~~Delayed~~ normalization accounts for temporal dynamics in visual and somatosensory cortices

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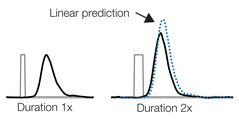
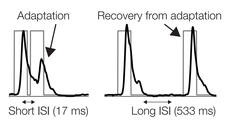
Temporal dynamics in vision

Neural responses in visual cortex exhibit complex temporal dynamics.

1 Sub-additive temporal summation

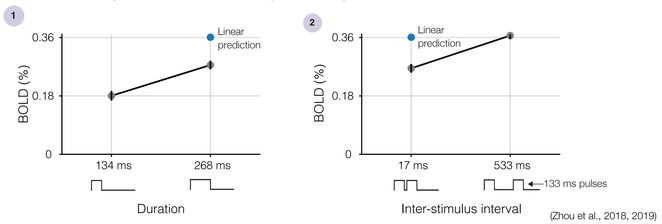


2 Reduced response to repeated stimulus



(Figures from Groen et al., 2022;
See also Tolhurst et al., 1981; Motter, 2006)

Some of these dynamics can be captured by fMRI.



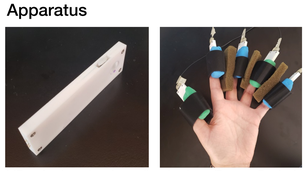
(Zhou et al., 2018, 2019)

Research question

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

Measuring fMRI responses in S1

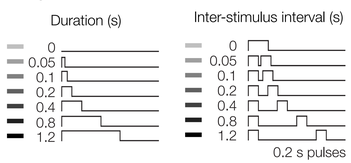
Apparatus



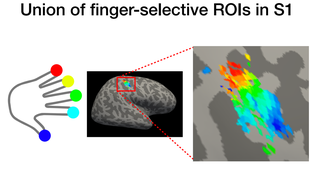
MR-safe piezoelectric tactile stimulator (Dancer Design)

Stimuli	Vibrotactile stimulation (110 Hz carrier) presented to all five fingers
Design	Fast event-related
Task	Report when only one finger is stimulated
Analysis	Deconvolution

