Hierarchical effects of contrast and motion coherence in early visual cortex

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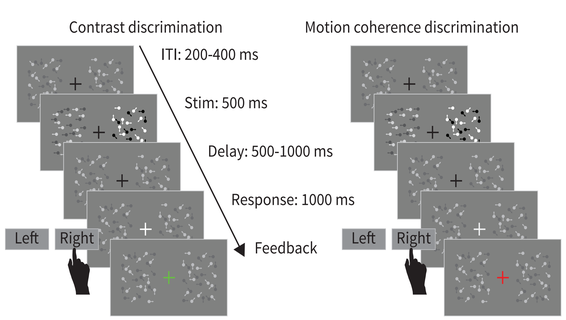
1. Introduction

An existing model of contrast discrimination suggests early visual cortex is sufficient to explain behavioral performance[1].

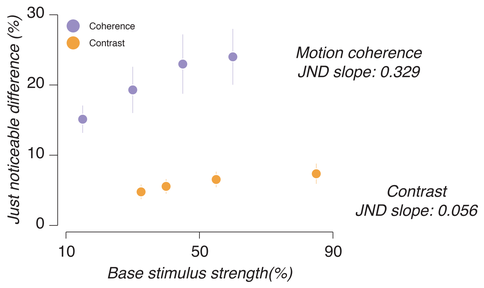
Can that approach be used to jointly explain motion coherence discrimination?

2. Discrimination task

We collected data on how well participants could discriminate small increments in contrast and motion coherence.

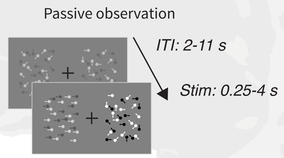


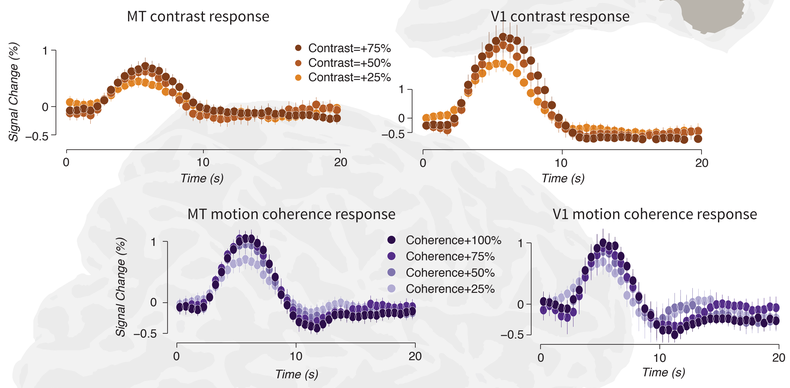
Just noticeable differences (n=21)

