Where do mothers point their head when they walk, and where do babies point their head when they are carried?

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Development of Patterns of Gaze and Heading

Gaze patterns differ by task, but how do task-relevant gaze patterns develop?
What are the differences in experienced flow between babies and adults?
Hayhoe, *Visual Cognition* 7, 2000

We compared patterns of eye and head motion produced while mothers carried their infants down an indoor hallway.

Eye-Tracking and Video Recording

Parent/infant dyads (N=6) walk down an indoor hallway.
Parent and infant wear a head-mounted eye tracker and scene camera with a resolution of 800 x 600 pixels (54° x 42°) at 30fps.
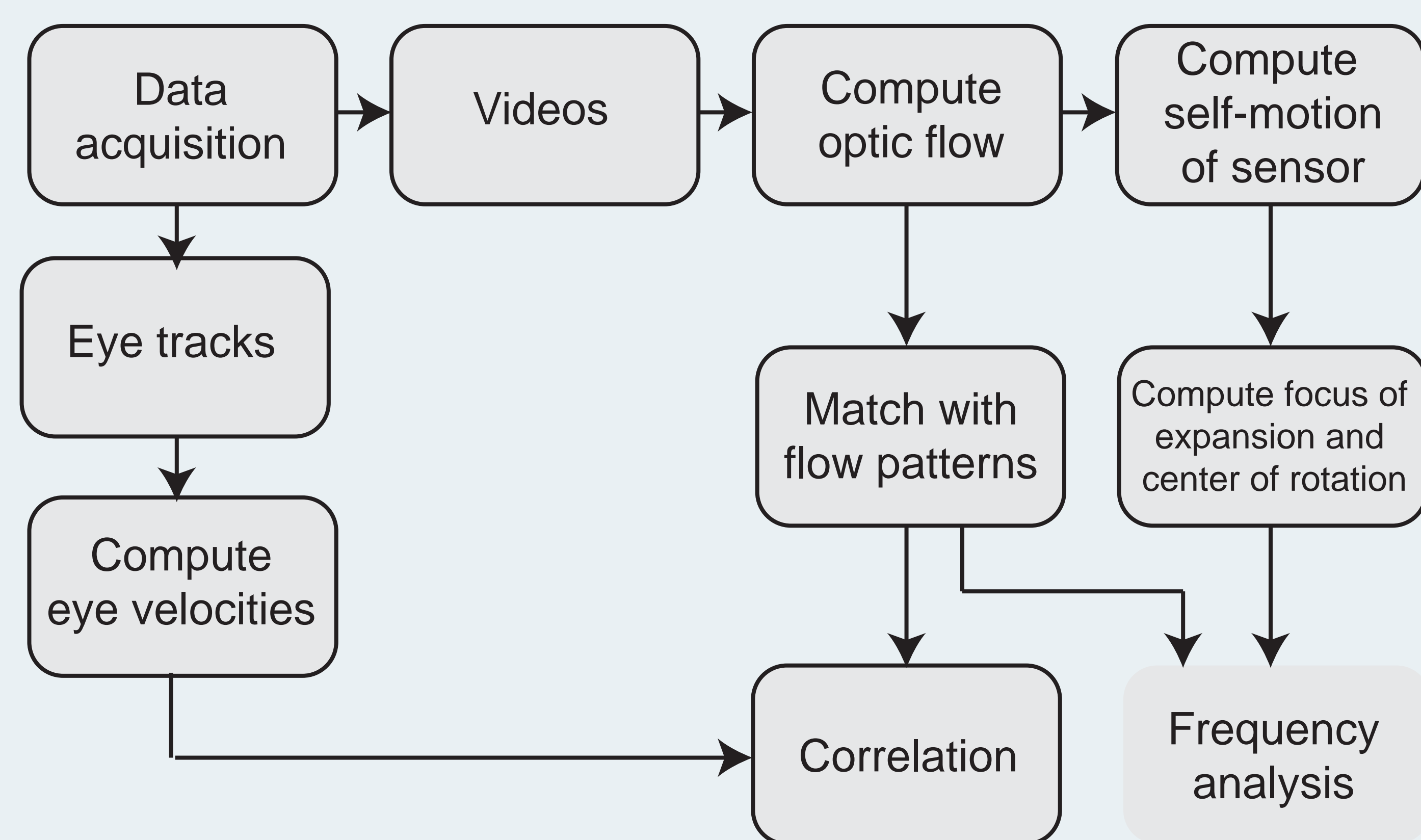
More information on methods
www.positivescience.com
Franchak et al., *Child Development* 82, 2011

