Incomplete Compensation for Self-Motion in the Visual Perception of Object Velocity during a Visual-Vestibular Conflict

Björn Jörges, Laurence Harris
Center for Vision Research, York University

Background & Objective

- Retinal motion elicited by an object is ambiguous and can be due to:
  - object-Motion
  - self-Motion
- Estimating self-motion is a multisensory process:
  - vestibular
  - visual
  - efference copies

How important are vestibular and efference copy cues? Can we compensate fully for self-motion in their absence?

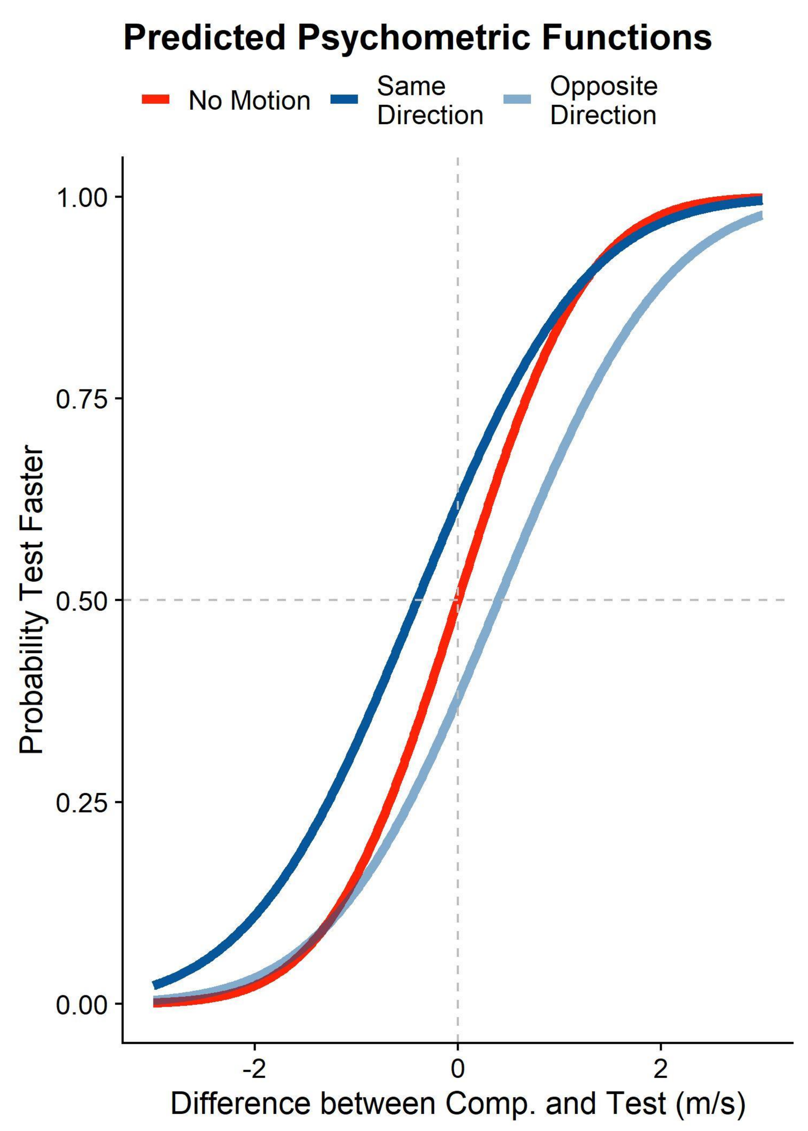

Figure 1: *Predicted psychometric functions*

Hypotheses:

- Congruent self-motion and object motion lead to an underestimation of target velocity and vice-versa
  - curve shifted to the left or right
- Self-Motion generally leads to noisier judgments
  - curve steeper when no observer motion

Methods

- **The task:** Which of two presented motions is faster?

