



Interactions of depth order and numerosity in transparent motion

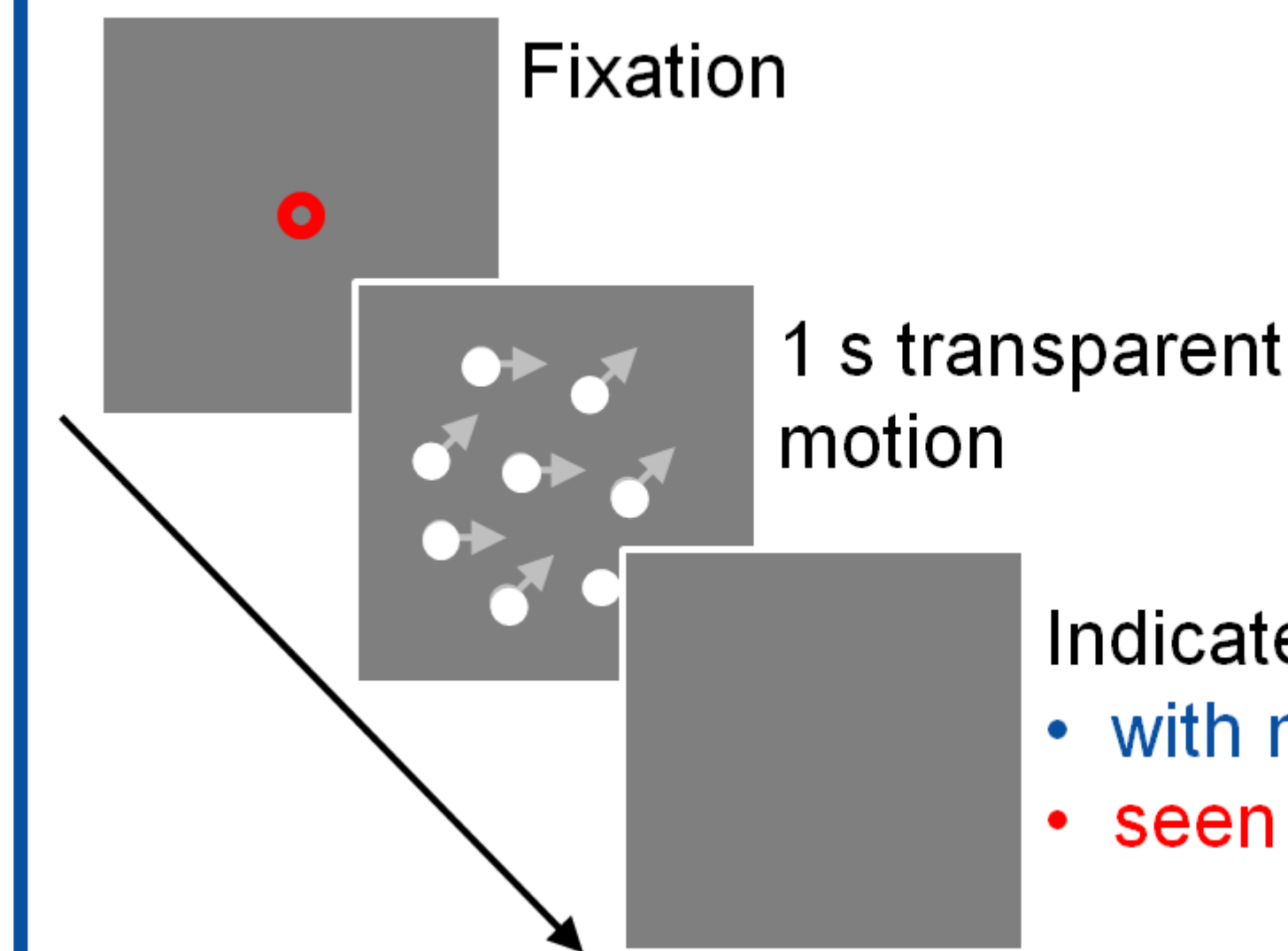
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Introduction

When a field of moving dots contains two motion directions, two transparent surfaces are perceived at different depth planes. The depth order of the surfaces is ambiguous. Recently it has been shown that there are sustained biases to see certain motion directions in the front [1] and that the more numerous surface tends to be seen in the back [2]. Here we investigated the relationship between motion direction, perceived depth order and perceived numerosity.