Data Processing

Optic flow and self-motion was computed from the video stream. Synchronized recordings of eye positions were transformed into rotational eye-velocities using a pinhole camera model.
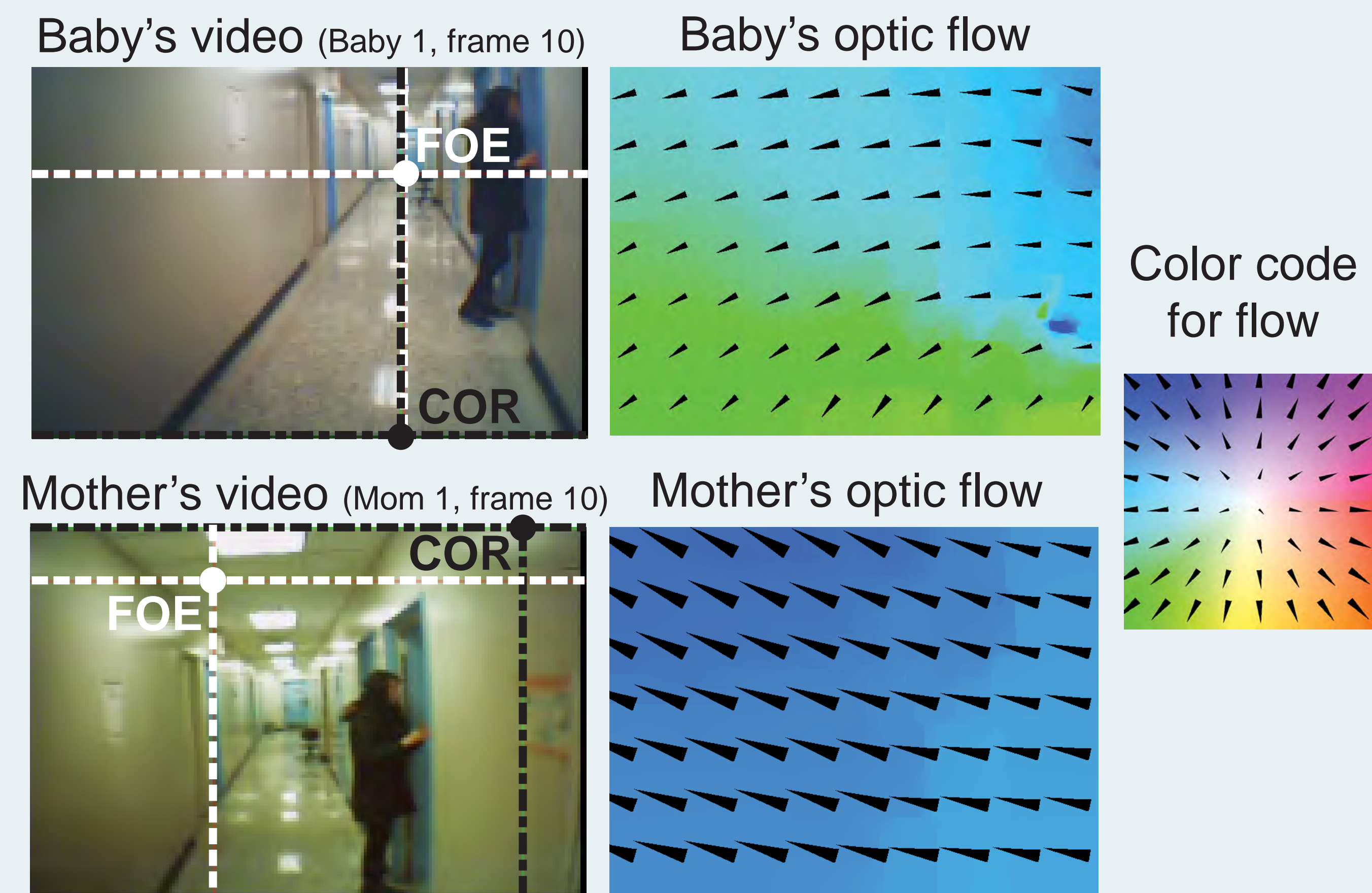
System diagram and data flow

Acknowledgments

Estimating Optic Flow from Videos

Optic flow is estimated from videos using an algorithm that assumes gray-value-constancy between frames and smoothness for the detected flow.
Brox et al., In Proceedings of *ECCV LNCS 3024*, 2004

