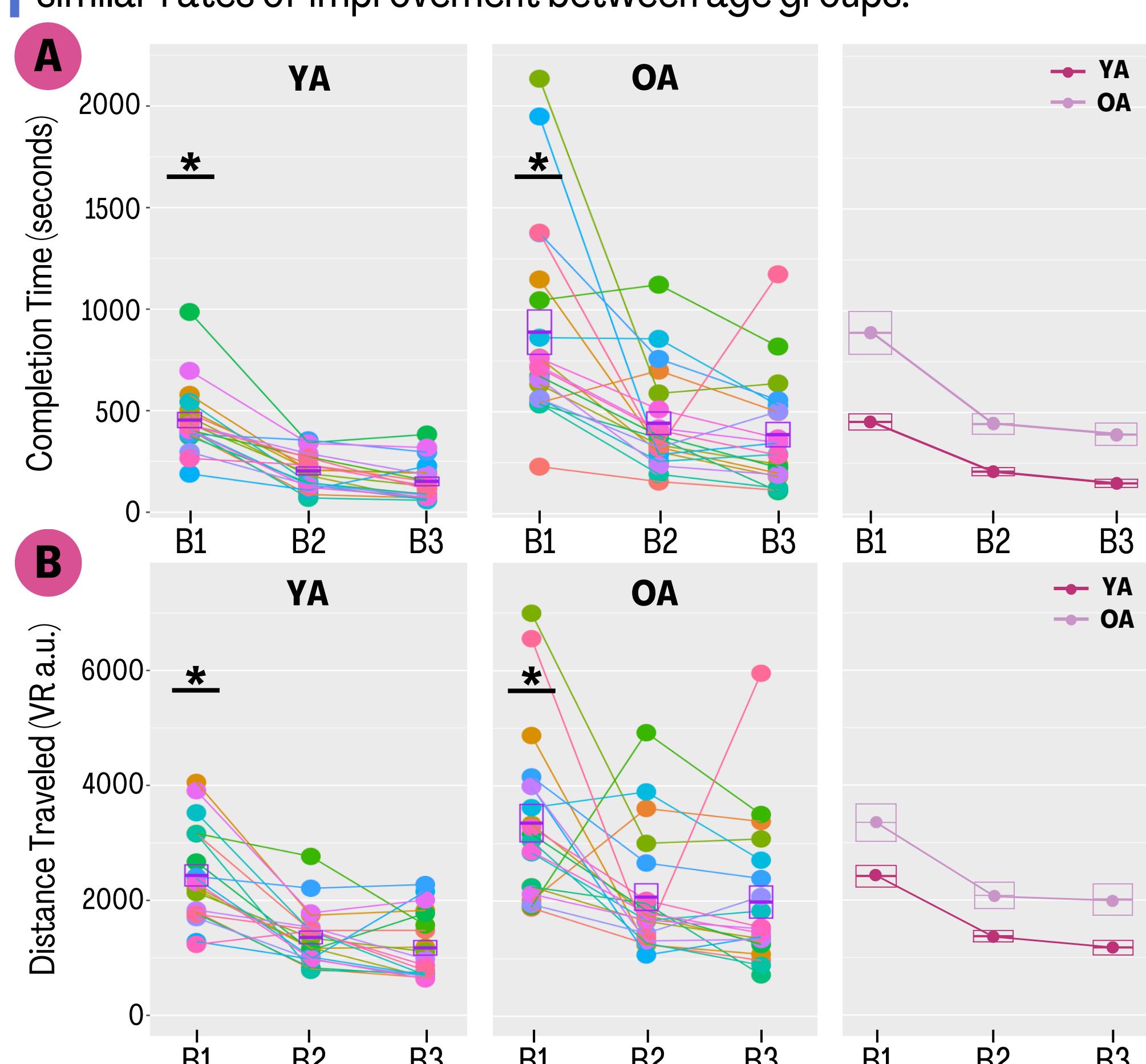
Participants completed 3 blocks of the VR City-Like maze to index naturalistic navigational ability and a questionnaire of navigational ability (Santa Barbara Sense of Direction, SBSOD).



**Figure 1.** Mean (A) completion time (CT) and (B) distance traveled (DT) on all blocks of City-Like VR Maze for YAs and OAs. (C) Individual self-report of navigational ability. Results indicate that YAs have decreased completion times ( $p = 6.706e-05$ ) and distances traveled ( $p = 0.001314$ ) than OA, indicating better navigation ability in YAs. Interestingly, OAs rated themselves as better navigators than YAs ( $p = 0.03666$ ).