Methods



Transparent motion stimulus:

- Aperture radius: 10 deg
- Overall dot density: 1 dot/deg² ~ 314 dots
- Dot lifetime: 200 ms
- Dot speed: 10 deg/s
- Cardinal and oblique motion directions, direction offset between surfaces: 45 deg
- Distribution of dots to the surfaces: -60, -40, -20, 0, 20, 40, 60%

Indicate direction:
• with more dots
• seen in the back

The point of subjective equality (PSE) and the standard deviation (SD) of numerosity and depth order judgments were calculated in dependence of dot distribution:

$$PSE = (N_{S1} - N_{S2}) / (N_{S1} + N_{S2})$$

Conclusion

The present results show that perceived numerosity and perceived depth order share the same directional biases [A]. When depth order is determined by disparity, the directional biases disappear and the numerosity in the back is overestimated relative to the numerosity in the front [B]. Compared to a single surface, the numerosity of the surface in the back is overestimated and the numerosity of the surface in the front is underestimated [C]. These effects are robust, since they are not affected by overall dot density, dot speed or dot lifetime [D].

These results indicate that not only the binding of features to single dots is difficult [3], but also the binding of single dots to the surfaces. This is in sharp contrast to the clear appearance of two separate surfaces. Since the bias to overestimate the numerosity of the surface in the back was present even with stationary dots, it might represent a general principle of numerosity and depth perception.

