School-age children perceive fast radial optic flow in noise more accurately than slow linear flow

Rick O. Gilmore *(rogilmore@psu.edu)*, Andrea R. Seisler, Michelle A. Shade, & Michael J. O'Neill

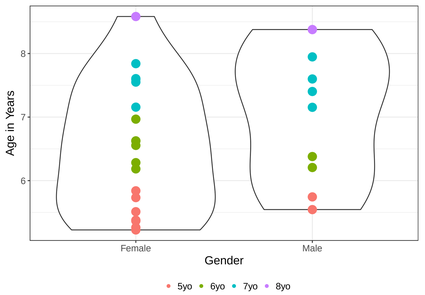
SRCD 2017 – Poster Session 13: Poster 181

Motivation

Behavioral and brain responses to optic flow undergo a prolonged developmental time course [**?**, **?**] in part due to the changing statistics of visual experiences [**?**, **?**]. This study examined whether the detection of optic flow in noise in child observers varies by pattern and speed in similar ways to adults [**?**]. We find that children show adult-like higher sensitivity to radial flow patterns, but immature sensitivity favoring fast (8 deg/s) flow speeds.

Method

Child observers (n=31; 5.2-8.6 years, *M*=6.7, 19 female) participated for $10 in compensation. One child failed to complete the study and was dropped from the analysis.



Two side-by-side, time varying (1.2 Hz coherent/incoherent cycle) annular-shaped (18°outer/5°inner diameter) optic flow displays were presented at a viewing distance of 60 cm. Optic flow was generated by random dot kinematograms with white dots (110 cd/m, 7 amin) presented on a black background. In each trial, one display depicted random (0% coherent) motion while the other depicted radial or linear motion at one of four fixed coherence levels in one of two coherence level profiles (20, 40, 60, 80%) or (15, 30, 45, 60%).

Observers fixated centrally and judged which side contained coherent motion, indicating the choice by pointing to the monitor. The choice was entered via keypress by an experimenter seated behind the observer. Four runs were collected per participant. Each run contained 5 blocks of 16 trials. Within a single run, speed was either 2 or 8 deg/s. Four runs were collected per participant. Participants were given the option to take a break half way through the experiment. All data were collected in a single visit lasting approximately 1 hour.

References

[1] R. O. Gilmore, A. L. Thomas, and J. Fesi, "Children's brain responses to optic flow vary by pattern type and motion speed," *PLOS ONE*, vol. 11, no. 6, p. e0157911, Jun. 2016. [Online]. Available: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157911

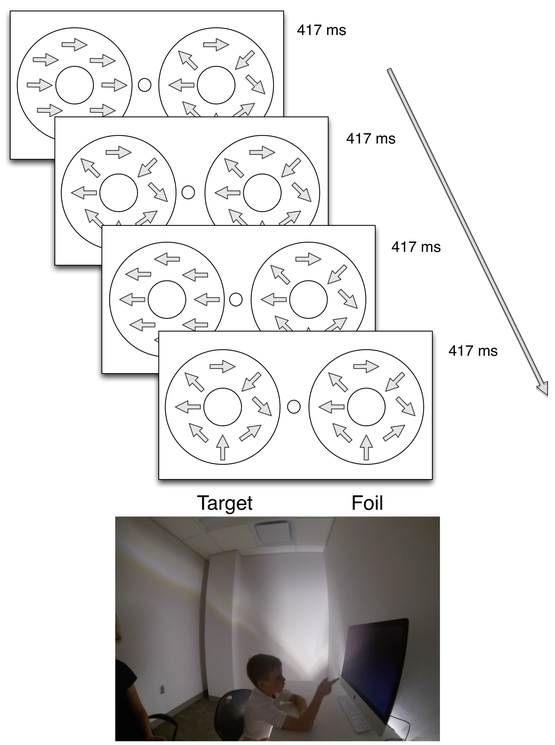
[2] J. D. Fesi, A. L. Thomas, and R. O. Gilmore, "Cortical responses to optic flow and motion contrast across patterns and speeds," *Vision Research*, vol. 100, pp. 56–71, Jul. 2014. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S0042698914000765

[3] R. Gilmore, F. Raudies, and S. Jayaraman, "What accounts for developmental shifts in optic flow sensitivity?" in *2015 Joint IEEE International Conference on Development and Learning and Epigenetic Robotics (ICDL-EpiRob)*, Aug. 2015, pp. 19–25.

[4] F. Raudies and R. O. Gilmore, "Visual motion priors differ for infants and mothers," *Neural Computation*, vol. 26, no. 11, pp. 2652–2668, Nov. 2014. [Online]. Available: http://dx.doi.org/10.1162/NECO_a_00645

[5] "Adult observers' sensitivity to optic flow varies by pattern."