Baby's video (Baby 1, frame 10) · Baby's optic flow

Mother's video (Mom 1, frame 10) · Mother's optic flow

Color code for flow

Estimating Self-Motion from Optic Flow

Self-motion is estimated from optic flow assuming instantaneous motion for a pinhole camera model. This model inlcudes three linear velocities, three rotational velocities, and the depth of each pixel sample. Self-motion is estimated with two methods and only estimates that are within a 2° error are evaluated.
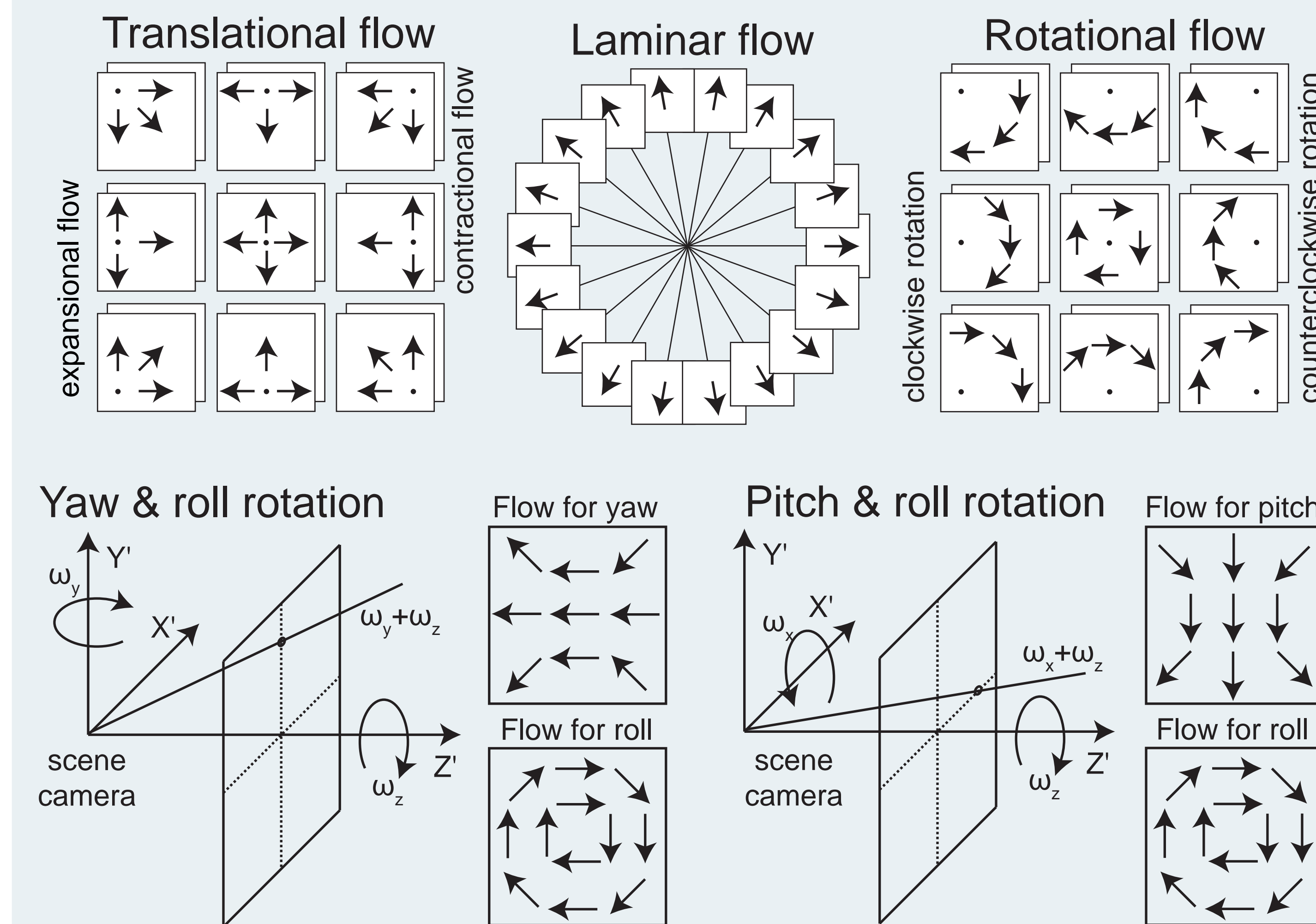Heeger & Jepson, *International Journal of Computer Vision* 7(2), 1992
Raudies & Neumann, *Computer Vision and Image Understanding* 116(5), 2012
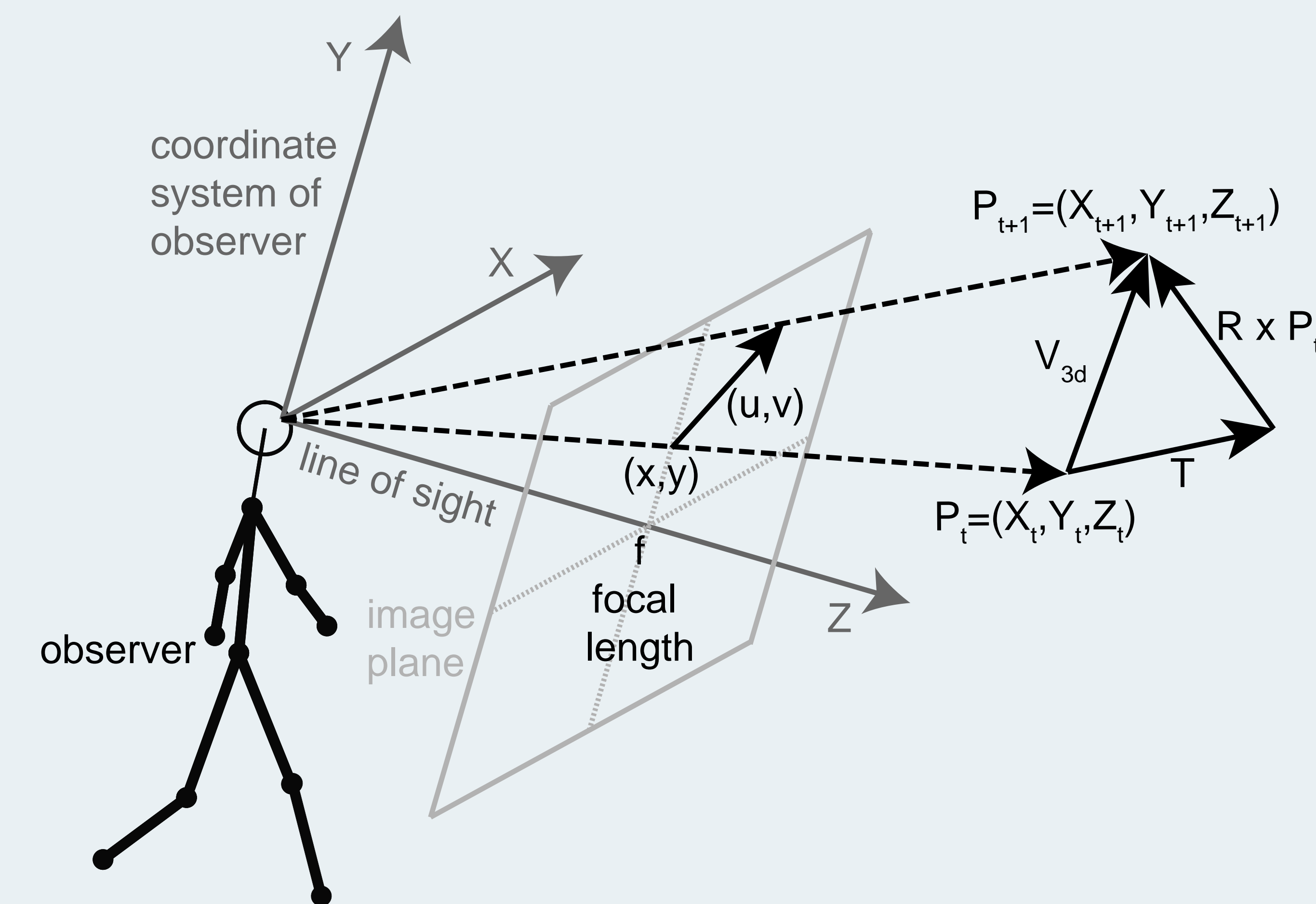

