Egocentric anchoring-and-adjustment of social knowledge in the hippocampus

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Abstract

Growing evidence suggests the hippocampus represents abstract relational knowledge, including social information, similar to how physical locations are represented on a map. Yet how map-like representations of abstract knowledge are influenced by personal biases is unclear. We test whether a prominent egocentric bias involving an implicit reliance on self-knowledge when rating others, anchoring-and-adjustment, affects how the relative attributes of different social entities are learned. Participants provided likelihood ratings of partaking in everyday activities for themselves, fictitious individuals, and familiar social groups. Subsequently during functional neuroimaging, participants learned a stranger's preference for an activity relative to one of the fictitious individuals and decided how the stranger's preference related to the groups' preferences. Egocentric anchoring-and-adjustment was present when participants rated the other entities, where anchoring interfered with performance when compared groups weren't too different or similar to self ratings. Hippocampal signals similarly related to group-self rating discrepancy, suggesting that hippocampal sensitivity to egocentric anchoring influences dynamic world-centered inferences. Linking the hippocampus to individual subjective biases, increased similarity in hippocampal signal patterns over trials reflected participants' propensity towards egocentrism. These findings imply that personal preferences help shape the hippocampus' mnemonic representation of other people's preferences.

Keywords: cognitive maps, anchoring and adjustment, social cognition, memory, hippocampus.

Introduction

Cognitive maps have inspired a better understanding of how neurons in the hippocampus and surrounding regions transform egocentric spatial cues into purely environment-centered allocentric coordinates supporting spatial navigation. Growing evidence suggests the hippocampal formation assimilates abstract knowledge similar to how it integrates spatial cues (Tavares, Mendelsohn, & Grossman, 2015; Kaplan & Friston, 2019; Park, Miller, Nili, Ranganath, & Boorman, 2020). Yet how personal biases influence map-like representations of abstract knowledge remains a mystery. One well-characterized subjective bias that could distort map-like learning is anchoring-and-adjustment, where an individual starts with an initial idea and incompletely shifts away from their initial starting point to make an inference (A. Tversky & Kahneman, 1974). In egocentric anchoring-and-adjustment, people commonly begin by recruiting self-knowledge and then adjust away from this self anchor to make inferences about others(e.g., The food I like informs what food someone else likes;(Epley, Keysar, Van Boven, & Gilovich, 2004)). Previous work has observed that the more divergent others' attributes are from a participant's, the more adjustment is needed and the longer it takes to make the inference (Tamir & Mitchell, 2013; Wang, Simpson, & Todd, 2022). Despite the ubiquity of egocentric anchoring in social inference tasks, evidence of its influence on world-oriented knowledge representations during memory-guided decision-making is missing (Kaplan & Friston, 2019; Arzy & Kaplan, 2022). In this work, we wanted to isolate the neural representation of egocentric anchor biases on world-centered abstract knowledge.

