Motion perception in 360° space:

Illusory perception of opposite direction of motion

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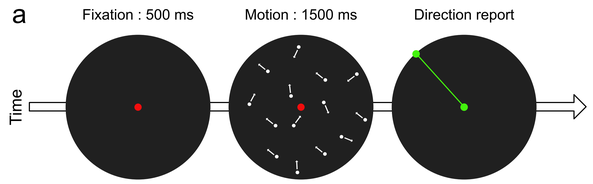
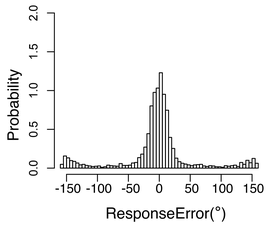
CONTINUOUS MOTION DIRECTION ESTIMATION WITH RDK

We used the standard random dot kinematogram (RDK) algorithm developed by Roitman & Shadlen (2002). Motion direction was randomly sampled from 360°. 2 levels of motion coherence (25% and 50%) were tested with 2 levels of duration (300 ms and 1000 ms). 24 observers participated.



At the end of the motion, participants reported the perceived motion direction by aligning the green response line. Performance was quantified as the angular difference between the true direction and the reported direction.



In a pilot experiment, we found that participants sometimes made 180° errors. The proportion of this opposite direction reports was small, but they were observed in almost all participants.

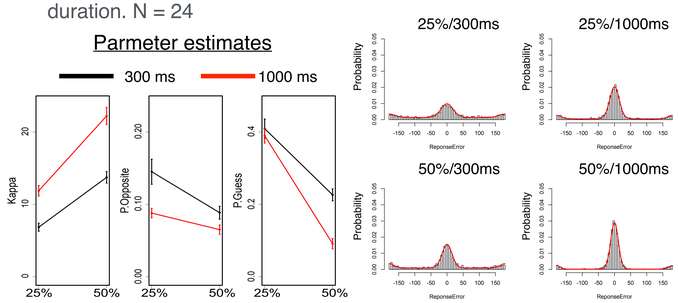
QUANTIFYING RESPONSE ERRORS USING A THREE-COMPONENT MIXTURE MODEL

In our analysis, we assumed that observers' direction reports were a combination of 1) correct perception of motion direction with some precision, 2) random guesses, and 3) opposite direction perception of the true motion direction.

$$P(\theta) = \underbrace{\alpha * \text{vonMises}(0, \kappa)}_{\text{reports based on the true direction}} + \underbrace{\beta * \text{vonMises}(\pi, \kappa)}_{\text{reports based on the opposite direction}} + \underbrace{(1-\alpha-\beta)/2\pi}_{\text{random guesses}}$$

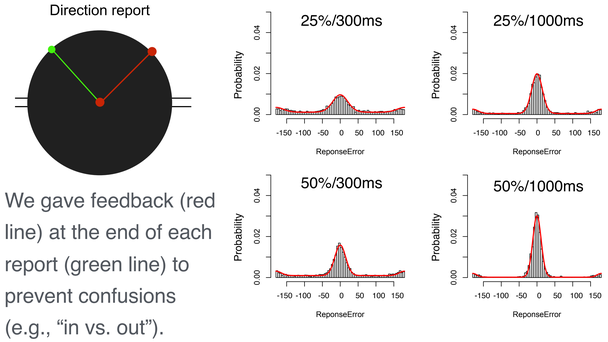
RESULT #1. PARTICIPANTS CONSISTENTLY PRODUCED OPPOSITE DIRECTION REPORTS

We found that the proportion of opposite direction reports varied systematically as a function of motion coherence and motion duration. N = 24



RESULT #2. IT'S NOT A RESPONSE CONFUSIONS

To make sure that the opposite direction reports were not driven by poor understanding of the task, we ran a replication experiment with response feedback. N = 24

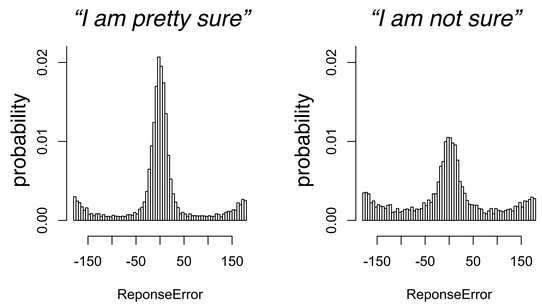


We gave feedback (red line) at the end of each report (green line) to prevent confusions (e.g., "in vs. out").