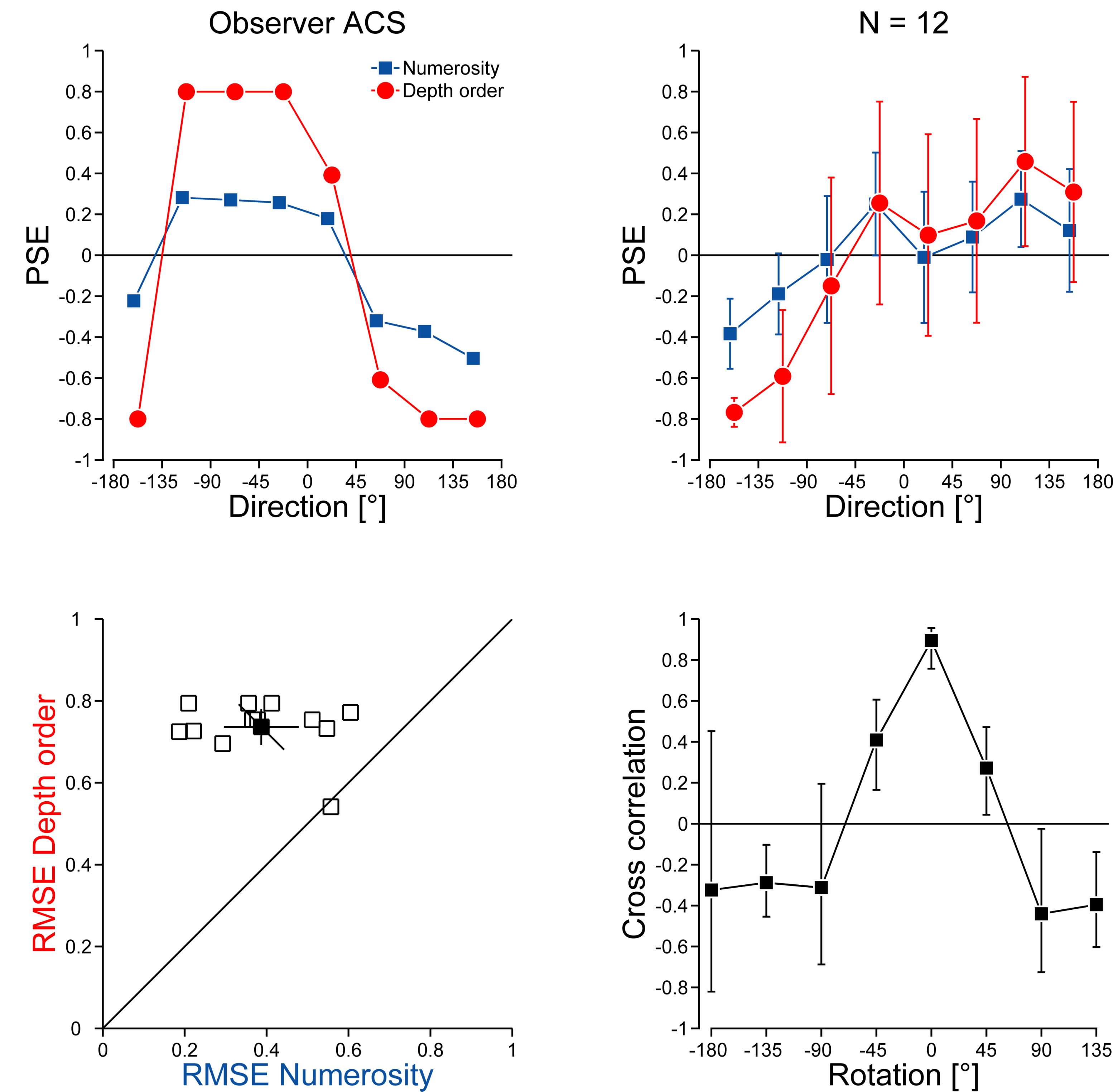
References

- [1] Mamassian, P., & Wallace, J. M. (2010). Sustained directional biases in motion transparency. *J Vis*, 10(13):23, 1-12.
- [2] Schütz, A. C. (2011). Motion transparency: Depth ordering and smooth pursuit eye movements. *J Vis*, 11(14):21, 1-19.
- [3] Saiki, J., & Holcombe, A. O. (2012). Blindness to a simultaneous change of all elements in a scene, unless there is a change in summary statistics. *J Vis*, 12(3):2, 1-11.

