An ideal observer model of infant object perception: Supporting material

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We describe how the posterior odds ratio in Equation 7 is approximated and specify the habituation model (Equation 8) in full detail.

1 One object or two?

To approximate the ratio in Equation 7, we compute a rough approximation of $\int f(\vec{v_1})d\vec{v_1}$ by summing over a finite space of velocity fields. We consider scenes built from five objects: a vertical rectangle, a horizontal rectangle, a small square, a large square, and an object that produces the same silhouette as a small square on top of a large square. Each object may follow one of 10 trajectories, all of which are rigid and piecewise linear: for instance, an object can remain stationary, move smoothly in one direction, move smoothly in one direction then double back, and so on. An object may begin at any point on a 30 by 30 grid, and we consider all fields that can be produced by choosing an object, a starting point, and a trajectory. All fields in this set have non-zero values of $f(\cdot)$ according to Equation 6, and we approximate $\int f(\vec{v_1})d\vec{v_1}$ by summing these values. A similar strategy can be used to approximate $\int f(\vec{v_1}, \vec{v_2})d\vec{v_1}d\vec{v_2}$. Now, however, we must allow for the fact that some pairs of fields are incompatible and contribute a value of zero to the sum.

2 Habituation model

The second expert in our product of experts model (Equation 8) assumes that velocity field \vec{v} is drawn from a Gaussian distribution centered on $\vec{v_H}$:

$$p(\vec{v}|\vec{v_H}) \propto \prod_{x,y,t} \exp\left(-\frac{1}{2\sigma^2} |\vec{v}(x,y,t) - \vec{v_H}(x,y,t)|^2\right) \tag{1}$$

where the product is computed over a space-time grid. Equation 1 assumes that the covariance of the Gaussian is diagonal with parameter σ^2 , and for all analyses we set $\sigma^2 = 1$.

When the habituation stimulus includes a block that passes behind an occluder, we use the same habituation field $\vec{v_H}$ for both the baseline and the smoothness model. In all analyses we use a field which specifies that the block moves smoothly behind the occluder, but note that the smoothness model alone can make this inference. Our results therefore provide an upper bound on the capacities of the baseline model, and show that this model cannot account for the relevant data even when supplied with an accurate interpretation of the habituation stimulus.