Bias in object location estimation following a perspective shift

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Overview

A lot of research has focused on investigating properties of spatial memory (e.g. King et al., 2002; Holden et al., 2015; Hartley et al., 2007)
However limited research has focused on investigating the precision of spatial memory (Kolarik et al., 2018; McAvan et al., 2021)
Spatial perspective taking tasks may be good candidates to assess spatial precision (Hartley et al., 2007; Hitlon et al., 2020; Montefinese et al., 2015)

- Require spatial representations as cannot be solved by image-matching (Nardini et al., 2009)
- Relatively easy to implement

Study 1: Systematic bias in object location memory

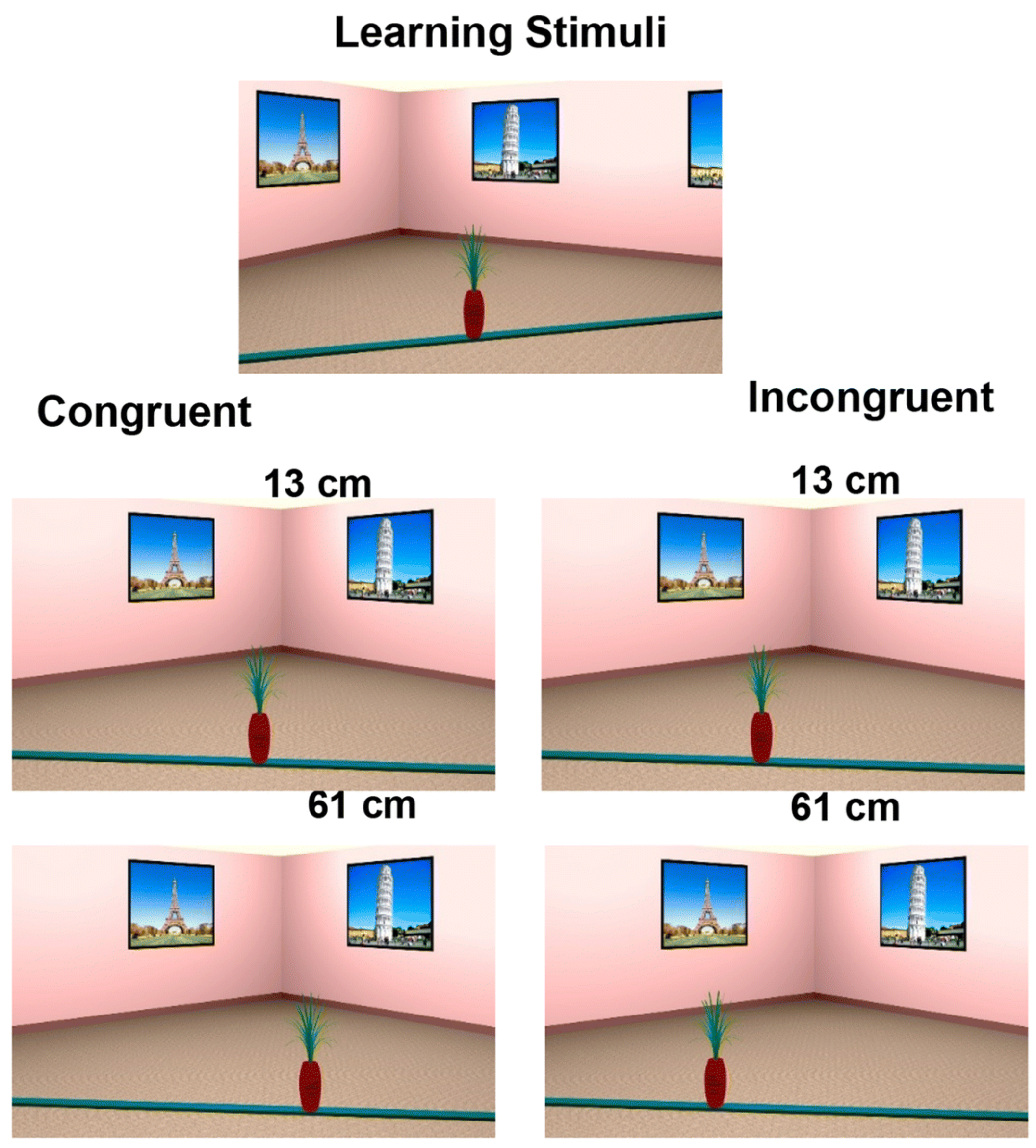
Key aim: Develop a spatial perspective task that taps into spatial precision