### 2. Task performance improvement is similar between OAs and YAs.

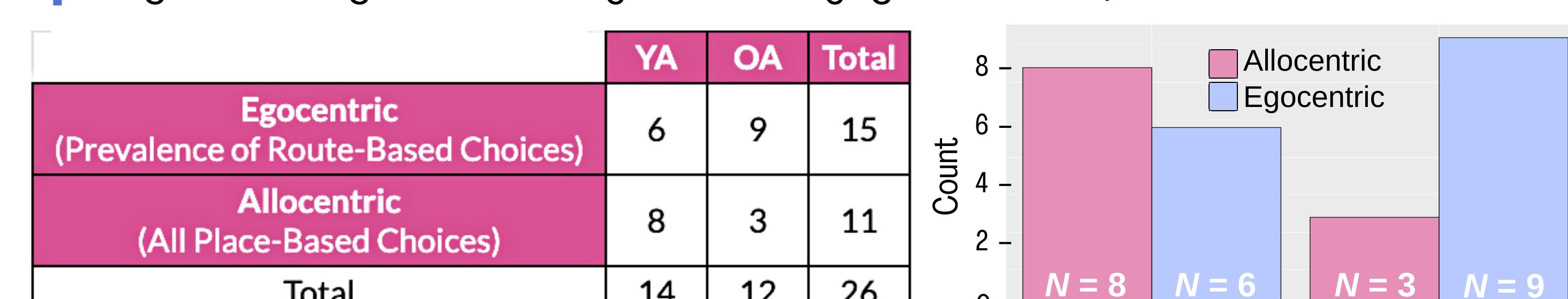
City-Like VR Maze outcome measures compared between blocks revealed significant reductions in completion time and distance traveled between Block 1 and Blocks 2 & 3, with similar rates of improvement between age groups.



**Figure 2.** (A) Completion times and (B) distances traveled per block of the City-Like VR Maze for YAs and OAs. In YAs, both outcome measures were significantly decreased between B1-B2 (CT  $p = 1.827e-06$ , DT  $p = 4.644e-11$ ) and B1-B3 (CT  $p = 7.333e-08$ , DT  $p = 2.507e-06$ ), but not B2-B3 (CT  $p = 0.07838$ , DT  $p = 0.289$ ). The same phenomenon was observed in OAs, with significantly decreased outcome measures between B1-B2 (CT  $p = 0.001022$ , DT  $p = 0.002786$ ) and B1-B3 (CT  $p = 0.0003405$ , DT  $p = 0.002804$ ), but not B2-B3 (CT  $p = 0.4971$ , DT  $p = 0.8132$ ).

### 3. OAs exhibit increased egocentric reference frame bias.

Participants also completed a computerized Y-Maze task to index reference frame bias, categorized as "egocentric" if they exhibited any egocentric bias, and "allocentric" otherwise.