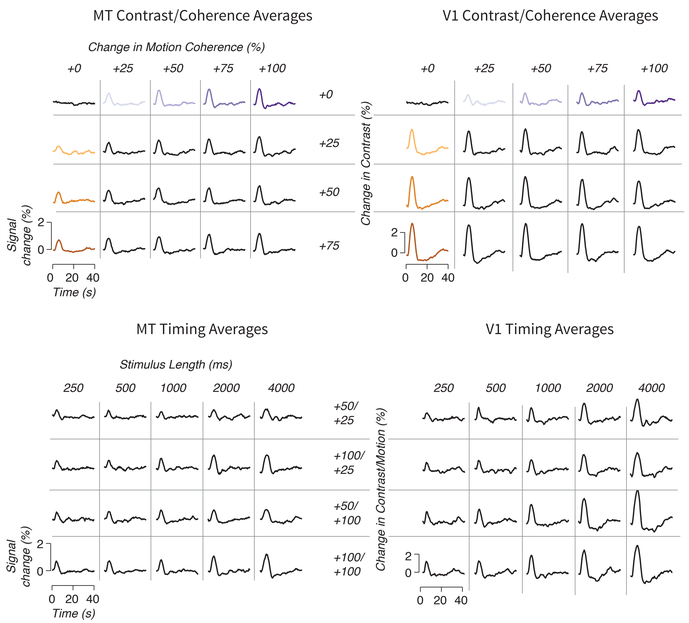


3. Cortical measurements (fMRI)

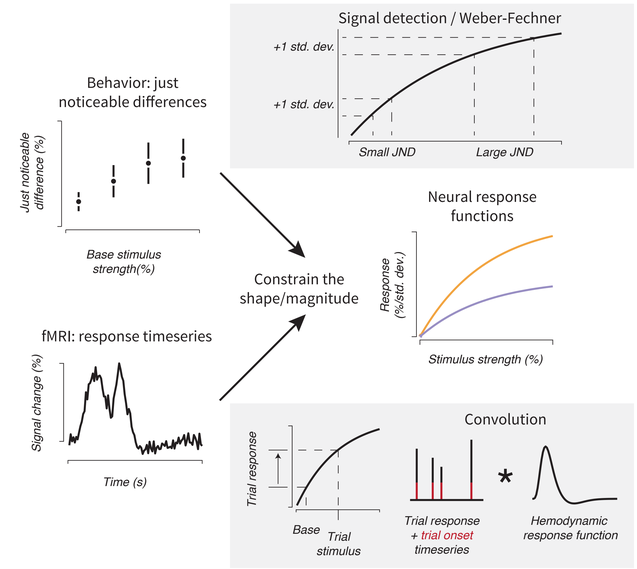
Cortical responses were measured during discrimination and passive observation while performing a fixation task.



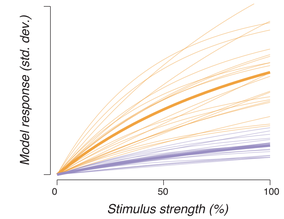




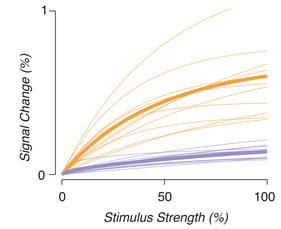
4. Neural response model



Contrast and motion coherence response functions constrained by behavior (n=21)

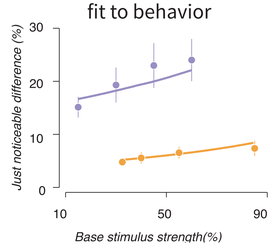


V1 contrast and MT motion coherence response functions constrained by fMRI (n=11)

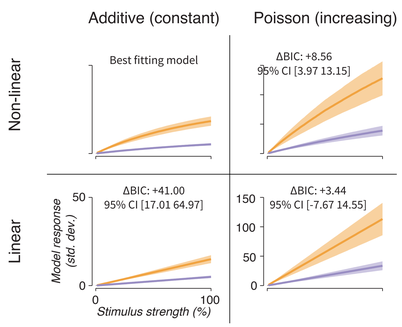


5. Model variations

Non-linear additive model fit to behavior



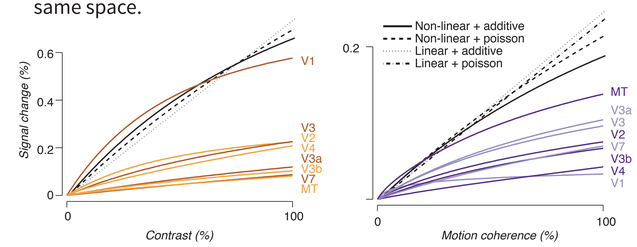
Neural response model variations[3,4]



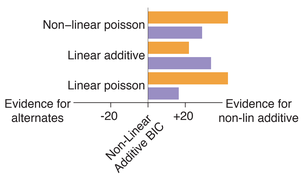
6. Conclusion

The same model of neural responses works for contrast using V1, and for motion using MT

We fit a neural noise[5] parameter to scale response models into the same space.



Model comparison of behavioral contrast and motion coherence response models to V1 and MT, respectively



All data shows bootstrapped mean ± 95% CI across subjects.
Non-linear response functions were modeled using an exponential that can interpolate between linear and non-linear responses: $Response(s) = \alpha - \alpha e^{-\kappa s}$

1. Boynton, G. M., Demb, J. B., Glover, G. H., & Heeger, D. J. *Vision Research* (1999).
3. V5/MT is thought to respond linearly to increasing motion coherence (see also 4). Rees, G., Friston, K., & Koch, C. *Nature neuroscience* (2000).
4. Simoncelli, E. P., & Heeger, D. J. *Vision Research* (1998).
5. 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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