Temporal Summation and Adaptation in Human Visual Cortex

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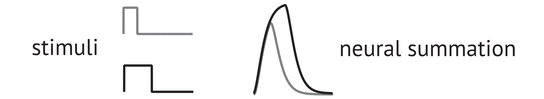
How does visual cortex integrate over time?

Summation: The visual system integrates input over time.

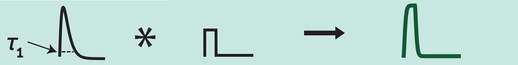


Adaptation: Responses decrease for sustained or repeated stimuli.

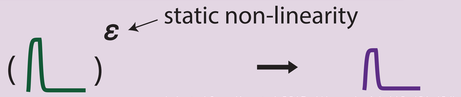
- **Goals:**
- Account for **summation** and **adaptation** in one model.
- Predict fMRI and ECoG responses to stimuli with different temporal patterns.
- Characterize differences between visual areas.

Three possible models

Linear Model (τ_1)

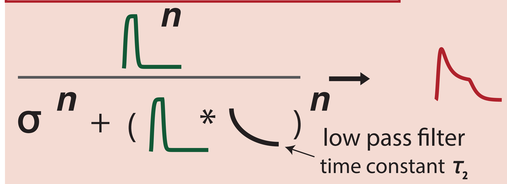


Compressive Temporal Summation (CTS) (τ_1, ε)



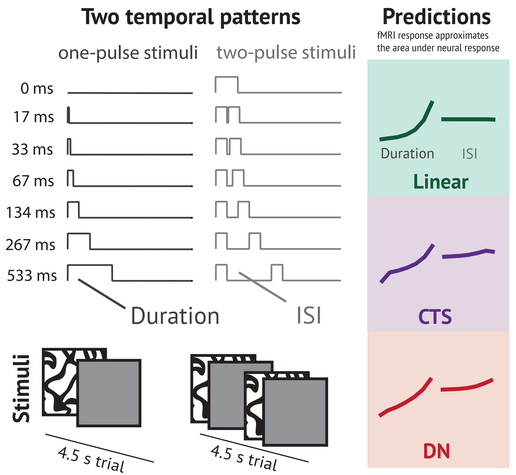
(adapted from Kay et al. 2013, *J.Neurophysiol.*, 110: 481-494)

Delayed Normalization (DN) (τ_1, n, τ_2, σ)

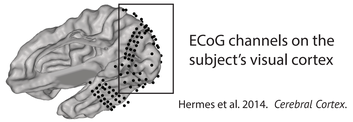


(adapted from Heeger, D.J. 1993, *J.Neurophysiol.*, 70(5):1885-98)

fMRI Design and Predictions

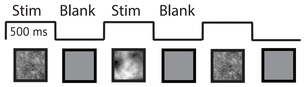


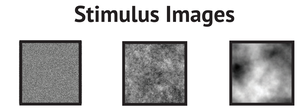
ECoG Design and Predictions

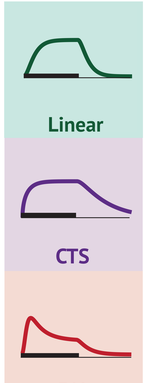


ECoG channels on the subject's visual cortex

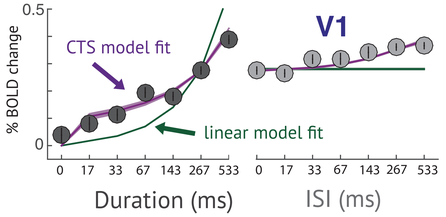
Hermes et al. 2014. *Cerebral Cortex.*

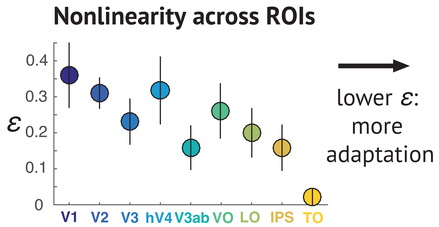


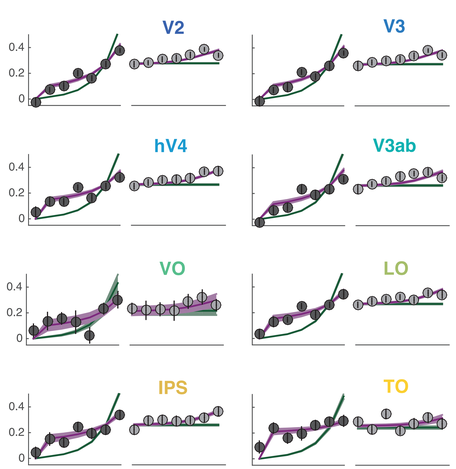




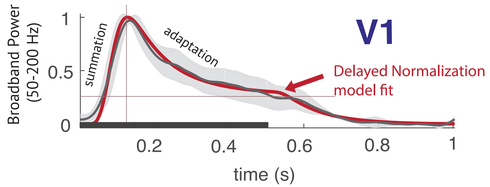
CTS model accounts for temporal nonlinearities in fMRI data

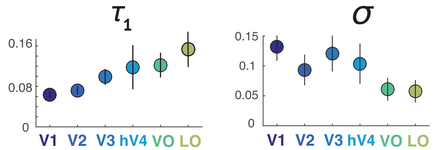






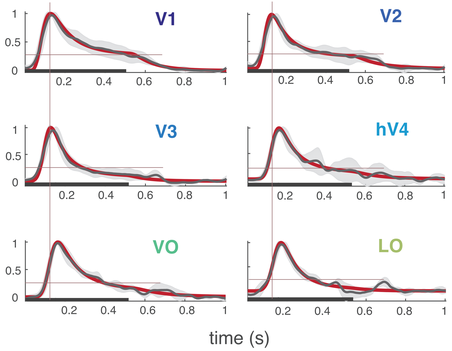
Delayed normalization accounts for transient & sustained ECoG responses





longer τ_1: longer summation period

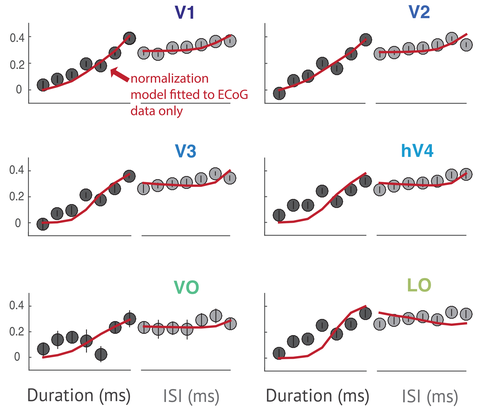
lower σ: more adaptation



τ_1 and σ vary systematically across the visual hierarchy.

Combining ECoG and fMRI

- Learn normalization parameters from ECoG.
- Predict fMRI responses.



Conclusions

- Delayed normalization accounts for both temporal summation and adaptation.
- Higher visual areas are more compressive than early visual areas.
- Higher visual areas have a longer period of temporal summation.
- Delayed normalization can account for both fMRI and ECoG data.

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