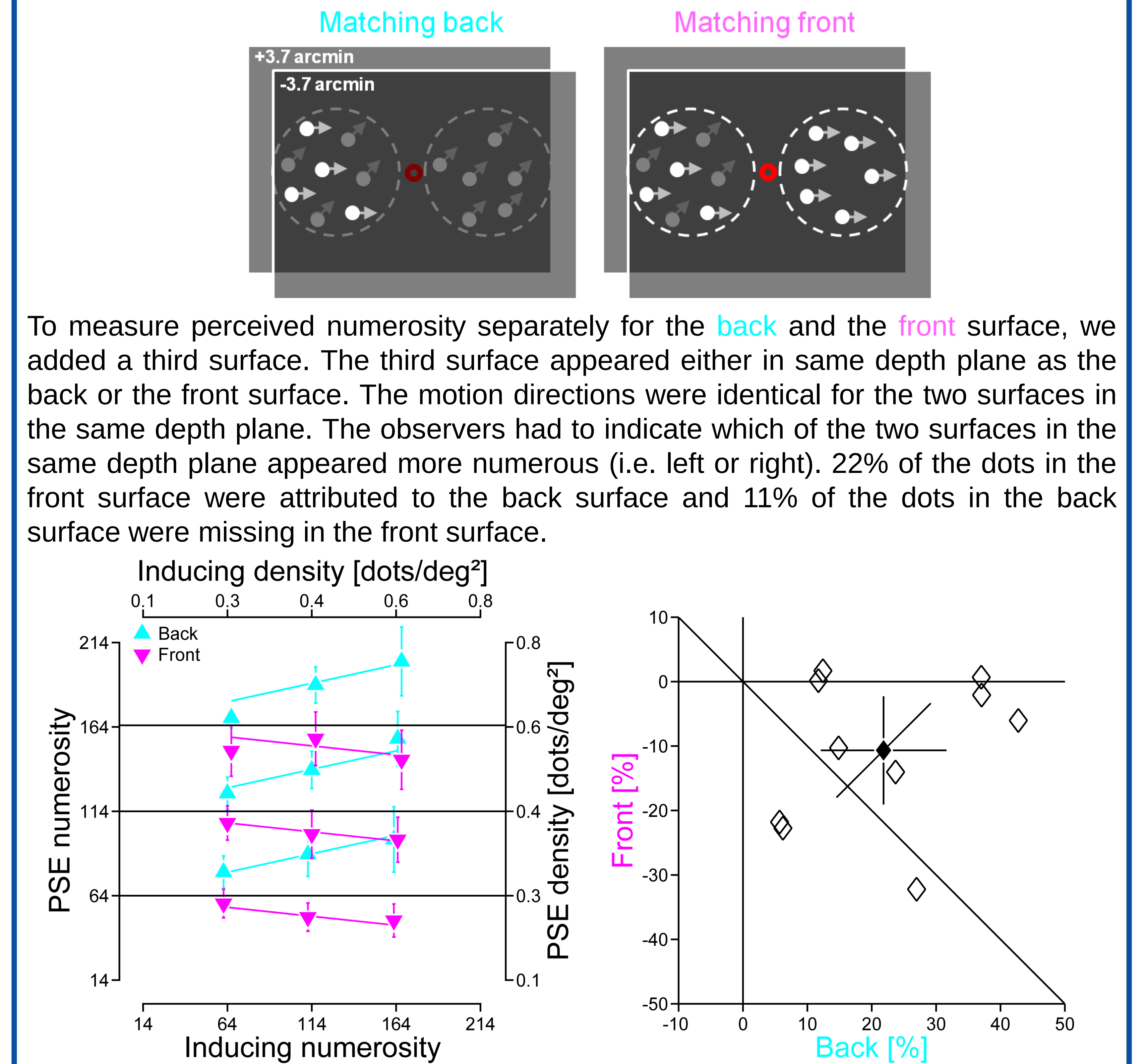
Acknowledgments

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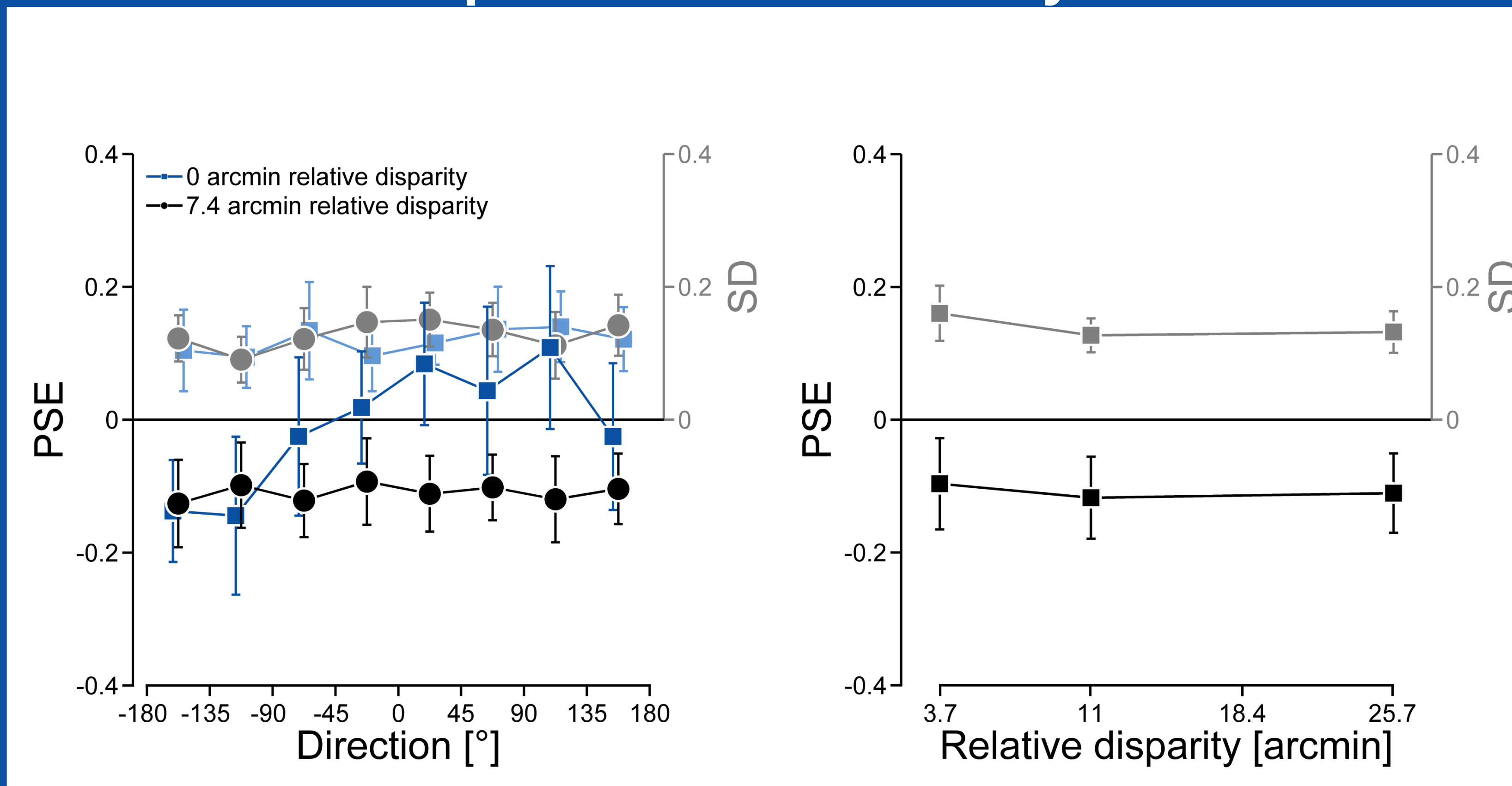
A Similar anisotropies of perceived numerosity and perceived depth order



C Numerosity is overestimated in the back and underestimated in the front



B Depth order, but not the magnitude of disparity determines perceived numerosity



D Numerosity bias is not affected by field density, dot speed or dot lifetime

