Does average size of an ensemble bias individual size representations during perception or working memory retention?

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Backgrounds

- To process complex visual information using limited resources, our visual system prioritizes more relevant information using selective attention (Carrasco, 2011) and summarizes multiple information using distributed attention (Alvarez, 2011; Baek & Chong, 2020)
- Individual- and group-level visual information interact with each other (Brady & Alvarez, 2011; Choi & Chong, 2020).

- **Ensemble effect**
  The size of an individual item is biased toward the average size of the same color group (Brady & Alvarez, 2011)

What is the source of the ensemble effect?
Perceptual bias VS. Memory bias

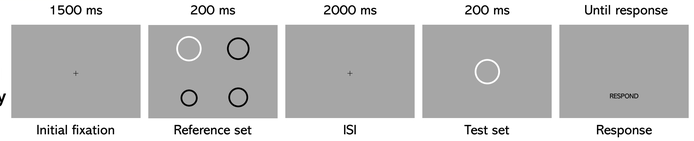
Experiment 1

"Compare the size of two white circles and report the larger circle"

Procedure

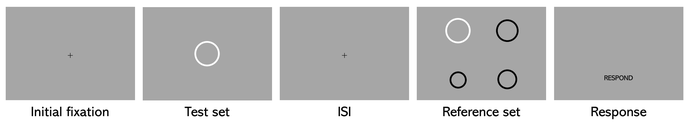
Memory bias condition

In the memory bias condition, **both perceptual bias and memory bias** can occur.



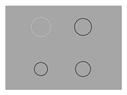
Perceptual bias condition

In the perceptual bias condition, **only perceptual bias** can occur.

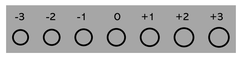


Stimuli

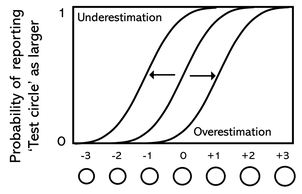
1. Reference set



2. Test set

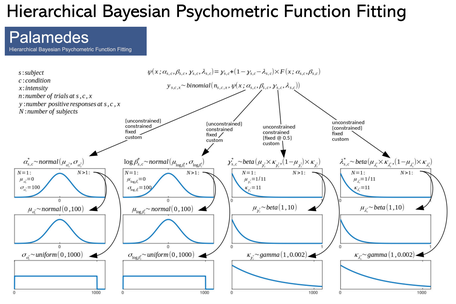


Analysis



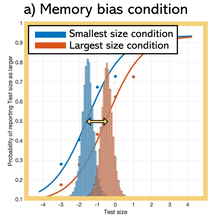
1. Leftward shift: Size underestimation
2. Rightward shift: Size overestimation

Hierarchical Bayesian Psychometric Function Fitting

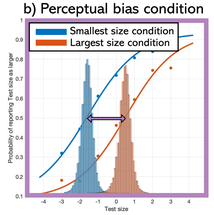


Results (n=12)

a) Memory bias condition



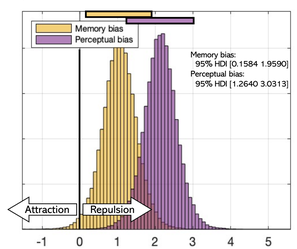
b) Perceptual bias condition



1. **Ensemble effect** indicated by shifted psychometric functions.

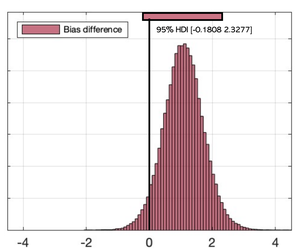
2. **Repulsion bias** indicated by underestimation in the smallest size condition and overestimation in the largest size condition.

c) Ensemble effect



Difference in Thresholds between the smallest and the largest size condition

d) Difference between conditions



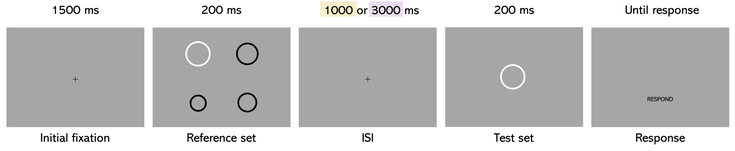
Difference in the ensemble effect between the perceptual and memory bias condition.

- The size of individual item was repulsed away from the average size of a stimuli.
- The magnitude of repulsion bias was not significantly different between the perceptual and memory bias conditions.
- The contextual effect seems to arise at initial perception.

Experiment 2

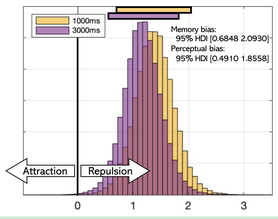
Does ensemble effect actively occur during memory retention period?

Procedure "Compare the size of two white circles and report the larger circle"

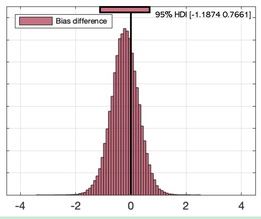


Results (n=12)

a) Ensemble effect



b) Difference between conditions

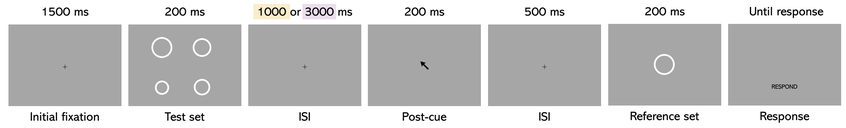


- The repulsion bias do not differ between 1000ms and 3000ms retention period.
- Individual and group-level information do not actively interact with each other within memory.

Experiment 3

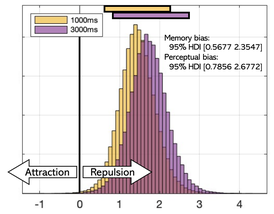
Does ensemble effect actively occur during memory retention period, when controlled for perceptual grouping?

Procedure "Compare the size of two relevant circles and report the larger circle"

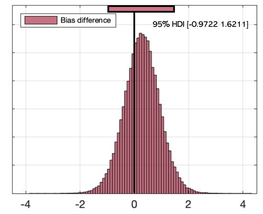


Results (n=12)

a) Ensemble effect



b) Difference between conditions



- The repulsion bias do not differ between 1000ms and 3000ms retention period.
- Individual and group-level information do not actively interact with each other within memory.

Conclusion

- The group-level ensemble representation biases the representation of individual item.
- In current set of stimuli, strong repulsion bias was found at perceptual encoding phase, instead of during memory maintenance.

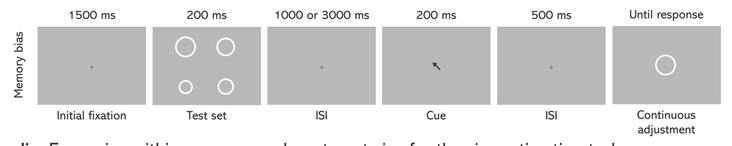
Future experiment (ongoing)

Experiment 4

Does the type of ensemble effect (attraction or repulsion) depend on the stimuli and task used to measure bias?

Procedure

"Report the size of cued circle by adjusting the size of probe circle"



Stimuli Every size within a group can be a target size for the size estimation task.

References

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- Brady, T. F., & Alvarez, G. A. (2011). Hierarchical encoding in visual working memory: Ensemble statistics bias memory for individual items. Psychological Science.
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