Method

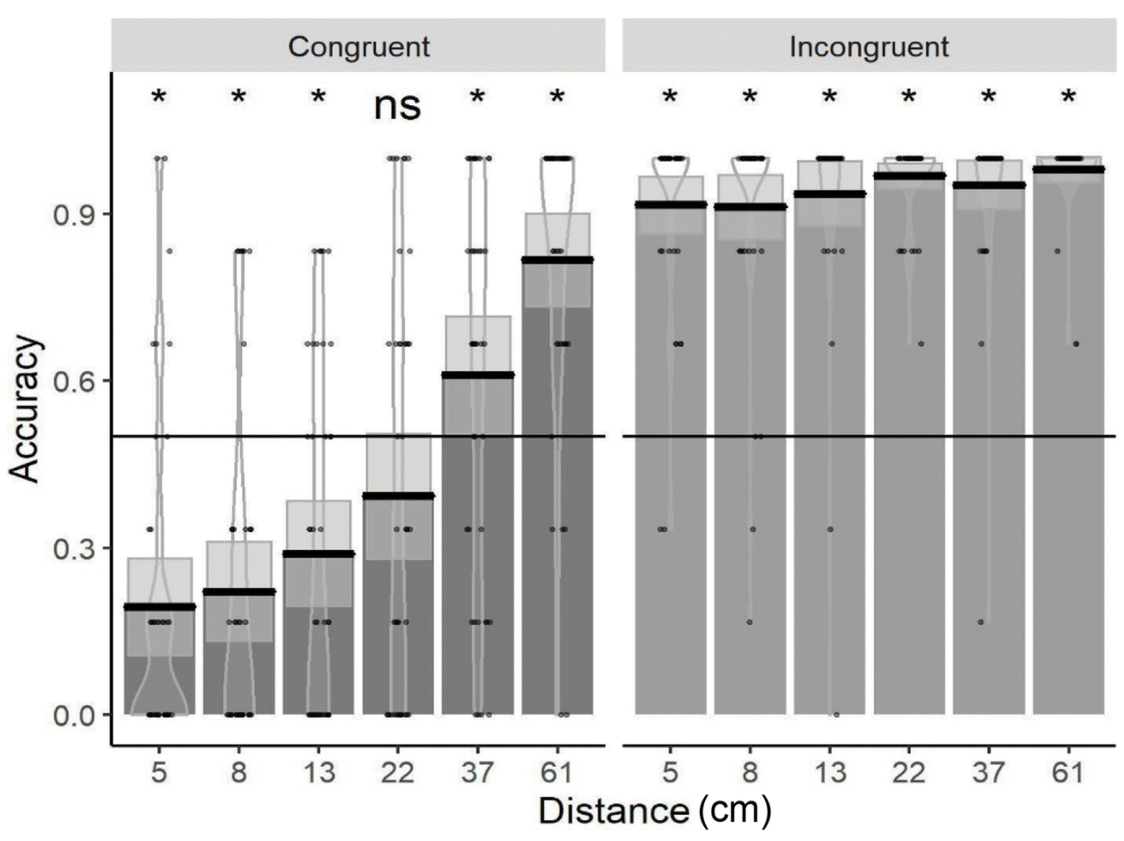
- 44 Young adults (M=25.5; 29 females)
- Participants judged the direction of object displacement (left/right) following a 20 perspective shift (left/right) using a 2-Alternative forced choice task
  - Object displaced by: 5,8,13,22,37,61 cm

Congruency

- *Congruent*: Object and camera move in the same direction
- *Incongruent*: Object moves in the opposite direction to the camera



Results



Congruent trials:

- Misjudged object directions movements for small displacements (5-22cm)
- Correctly detected movements only when the object moved by 37 + cm

Incongruent trials:

- Ceiling level performance on all trials
- Object displacement distance did not affect performance

Discussion

- Combination of object and perspective shift direction give rise to a systematic bias
- Possible explanation: perspective shift (camera movement) gives rise to an *induced object motion effect* i.e. expect the object to move with them
- Driven by uncertainty due to difficulties in:
  - precisely encoding object location
  - understanding the effect of perspective shift on the projected position of the object on the 2D image

