Motion extrapolation in the flash-lag effect depends on perceived, rather than physical speed

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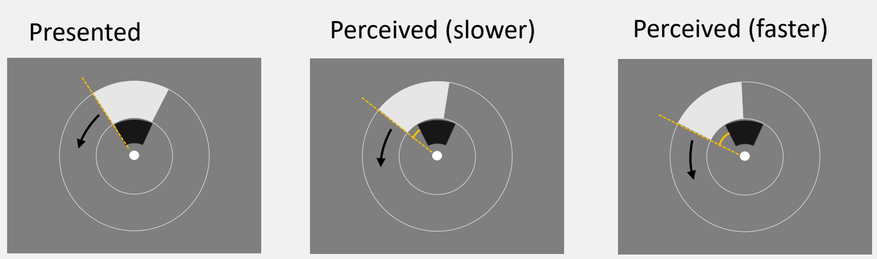
Introduction & Methods

- The visual system may compensate for neural delays using motion extrapolation, whose mechanism could also underlie the flash-lag effect (FLE)[1].
- Motion extrapolation mechanisms predict an object's position based on a neural representation of its previous trajectory, including velocity.
- The magnitude of the FLE should depend on the perceived speed[2] of the moving object, which may differ from its physical speed.
- Other explanations of the FLE do not rely on an explicit representation of velocity.

- **Does the magnitude of the FLE modulate with illusory changes in perceived speed?**

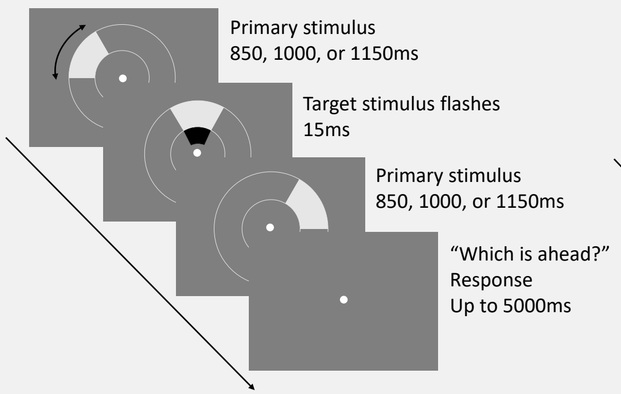
If FLE depends on perceived speed, then faster perceived speed -> greater FLE magnitude
If FLE does not depend on perceived speed, then no change in FLE magnitude

- **Experimental manipulations:**
- Temporal noise[3] (static noise versus dynamic noise pattern)
- Luminance contrast[4] (high contrast 100% versus low contrast 10%)

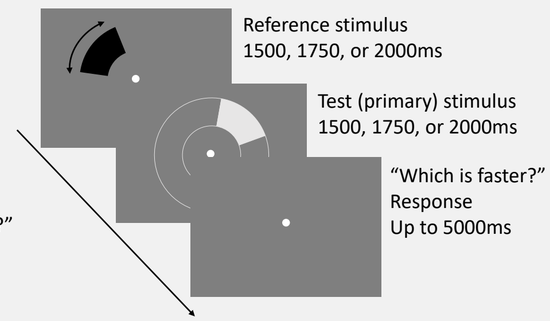


- **Experimental paradigm:**

A Flash-lag task



B Speed-matching task

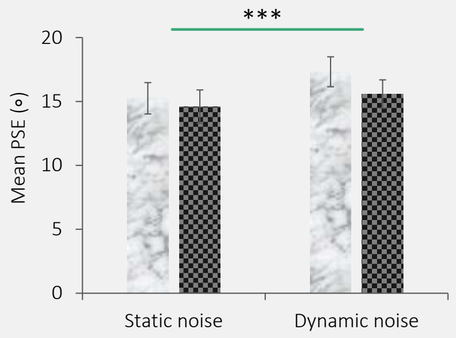


- Observers viewed the wedge stimulus on a rotational trajectory at a constant speed of 200°/s.
- We estimated the point of subjective equality (PSE) to quantify the perceived flash-lag and perceived speed for each condition.