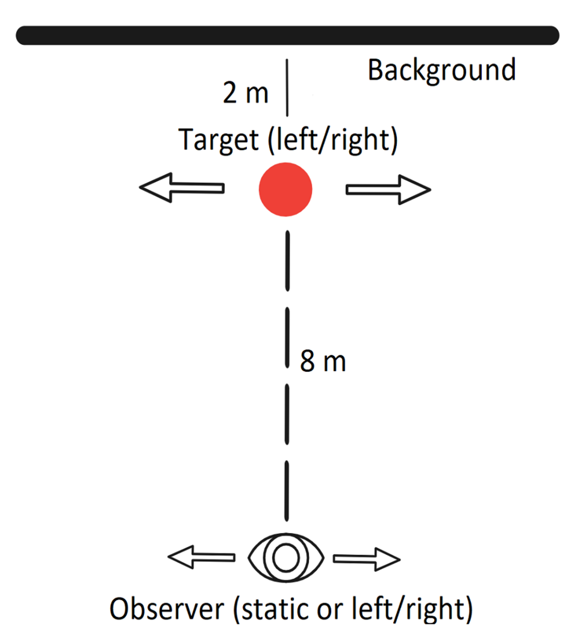

Figure 2a: *Top view schematic of stimulus*

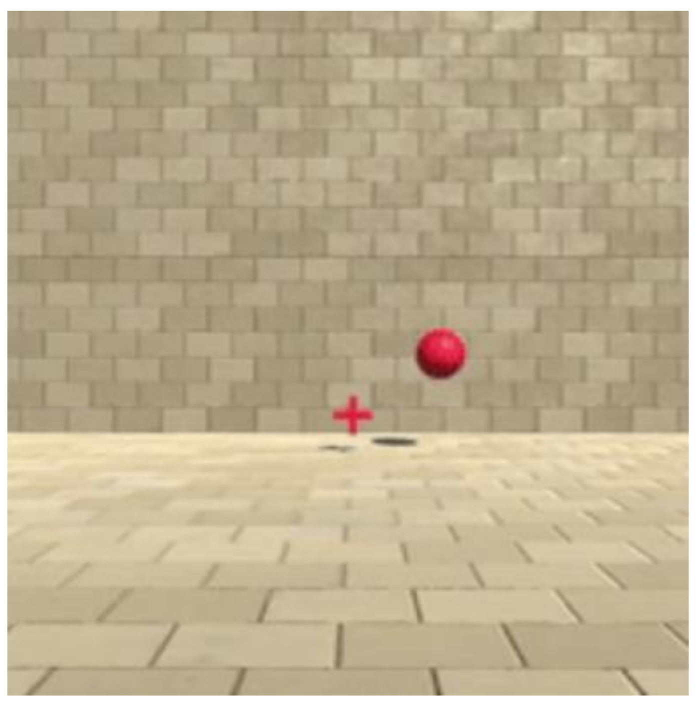

Figure 2b: *Participant view of stimulus*

- **The stimuli**
  - Two intervals of left or rightwards motion presented at eye-height in 3D virtual environment
  - One big target (6.6 m/s or 8 m/s left or right), one ball cloud (velocity staircase-controlled)
  - Participant moved visually in the same or opposite direction as the target, or static during observation of big target; no physical motion
- **Dependent variables:** Mean (accuracy) and slope (precision) of psychometric function
- **Participants:** n=8, s07 excluded due to mix up in controls