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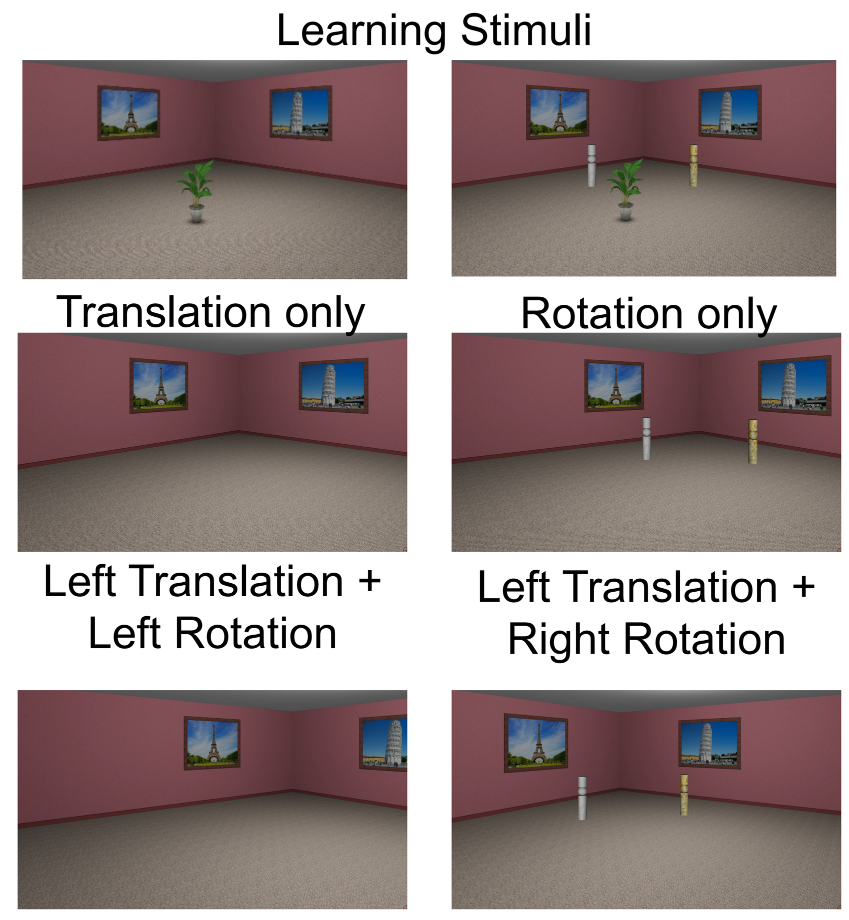
Study 2: Investigating the bias further

- Our previous work shows that the bias is driven by the perspective shift (Segen et al.2021a; 2021b) , yet it is unclear if it arises due to camera rotations or translations or a combination of both.
- If the bias is driven by uncertainty, we expect that adding more spatial information should reduce the bias
- Lastly, we investigated if older adults are differentially affected by camera rotations and translations as well as addition of spatial information

Method

- 45 Young (M=20.7; 25 females) and 41 older adults (M=68.0; 21 females)
- Memorized object location and following a short delay estimated the position of the object
- Camera movements: no movement, translation only, rotation only or a combination of rotation + translation
- Environment: No columns /Additional columns



Results

- **Camera Rotations** introduced a **small** error bias in the direction of the camera rotation.
- **Camera Translations** had a much **larger** effect on the bias
- Reduced effect of Camera Translations in the Additional columns condition
- Older adults **more** affected by Camera Translations and showed **no bias** in response to Camera Rotations

Conclusion

- Camera translations give rise to a systematic bias in object location estimates
  - Larger change in the relations between own position and the object & other features in the environment

-> Increase the uncertainty about object position leading to greater reliance on the object position during learning as an anchor (cf. Anchor & Adjustment Heuristic, Tversky & Kahneman,1974)

- The anchor is insufficiently adjusted resulting in the observed bias
- Role of uncertainty in the bias is supported by:
  - A reduction in the bias when the environment is more informative
  - An increase in the bias in older adults in whom spatial precision & perspective taking are impaired (McAvan et al., 2021; Segen et al., 2021c)

References

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *science*, *185*(4157), 1124-1131
Montefinese, et al. . (2015). Age-related effects on spatial memory across viewpoint changes relative to different reference frames. Psychological research, 79(4), 687-697.
McAvan et al., (2021).Older adults show reduced spatial precision but preserved strategy-use during spatial navigation involving body-based cues. Frontiers in Aging Neuroscience,13, 129
King, J. A., Burgess, N., Hartley, T., Vargha-Khadem, F., & O'Keefe, J. (2002). Human hippocampus and viewpoint dependence in spatial memory. Hippocampus, 12(6), 811-820
Nardini, M., Thomas, R. L., Knowland, V. C., Braddick, O. J., & Atkinson, J. (2009). A viewpoint-independent process for spatial reorientation. Cognition, 112(2), 241-248
Holden, et al., (2015). Categorical biases in spatial memory: The role of certainty. Journal of Experimental Psychology: Learning, Memory, and Cognition, 41(2), 473
Segen, V., et al. (2021a). Perspective taking and systematic biases in object location memory. Attention, Perception, & Psychophysics, 83(5), 2033-2051
Hilton, et al., (2020). Differences in encoding strategy as a potential explanation for age-related decline in place recognition ability. Frontiers in Psychology, 11.
Segen, V., Colombo, G., Avraamides, M., Slattery, T., & Wiener, J. M. (2021b). The role of memory and perspective shifts in systematic biases during object location estimation. bioRxiv.
Segen, V., et al. (2021c). Age-related differences in visual encoding and response strategies contribute to spatial memory deficits. Memory & cognition, 49(2), 249-264.