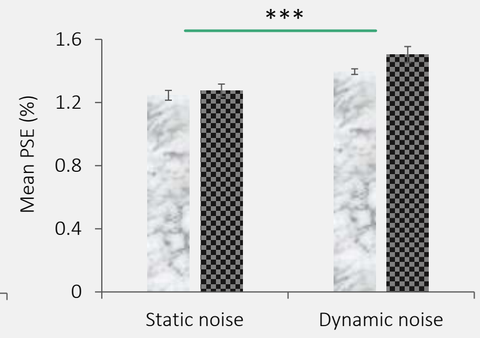
Results

Experiment 1

A Perceived flash-lag (n=76)

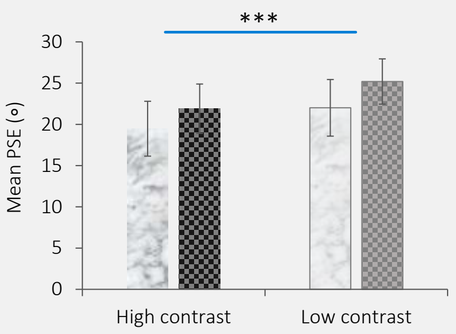


B Perceived speed (n=68)

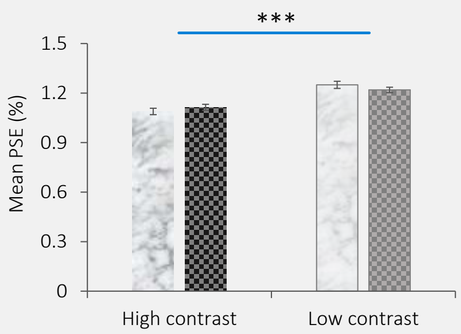


Experiment 2

A Perceived flash-lag (n=7)

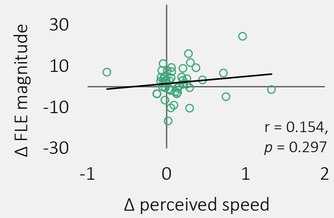


B Perceived speed (n=7)

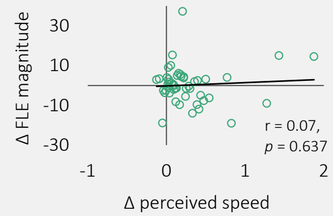


*** $p < .05$. Bonferroni-corrected

Filtered noise texture



Square checkers texture



- Exploratory inter-subject correlation analysis (n=48): Δ FLE did not correlate with Δ perceived speed, possibly due to large individual variability in the data.

Conclusions

- We show for both manipulations, differences in perceived speed corresponded to differences in FLE magnitude: both perceived speed and perceived flash-lag increased when the wedge contained dynamic noise relative to static noise, and when it was presented in low relative to high contrast. This effect was qualitatively similar across different textures.
- **These results indicate that the differences in the FLE magnitude may be explained by differences in perceived speed.**
- This is **consistent with motion extrapolation**, which suggests that the FLE depends on an explicit neural representation of velocity.

References:
[1]Nijhawan, R. (1994). Motion extrapolation in catching. *Nature, 370,* 256–257.
[2]Wojtach, W.T., Sung, K., Truong, S., & Purves, D. (2008). An empirical explanation of the flash-lag effect. *PNAS, 105*(42), 16338—16343.
[3]Carlson, T.A., Schrater, P., & He, S. (2006). Floating square illusion: Perceptual uncoupling of static and dynamic objects in motion. *Journal of Vision, 6,* 132–144.
[4]Stone, L. S., & Thompson, P. (1992). Human speed perception is contrast dependent. *Vision Research, 32*(8), 1535–1549.

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