Methods

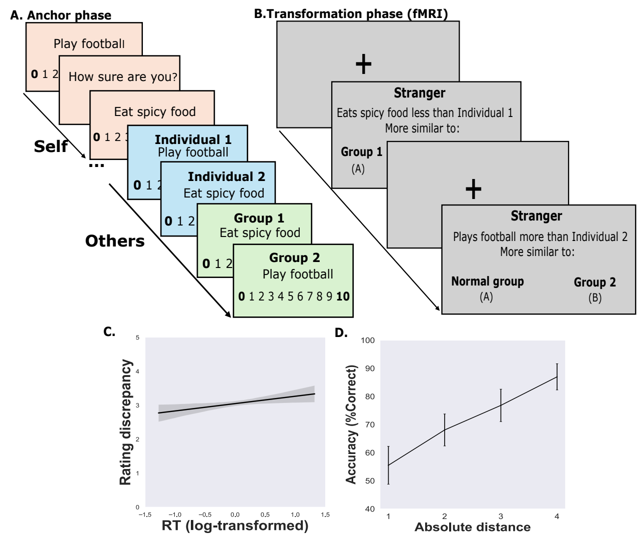

Figure 1: Experimental paradigm and behavioral results. A. Anchor Phase: Self: Participants provide a likelihood rating for themselves in different everyday scenarios, as well as confidence ratings about their preferences. Others:After reading a description of two different fictive individuals and two different social groups, participants inferred the likelihood preferences of these entities from 1-9 on a scale of 0 to 10. Anchor ratings were provided both before and after fMRI scanning sessions. B. Transformation phase (fMRI scanning): Participants infer a stranger's preference relative to one of the anchor phase's individuals in a particular scenario and in a two-alternative forced choice(2AFC) determine if that stranger's preference is more similar to a normal group (participants informed beforehand that this group always has a preference rating of 5), or one of the two groups they previously rated(using the preference rating provided by the participant for that entity). C. Positive relationship(anchoring) between self versus other entity rating discrepancy(RD) and RT(centered by group mean). D. Correlation between accuracy and absolute distance between the stranger's rating and two choice options for each transformation trial. Error showing mean ± SEM.

To study the influence of the self on social inferences in a world-centered reference frame, we adapted the Kaplan and Friston (2019) paradigm. Participants (N=20) provided ratings for themselves, two fictitious individuals, and two societal groups (people from cities and rural areas) on everyday activities (e.g., eat spicy food, read a book, cycle to work)(Fig.1A).Next, during the transformation phase and under functional magnetic resonance imaging(fMRI), participants inferred a stranger's preference for an everyday activity-relative to previously provided ratings for one of the two fictitious individuals and decided how a stranger's preference relates to a medium preference (normal group) and a preference of one of the two societal groups. More specifically, participants needed to decide whether the stranger's rating was closer to one of the two groups, or a normal group with a medium rating of 5 (Fig. 1B). We predicted that egocentric anchoring-and-adjustment would bias world-centered representations of abstract knowledge in the hippocampal formation and dorsal medial prefrontal cortex(dmPFC).

Results

Testing for the presence of anchoring-and-adjustment, we applied a linear mixed effect model between participant RTs when inferring others' preferences and rating discrepancy (RD), calculated as the absolute differences between participants' self-preferences and others' preferences. Replicating prior social anchoring findings, we found a significant effect of RT on self-other discrepancy scores (b=0.21, t(19)=2.18, p=0.030; Fig.1C). Capturing previously observed behavioral performance in map-like decision-making paradigms (Kaplan & Friston, 2019), the absolute distance between the stranger and the two compared groups correlated with performance (t(19) = 12.54, p <0.001, Fig. 1D). To test which regions represented egocentric anchor biases and other choice demands during the transformation fMRI task, we performed a whole-brain searchlight representational similarity analysis (RSA). This allowed us to determine whether the neural representation of anchor biases in both relative (self rating discrepancy with individual rating: RDindividual) and absolute/world-centered (self rating discrepancy with groups: RDgroup) reference frames is different after explaining variance related to other important cognitive aspects in the transformation phase (Fig. 2A). We observed a relationship between group rating discrepancy(RDgroup) and left hippocampus pattern dissimilarity (x=-27,y=-39,z=1; t(19)=5.01, small-volume corrected peak-voxel p=0.042; Fig. 2B). However, we didn't observe any RSA effects in dmPFC. Next, we tested whether hippocampal pattern dissimilarity varied depending on the level of self-group rating discrepancy(0-8). We observed a significant quadratic effect (t(19)=37.84, p<0.001) between RDgroup values and hippocampal pattern dissimilarity(Fig. 2C). Testing if the hippocampal pattern dissimilarity effects paralleled a u-shaped behavioral effect observed between RDgroup values and accuracy, we observed a correlation (r(19)= 0.53, p= 0.017) between these two u-shaped effects. In other words, participants' anchor biases in the hippocampus most strongly interfered with comparisons of group preferences when the entities being compared weren't too similar or different from the participants' personal preferences(Fig. 2C). To explore the relationship between participants' hippocampal representations and individual propensity for egocentric biases, we calculated egocentrism scores by examining the correlation between participants' own ratings and group ratings (Zhao, Sened, & Tamir, 2023). We observed a significant negative correlation(r(19) = -0.51, p = 0.021) between participants' egocentrism scores and their mean hippocampal pattern dissimilarity. This implies that participants who generally represented trials with more similar hippocampal patterns exhibited higher egocentrism scores(Fig. 2D).

