Flexible readout of stable cortical representations support motion visibility perception

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1. Introduction: Features

Motion visibility is a key tool in cognitive neuroscience. How does the brain read out from visual cortex to support motion visibility perception?

Contrast

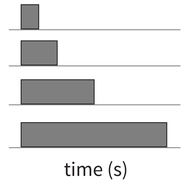
The relative luminance to a gray background

Coherence

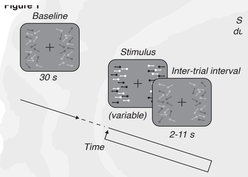
Coherence is the % of dots moving in sync

Duration

The length of time the stimulus is visible



2. Cortical measurements

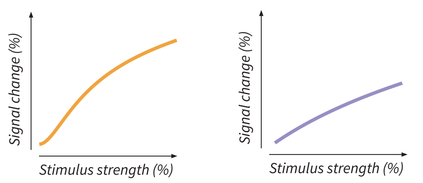


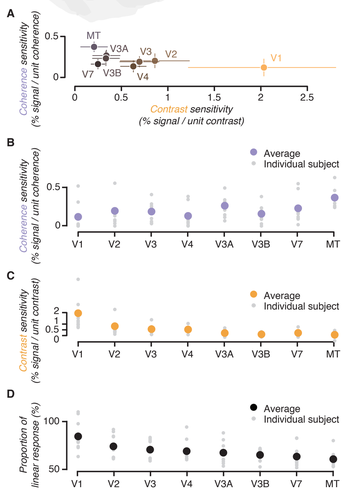
BOLD response was measured while participants passively observed the stimulus.

We fit a quantitative framework for motion visibility response to understand how sensitivity to different visibility features varied across cortex.

We assumed that the contrast response was a Naka-Rushton function and that coherence linear or saturating nonlinearity.

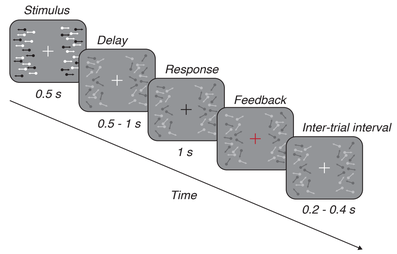
$$R(s) = \alpha\left(\frac{s^{0.3}}{s^{1.6} + s_{50}^{1.6}}\right) \qquad R(s) = \alpha\left(1 - e^{-\frac{s}{\kappa}}\right)$$

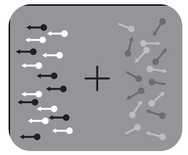




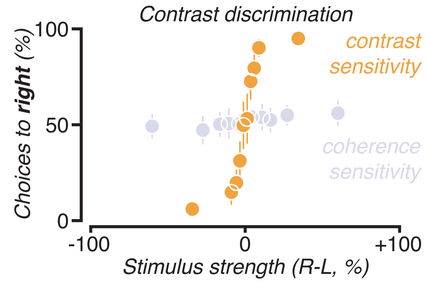
3. Behavior

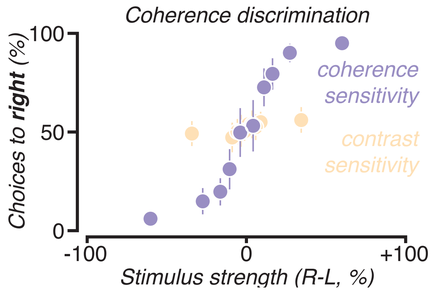
We collected data on how well observers could discriminate small increments in the motion visibility features.



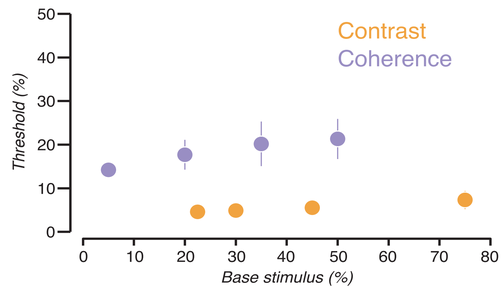


Which side has higher contrast?
or
Which side has higher coherence?





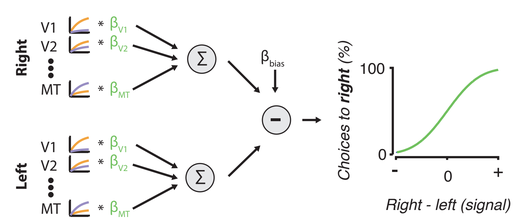
Observers performed the task at varying base stimulus strengths and showed a slight Weber-law like effect.

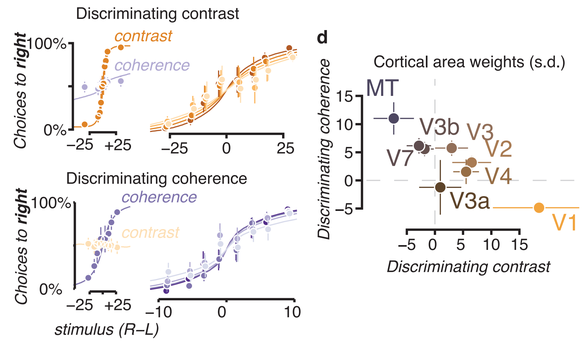


4. Readout model

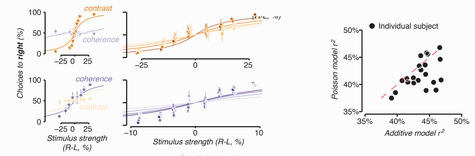
To read out from visual cortex for perception, we performed a linear weighting of visual cortex responses.

The weighted output was compared for the left and right dot patches, subject to Gaussian noise.



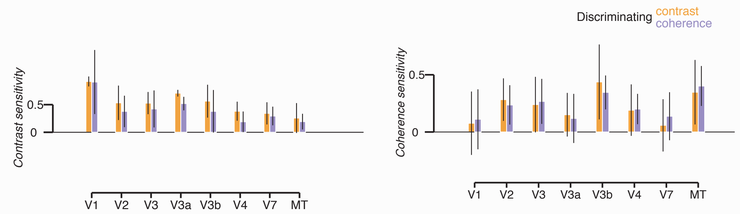


5. Noise



6. Stability

Observers performed the task in the scanner to determine whether sensory responses were subject to enhancement or suppression during active viewing.



All data shows bootstrapped mean ± 95% CI across subjects.

1. Boynton, G. M., Demb, J. B., Glover, G. H., & Heeger, D. J. *Vision Research* (1999).
2. V5/MT is thought to respond linearly to increasing motion coherence (see also 4). Rees, G., Friston, K., & Koch, C. *Nature neuroscience* (2000).
3. Simoncelli, E. P., & Heeger, D. J. *Vision Research* (1998).
4. Previous reported values for neural noise in a similar model of contrast discrimination were 0.064% and 0.016% for distributed and focal attention. Pestilli, F., Carrasco, M., Heeger, D. J., & Gardner, J. L. *Neuron* (2011).

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