Effect of stimulus range on center bias in heading judgments from optic flow

Bao Hong[1,3], Yonglun Ji[1,3], Li Li[2,3,1]
[1] School of Psychology and Cognitive Science, East China Normal University, Shanghai, China
[2] Faculty of Arts and Science, New York University Shanghai, Shanghai, China.
[3] NYU-ECNU Institute of Brain and Cognitive Science at New York University Shanghai, Shanghai, China.

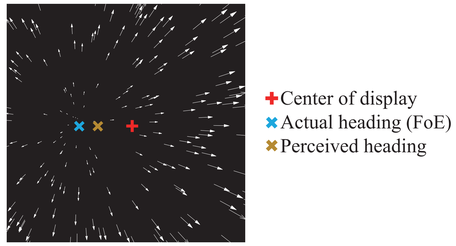
Introduction

Humans can perceive their direction of self-motion (i.e., heading) from optic flow stimuli, where the focus of expansion (FoE) in a radial flow pattern indicates the heading direction (Warren et al., 1988; Li & Warren, 2000).

Although heading perception from optic flow is generally accurate, a center bias still exists. Center bias in heading perception refers to the tendency for heading judgments to be biased toward the center of the display, as reported in previous studies (Warren & Hannon, 1988; Sun et al., 2020).

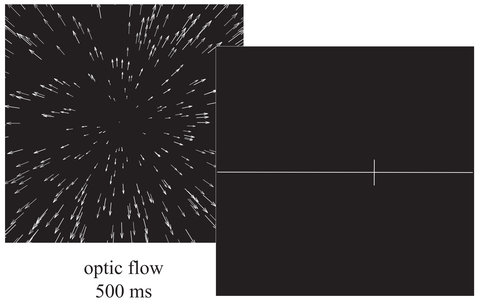
In this study, we investigated the effect of stimulus range, i.e., the range of tested heading angles on center bias in heading judgments.

Center bias in heading judgments



General Methods

Heading judgment task

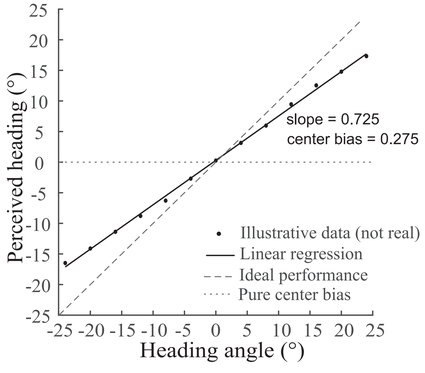


Visual stimuli:
A large display (80°H × 80°V) simulated an observer forward translating through a 3D cloud composed of 200 dots at 3 m/s (depth range: 0.565 - 2.0 m, dots diameter: 0.3°, luminance contrast: 81.63%).
On each trial, participants view the display (duration: 500 ms) using their dominant eye. At the end of the trial, they were asked to move a vertical bar along a horizontal line to indicate their perceived heading direction.

Condition:
The simulated heading angles ranged from -24° (left) to 24° (right) in steps of 4° with respect to the center of the display. We categorized heading responses from trials with tested heading angles ranging from -12° to 12°, -16° to 16°, -20° to 20°, or -24° to 24°, resulting in four heading response groups corresponding to four stimulus ranges.

Participants:
Twenty-nine undergraduate and graduate students (aged 19-26 years, F/M = 18/11).