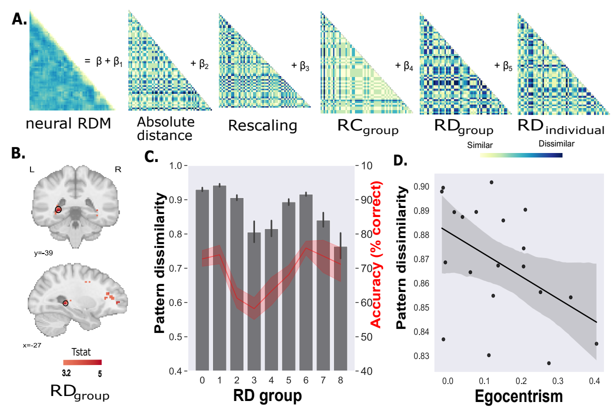

Figure 2: Egocentric anchoring-and-adjustment in the hippocampus. A. Neural and behavioral representational dissimilarity matrices (RDMs) for the GLM searchlight analysis. Predictor variables used: absolute distance between the stranger and choice options, rescaling/displacement of the relative position of the stranger's rating in relation to the individual to its absolute position on the rating scale, the differences between anchor phase ratings pre- and post-fMRI scanning for groups (RCgroup), the absolute differences between self and individual rating (RDindividual), and differences between self and groups rating (RDgroup). B. Group activation maps for RDgroup. Highlighted hippocampal region survives peak-voxel FWE correction for multiple comparisons at $p < 0.05$. C. Pattern dissimilarity (gray plot) in left hippocampal peak and trial-by-trial transformation accuracy (red line) for each RDgroup bin. Error bars showing mean ± SEM. D. Correlation between left hippocampal dissimilarity pattern and egocentrism score for each participant.

Conclusion

We highlight how personal preferences influence knowledge about others in the hippocampus, where anchoring is detrimental when the choice options aren't too similar or different to the self. Future work can determine whether similar egocentric biases influencing cognitive map-like representations are transferable to spatial and other non-spatial domains (B. Tversky, 2019). By disentangling the role of the self in shaping hippocampal models of the world, a better understanding of variability in allocentric representations can be formed.

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References

Arzy, S., & Kaplan, R. (2022). Transforming social perspectives with cognitive maps. *Soc Cogn Affect*, *17*, 939–955.

Epley, N., Keysar, B., Van Boven, L., & Gilovich, T. (2004). Perspective taking as egocentric anchoring and adjustment. *Journal of Personality and Social Psychology*, *87*(3), 327–339.

Kaplan, R., & Friston, K. J. (2019). Entorhinal transformations in abstract frames of reference. *PLoS Biology*, *17*, e3000230.

Park, S. A., Miller, D. S., Nili, H., Ranganath, C., & Boorman, E. D. (2020). Map making: constructing, combining, and inferring on abstract cognitive maps. *Neuron*, *107*(6), 1226–1238.

Tamir, D. I., & Mitchell, J. F. (2013). Anchoring and adjustments during social inferences. *J Exp Psychol Gen*, *142*, 151–162.

Tavares, R. M., Mendelsohn, A., & Grossman. (2015). A map for social navigation in the human brain. *Neuron*, *87*(1), 231–243.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131.

Tversky, B. (2019). *Mind in motion: How action shapes thought*. Hachette UK.

Wang, D. L., Simpson, A. J., & Todd, A. R. (2022). Egocentric anchoring-and-adjustment underlies social inferences about known others varying in similarity and familiarity. *Journal Exp Psychol General*, *142*, 151–162.

Zhao, Z., Sened, H., & Tamir, D. I. (2023). Egocentric projection is a rational strategy for accurate emotion prediction. *J Exp Soc Psychol*, *109*, 104521.