Divisive normalization accounts for temporal dynamics in somatosensory cortex

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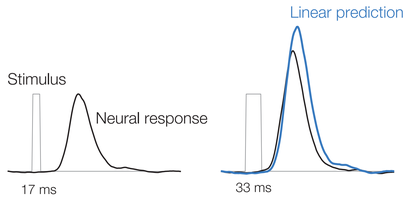
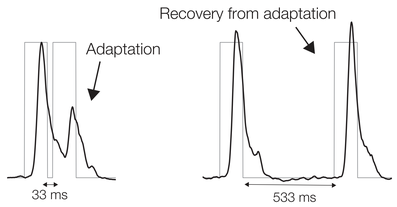
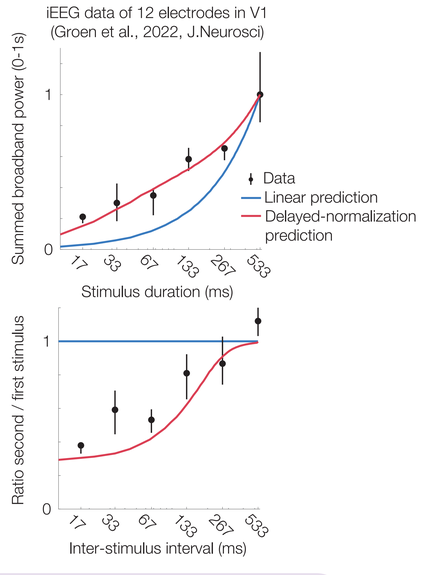
Temporal dynamics in vision

1. Sub-additive temporal summation



2. Repetition suppression

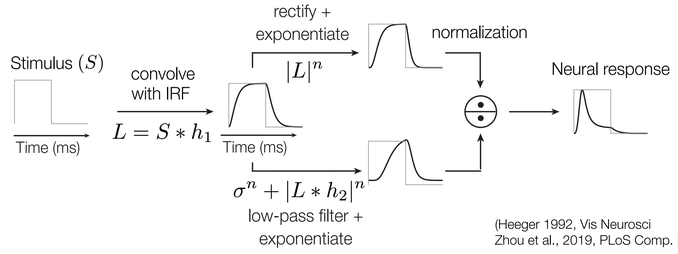




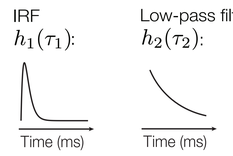
Research question

Do principles of temporal dynamics observed in visual cortex also apply to somatosensory cortex?