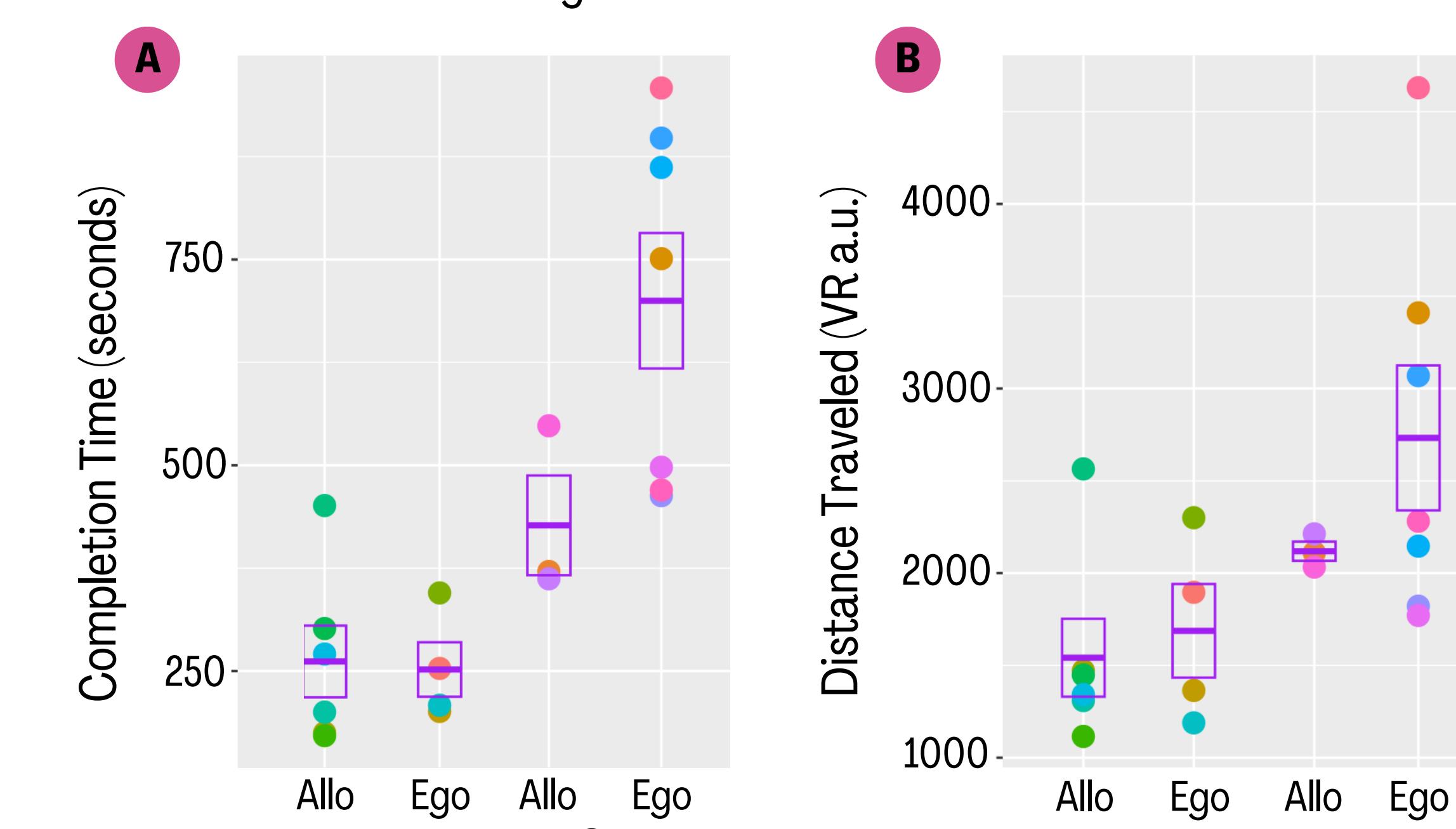


**Figure 3.** Number of Participants Exhibiting Egocentric and Allocentric Reference Frame Bias. Participants were classified as "Egocentric" if they made any egocentric choices on the 5 environments of the y-maze and "Allocentric" if they made all allocentric choices.

## Results (cont.)

### 4. Egocentric bias may be associated with aging-related decreased naturalistic navigation ability.

Interactions between effects of aging and reference frame bias were characterized on outcome measures of the VR City-Like Maze.



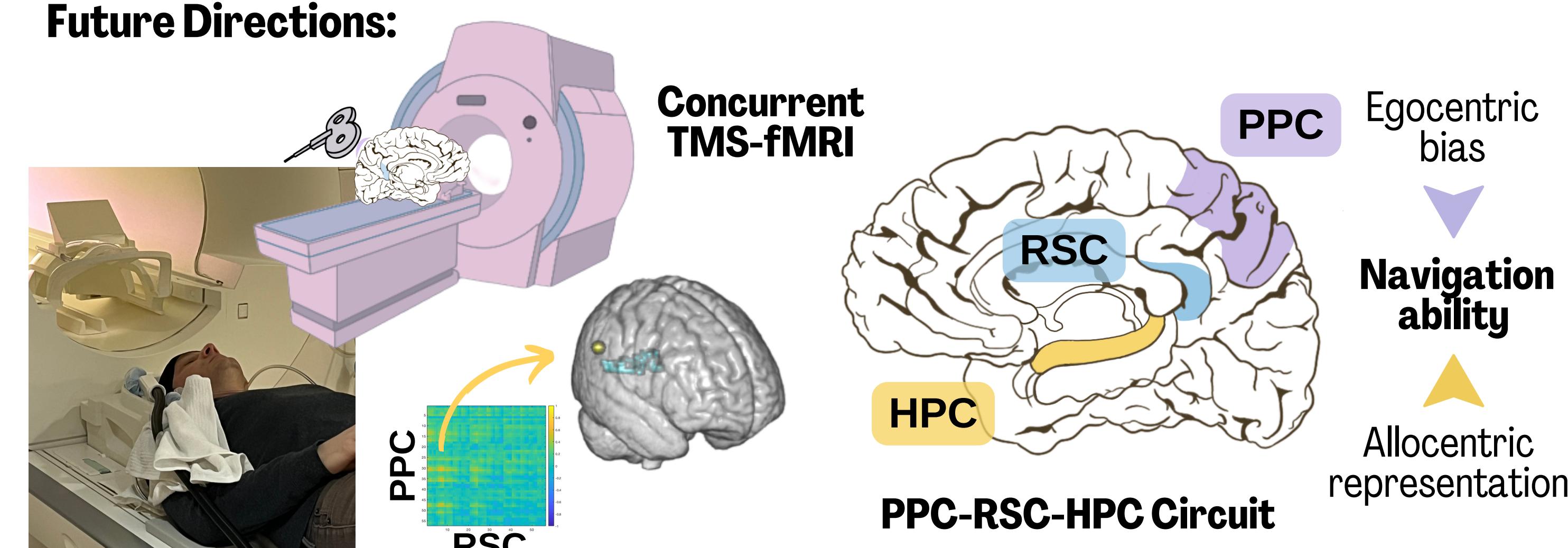
**Figure 4.** VR City-Like Maze Outcome Measures Based on Y-Maze Classification. In process of recruiting participants to create equivalent sample sizes for statistical testing. Visual observations show differences between groups, with older age and egocentric RF bias correlating with poorer navigational performance.

## Discussion & Future Directions

### Main Takeaways:

- Aging was associated with decreased VR-based naturalistic navigational ability, though OAs self-report higher navigational ability than YAs.
- Although OAs had decreased baseline navigational ability, OAs and YAs improved performance on navigating novel city-like environments at similar rates.
- Aging was associated with greater egocentric RF bias, which was correlated with decreased VR-based naturalistic navigational ability.

### Future Directions:



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