Contact: bjoerges@yorku.ca, or Twitter: @b_jorges

Results

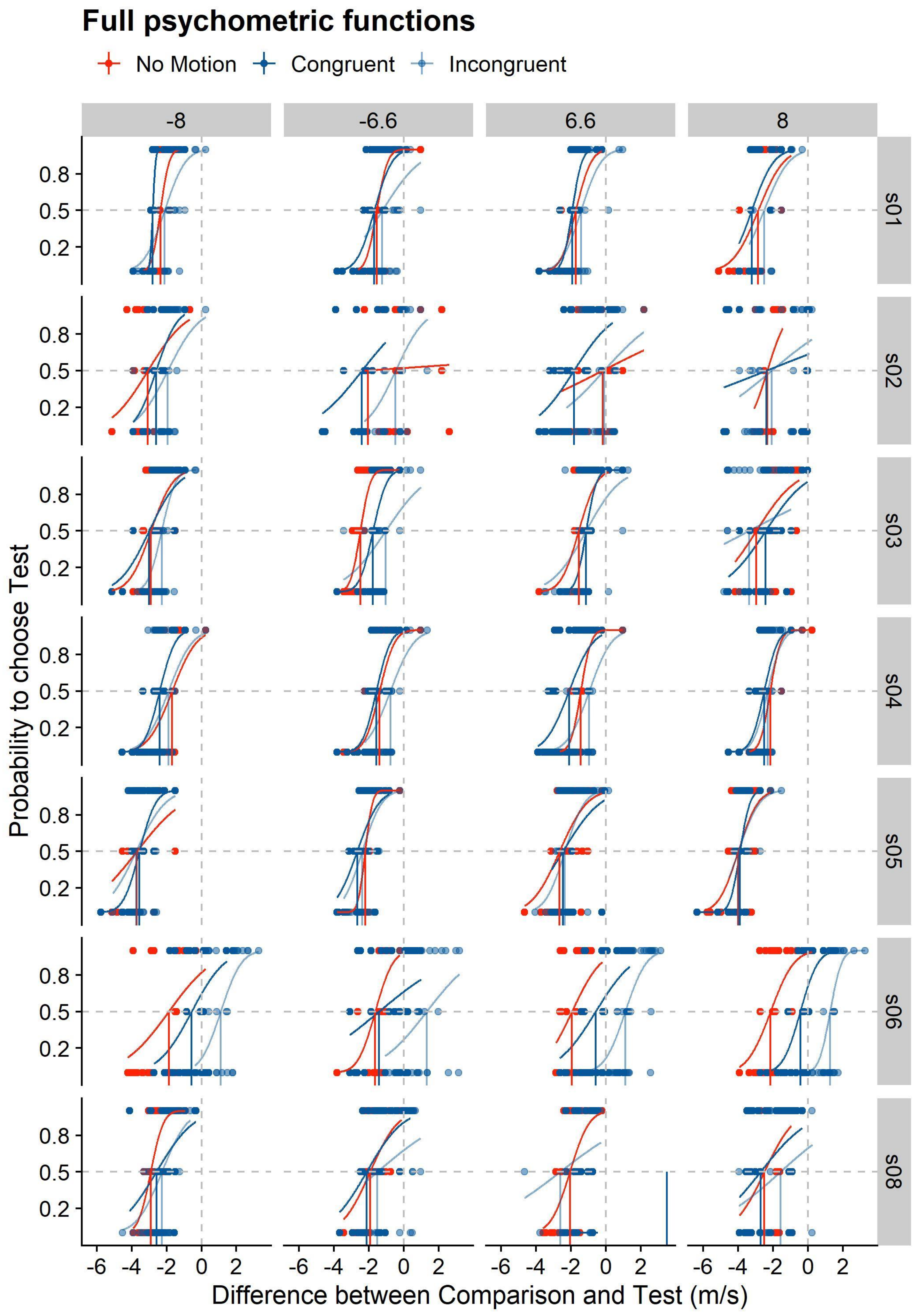

Figure 3: *Psychometric functions per participant (rows of panels) and standard velocity (columns of panels); negative velocities correspond to leftwards object motion*