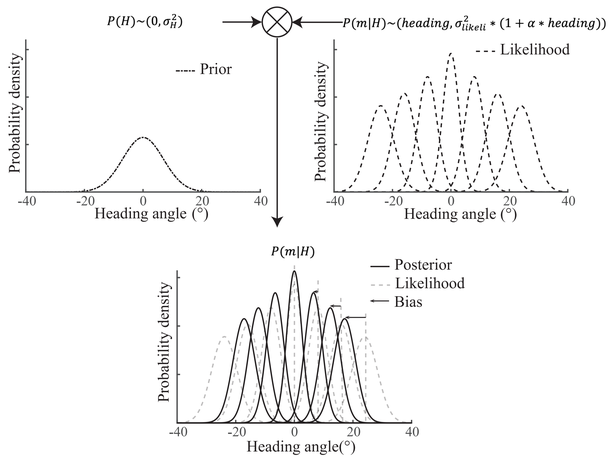
Illustration of center bias calculation



• Center bias effect = 1 - slope

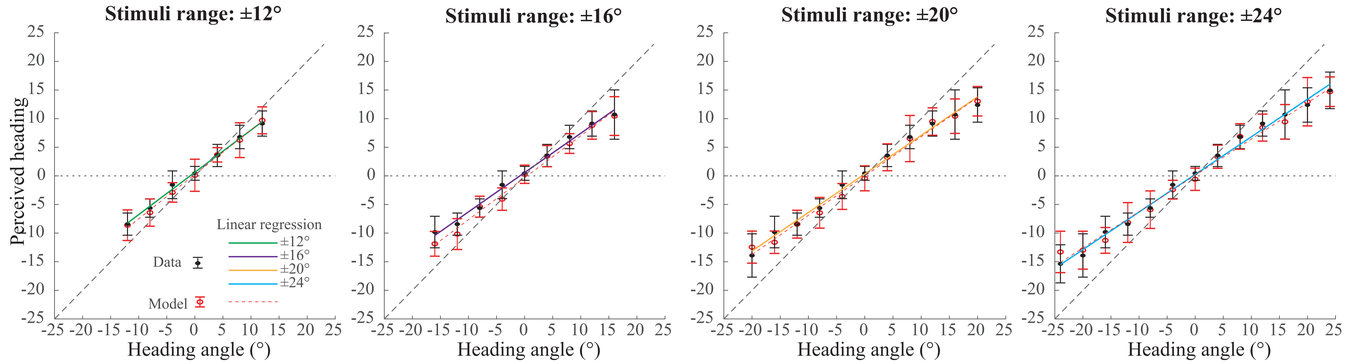
Bayesian model

• $P(H|m) \propto P(m|H)P(H)$



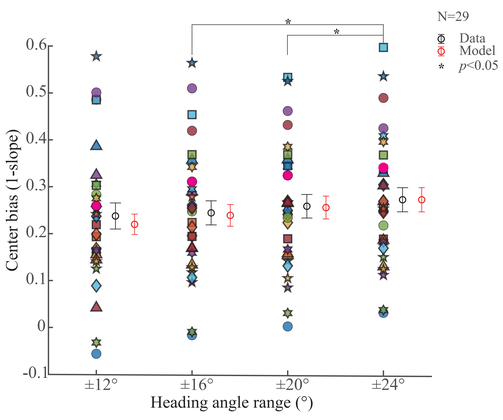
Results

Sample participant



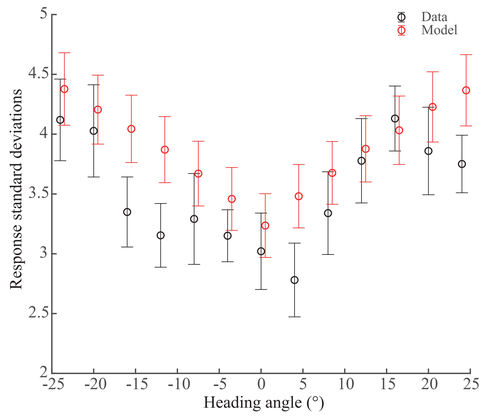
All participants

Effect of stimulus range on center bias



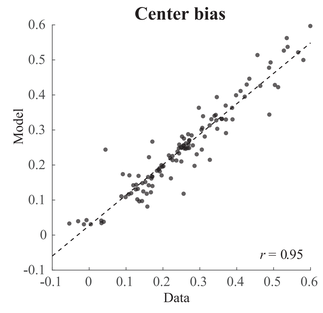
• Center bias in heading judgments from optic flow increases with larger stimulus range.

Response standard deviations

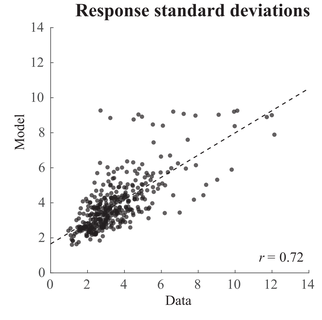


• The variance in participants' heading responses became larger for larger heading angles (i.e, greater uncertainty).

Center bias



Response standard deviations



Modeling results:

• Simulations of a Bayesian model that combined heading priors with reliability-weighted incoming sensory information showed that greater uncertainty in sensory processing of larger heading angles could lead to a stronger influence of the prior, resulting in a larger center bias.

Conclusion

• Center bias in heading judgments from optic flow increases with larger stimulus range.

• The Bayesian modeling results show that this increase in center bias is likely due to increased uncertainty in heading judgments for larger heading angles away from the center of the display.

References

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This study was supported by research grants from the National Natural Science Foundation of China (32161133009, 31800904), Shanghai Science and Technology Committee (20ZR1439500, the basic research project 19JC1410101), China Ministry of Education (ECNU 111 Project, Base B1601), NYU shanghai (the major grant seed fund and the boost fund) and East China Normal University (the "Flower of Happiness" fund pilot project 2019JK2203).