Delayed-normalization model

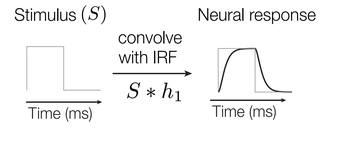


Free parameters

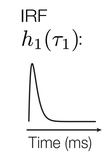


σ: semi-saturation constant
n: exponent

Linear model

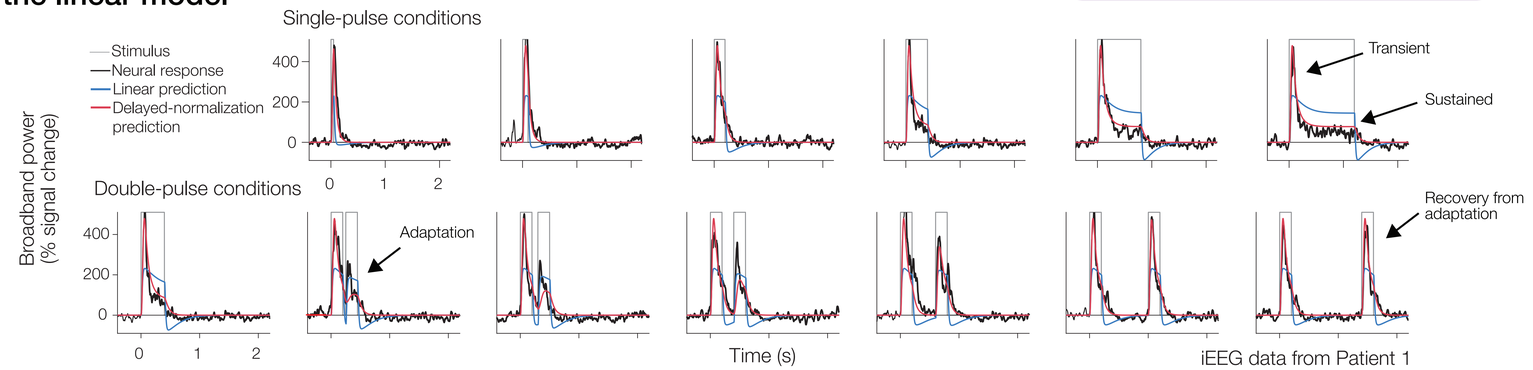


Free parameters



	#Electrodes	Cross-validated R^2 Delayed normalization	Linear
Patient 1	4	0.885	0.535
Patient 2	21	0.889	0.537

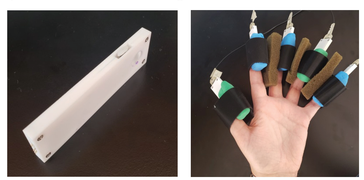
iEEG responses are better fit by the delayed-normalization model than the linear model



We measured somatosensory cortex responses by fMRI and iEEG using the same stimuli

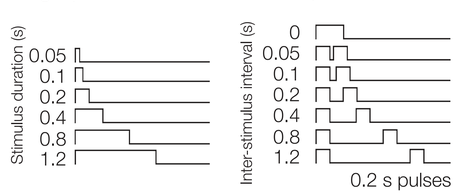
Apparatus

Vibrotactile stimulation (110 Hz carrier) presented to all five fingers



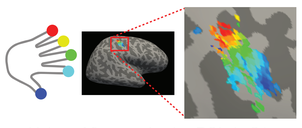
MR-safe piezoelectric tactile stimulator (Dancer Design)

Temporal conditions



fMRI

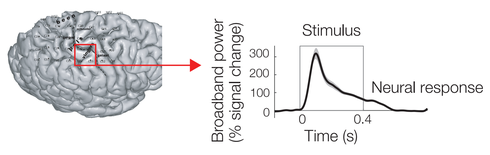
Estimate BOLD time-courses by deconvolution from 6 participants



Union of finger-selective ROIs in S1

intracranial EEG (iEEG)

Extract envelope of broadband power from electrodes in somatosensory cortex from 2 patients



Can we predict fMRI BOLD response amplitudes to the same stimuli with the same model?

Sum and scale the model prediction of time-series to iEEG data

$$k\Sigma\left(\quad\right)$$

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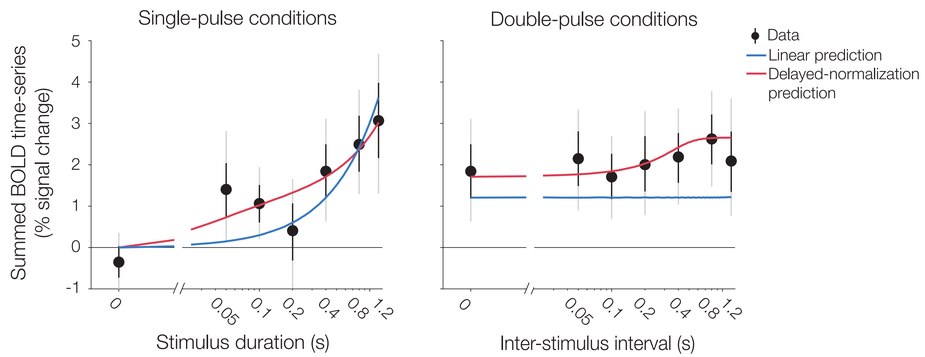
$$k = \frac{\text{Mean BOLD}}{\text{Mean broadband power}}$$

fMRI BOLD responses are well captured by the scaled model prediction based on iEEG data



Conclusions

- Temporal dynamics are similar in visual and somatosensory cortex.
- Divisive normalization with a delay captures temporal dynamics in both sensory cortices measured by fMRI and iEEG.

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