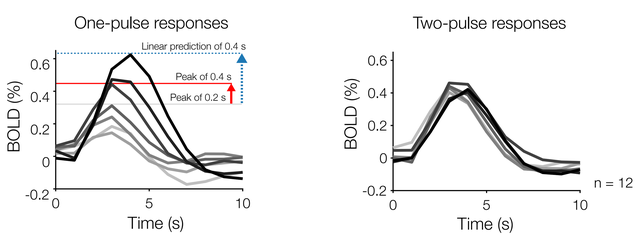
Temporal conditions



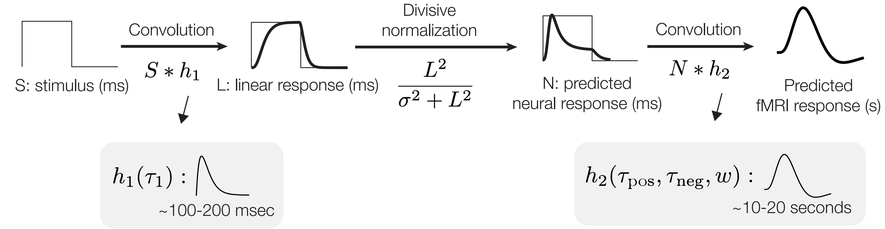
Union of finger-selective ROIs in S1



fMRI time courses from deconvolution

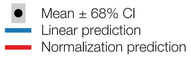


Normalization model

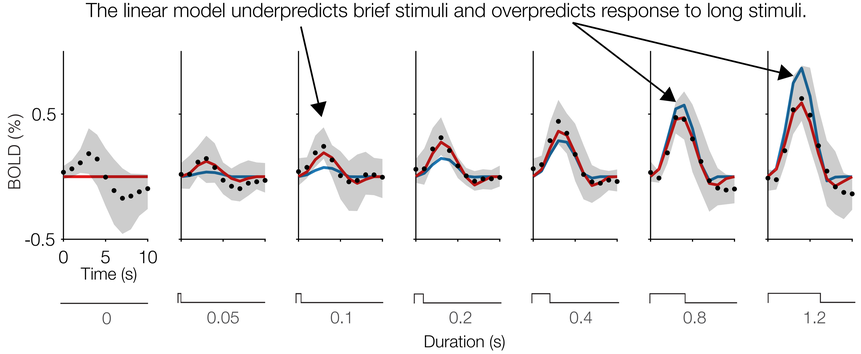


(Carandini & Heeger, 2011; Zhou et al., 2018)

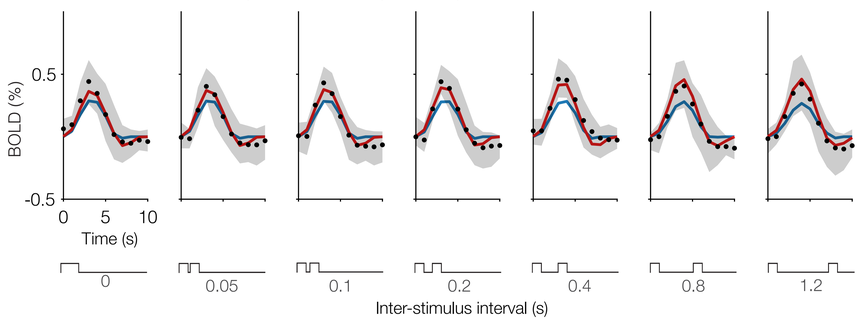
Normalization model outperforms linear model when predicting fMRI responses in S1



The linear model underpredicts brief stimuli and overpredicts response to long stimuli.



The linear model underpredicts all two-pulse responses while the normalization model does not.



Conclusions

- *The normalization model captures temporal dynamics of visual and tactile neural responses measured by different neuroimaging methods.*
- *Normalization constitutes a canonical neural computation across modalities.*

References

Carandini & Heeger, 2011, *Nat. Rev. Neurosci.*
Groen et al., 2022, *J. Neuroscience*
Motter, 2006, *J. Neuroscience*
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Zhou et al., 2018 *J. Neuroscience*
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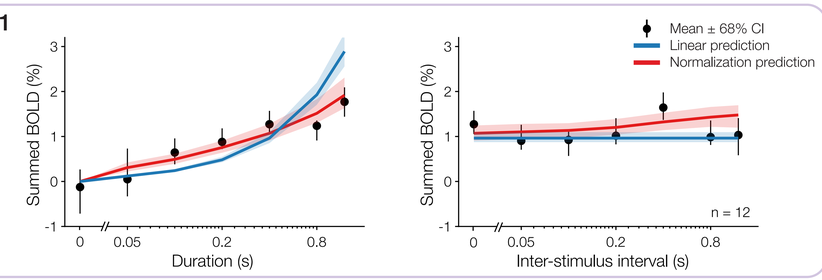
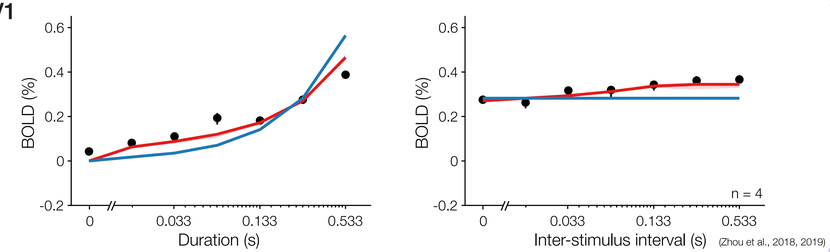
Similar sub-additive fMRI measurements in S1 and V1

S1



V1



Similar dynamics at millisecond time-scale in S1 and V1, measured with iEEG