Matching Optic Flow against Flow Patterns

We match the detected optic flow against a set of flow patterns.

Translational flow · Laminar flow · Rotational flow

Yaw & roll rotation · Flow for yaw · Flow for roll

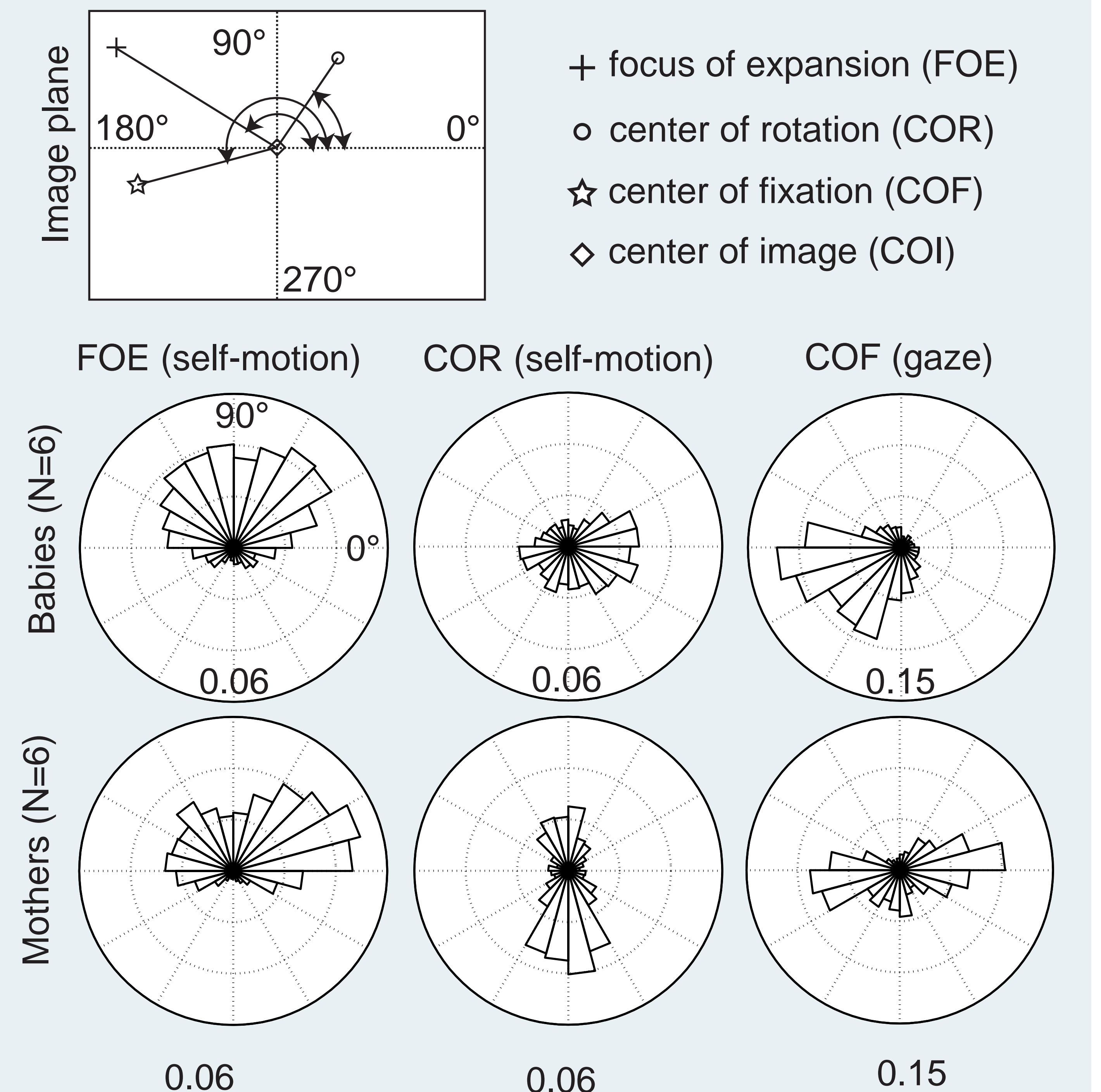Pitch & roll rotation · Flow for pitch · Flow for roll

Results: Correlations for Flow and Eye-velocity

Correlations are computed with reference to a baseline that computes the mean correlation where data of one sequence are randomly shuffled multiple times.