RESULT #3. IT'S REAL PERCEPTION!

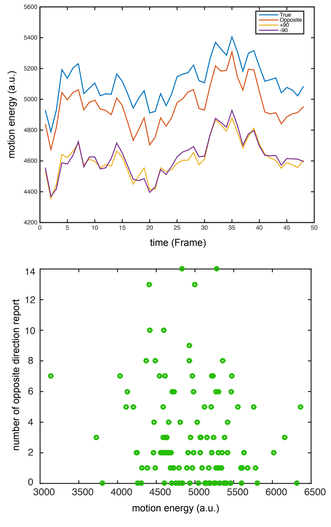
We wanted to make sure the opposite direction reports reflected actual perception. So, in another replication experiment, we had participants indicate their confidence after each direction report.

Opposite direction reports were observed in trials with both high and low confidence. N = 24



RESULT #4. STIMULUS MOTION ENERGY WAS NOT CORRELATED WITH THE OPPOSITE DIRECTION REPORTS

To test whether stimulus motion energy was responsible for the opposite direction reports, we estimated motion energy toward the opposite direction of the true motion direction using spatial-temporal motion energy filter. We then correlated the motion energy for a given motion trajectory with the number of opposite direction reports for that trajectory. We found no significant correlations.

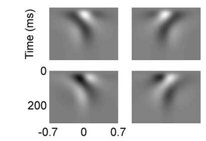


Motion energy toward the true motion direction, the opposite motion direction, and the two orthogonal motion directions were estimated for each time frame. Overall, the true motion direction produced the strongest motion energy.

We correlated the motion energy for each trajectory and the number of opposite direction reports (abs(error)>150°) of the trajectory. We found no significant correlation.

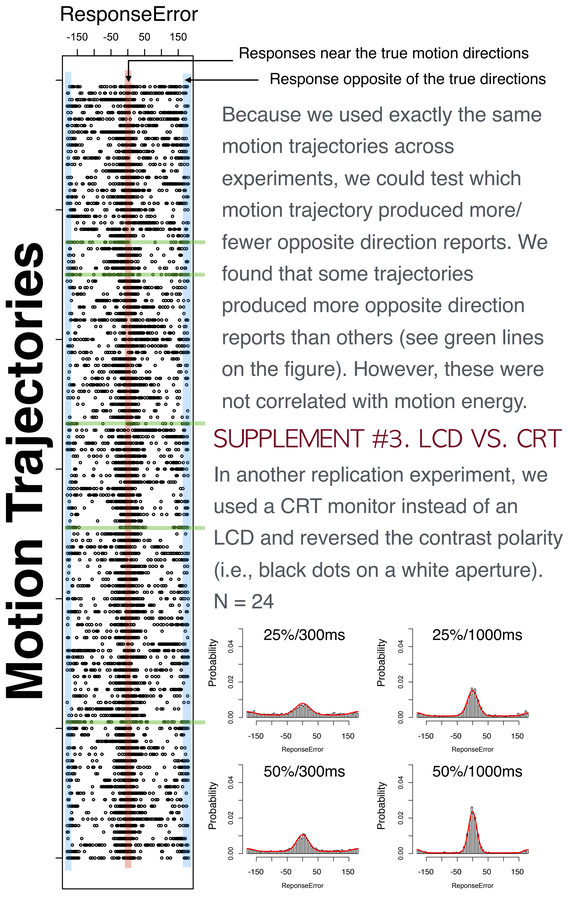
SUPPLEMENT #1. SPATIAL-TEMPORAL MOTION ENERGY FILTER

We estimated motion energy using the spatial-temporal motion energy filter developed by Kiani, Hanks, & Shadlen (2008).



The filter was applied to each video frame. Motion energy was computed by summing the filtered values.

SUPPLEMENT #2. SOME MOTION TRAJECTORIES PRODUCED MORE OPPOSITE DIRECTION REPORTS



Because we used exactly the same motion trajectories across experiments, we could test which motion trajectory produced more/ fewer opposite direction reports. We found that some trajectories produced more opposite direction reports than others (see green lines on the figure). However, these were not correlated with motion energy.

SUPPLEMENT #3. LCD VS. CRT

In another replication experiment, we used a CRT monitor instead of an LCD and reversed the contrast polarity (i.e., black dots on a white aperture). N = 24