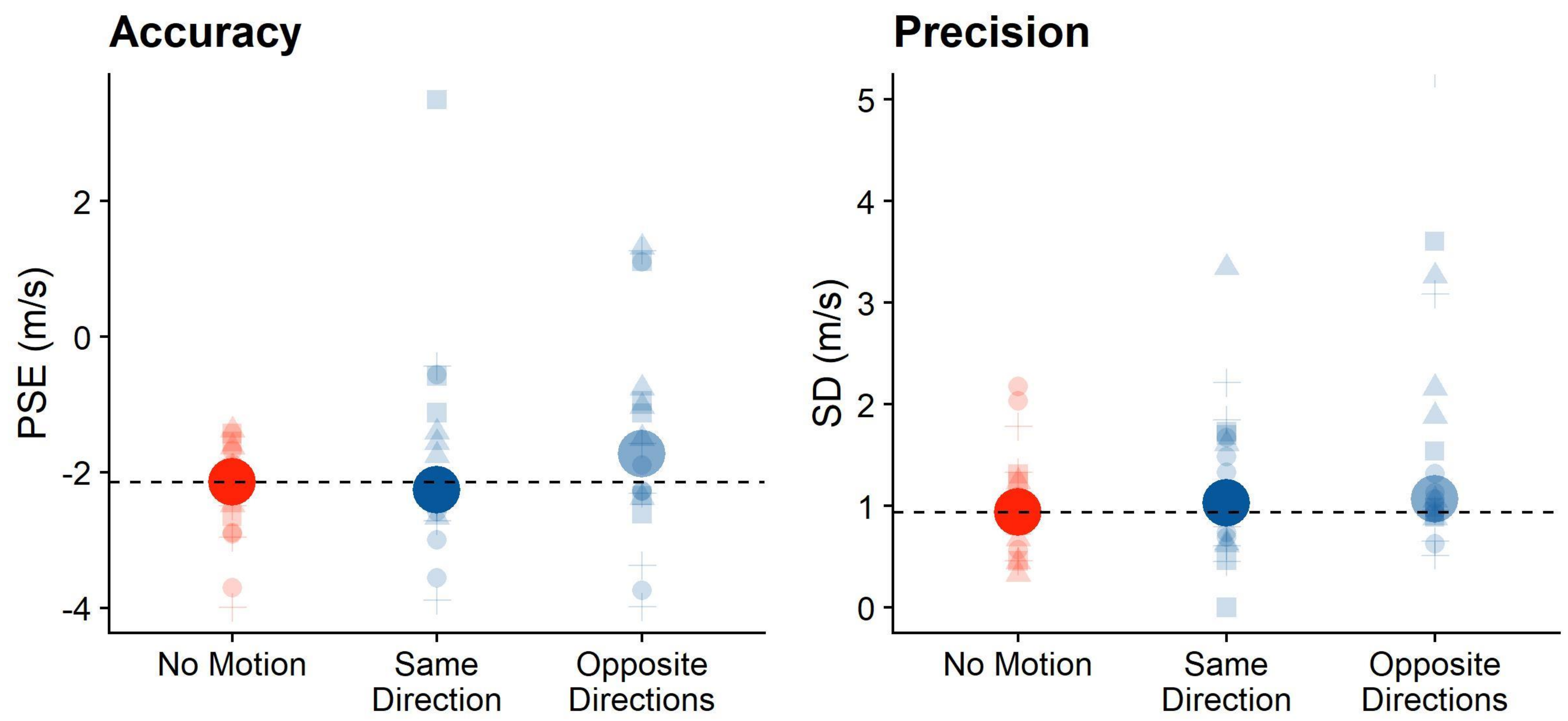

Figure 4: *Big solid dots – median PSEs/SDs across participants and standard velocities. Translucent dots – PSEs/SDs per participant and standard velocity*

- Big between-participant variability
- On average, incongruent motion is judged as too fast ($p < 0.05$) and congruent motion judged roughly as accurately as no motion ($p = 0.8$)
- On average, subjects judge speed somewhat less precisely when self-motion is simulated ($p = 0.09$)

Conclusions

- Opposite direction motion is perceived as faster than same direction motion/no motion, but very small effect
- Observer motion might lower precision

Acknowledgements, Open Science & References

- We thank the Canadian Space Agency for their support.
- All resources are available under https://github.com/b-jorges/Motion-Perception-during-Self-Motion/.

[1] Dokka, K., MacNeilage, P. R., DeAngelis, G. C., & Angelaki, D. E. (2015). Multisensory self-motion compensation during object trajectory judgments. *Cerebral Cortex*, *25*(3), 619–630. https://doi.org/10.1093/cercor/bht247
[2] Dupin, L., & Wexler, M. (2013). Motion perception by a moving observer in a threedimensional environment. *Journal of Vision*, *13*(2), 1–14. https://doi.org/10.1167/13.2.15