Displays



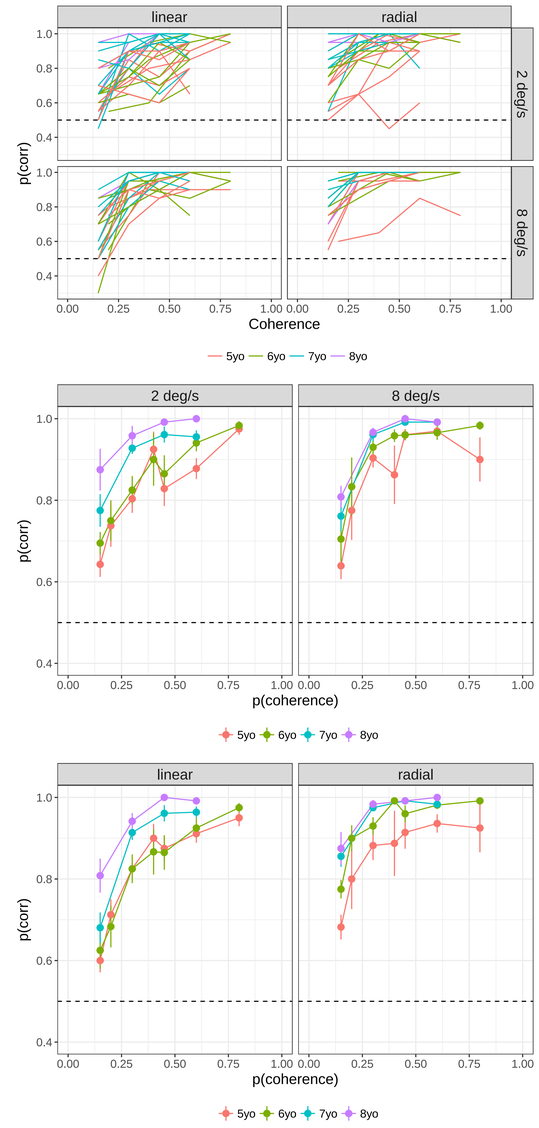
Results: Statistics

The figures show that with increasing motion coherence the proportion of correct judgments increased and response times declined. Accuracy in detecting flow at reached asymptote more quickly for faster (8 deg/sec) speeds than for slow (2 deg/sec) speeds. Similarly, accuracy in detecting radial flow patterns reached asymptote more quickly than detection of flow in linear patterns. Across all speed and pattern conditions, younger children showed poorer performance.

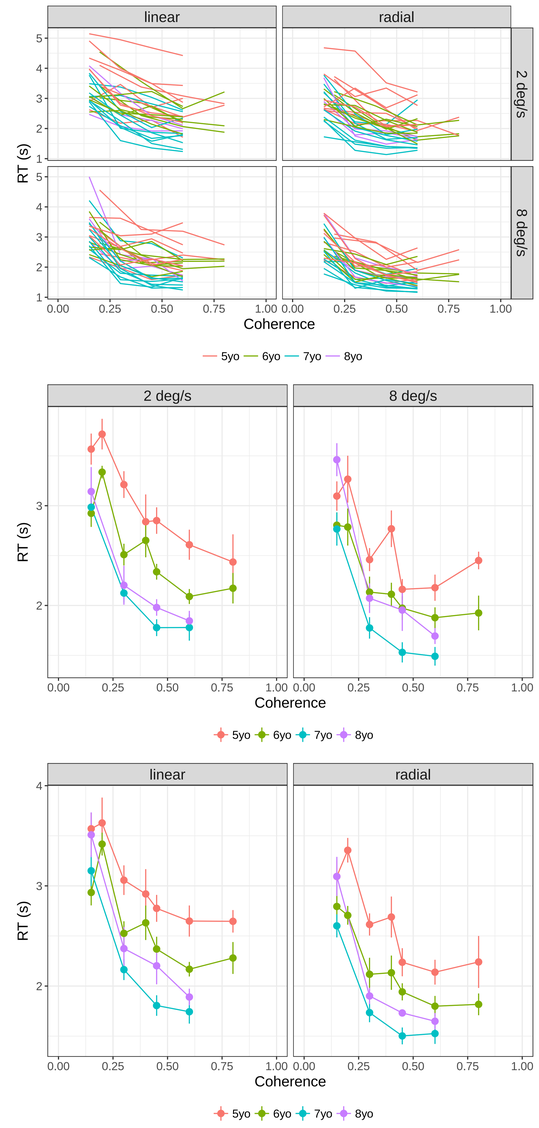
We quantified these observations by using a generalized linear mixed effects model with a probit link function. The final model chosen included a random intercept term for participant and fixed effects for Age (b=0.850, z=5.533, p=3.15×10^{-8}), Pattern (b=0.604, z=11.307, p<2×10^{-16}), Coherence (b=3.677, z=22.549, p<2×10^{-16}), and Speed (b=0.057, z=6.508, p=7.61×10^{-11}. The model suggests that overall accuracy increases with age and with increasing coherence, and that accuracy is higher to faster radial patterns.

We found, but do not report here for space reasons, similar results for reaction time.

Results: Accuracy



Results: Reaction Time



Data Sharing

Movies of the displays, metadata about the participants, and raw data files are available at: `http://databrary.org/volume/218`. Full reports of our data analysis workflows are available at: `http://github.com/gilmore-lab/moco-psychophysics/child-laminar-radial`

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant Number BCS-1147440. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.