Baby and mother correlations for

Flow patterns · Eye velocity

Flow and eye-velocity correlations for

Baby · Mother
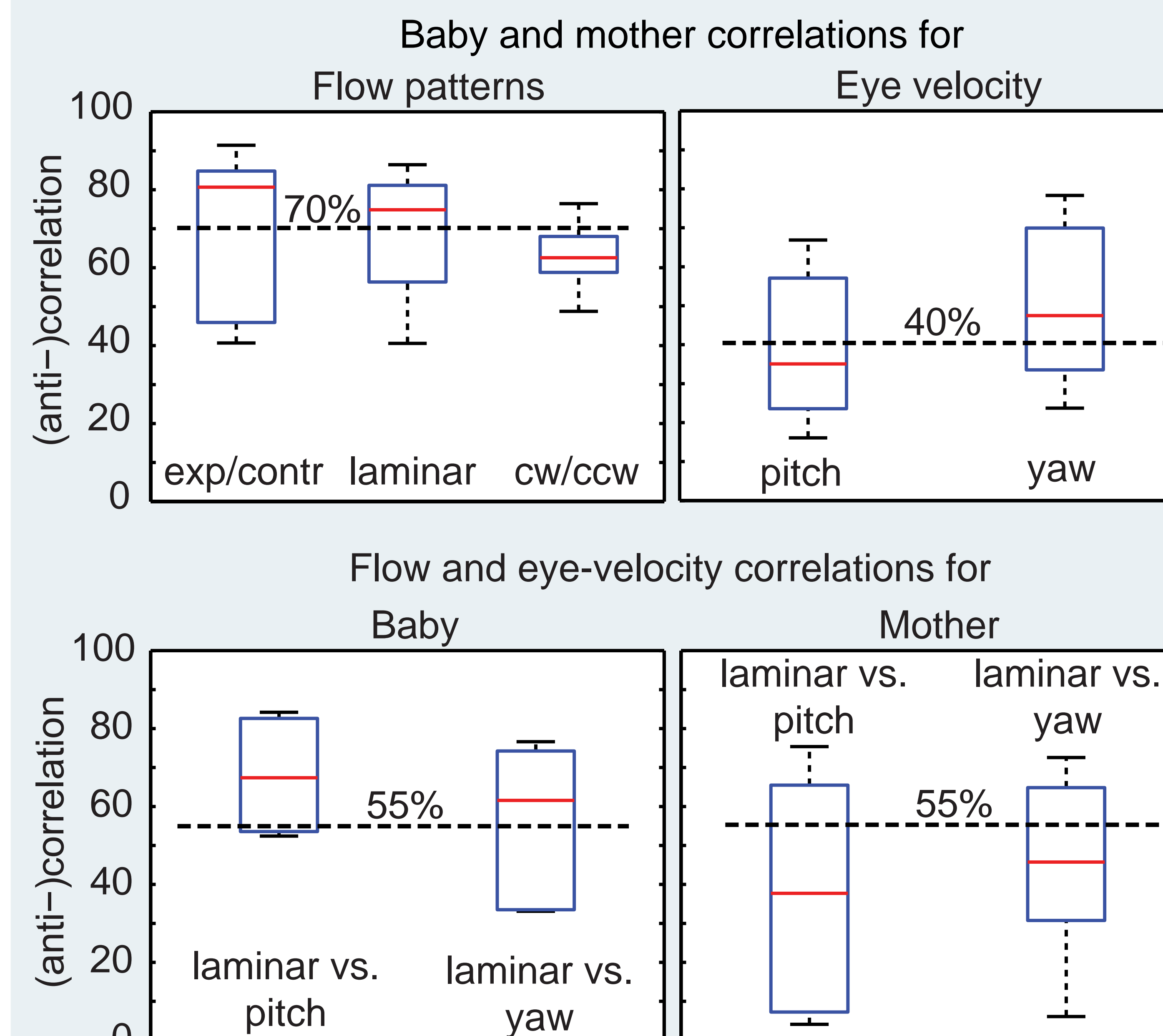
Results: Focus of Expansion and Gaze Statistics

We evaluated the angular statistics of the focus of expansion and gaze location in the image plane referencing the image center.

+ focus of expansion (FOE)
o center of rotation (COR)
☆ center of fixation (COF)
◇ center of image (COI)

FOE (self-motion) · COR (self-motion) · COF (gaze)

Babies (N=6) · Mothers (N=6)

Results: Summary

In infants, the FOE pointed upward, consistent with a downward pointing head.
Mothers' FOEs pointed to the left and right.
Babies CORs were elongated along the horizontal axis; that of mothers was elongated along the vertical axis.
Mothers shifted gaze left/right more often than up/down.
Correlations between flow of the scene videos from babies and their mothers were higher (~70%) than those for the eye-velocities and laminar flow (~55%), and were higher than those for eye-velocities of mothers and their babies (~40%).

Conclusions

Mothers explore the scene along the horizontal axis more so than infants.
Passively carried infants experience pitch rotation and generally direct their head toward the ground.