Characterizing unobserved factors driving local field potential dynamics underlying a time-varying spike generation

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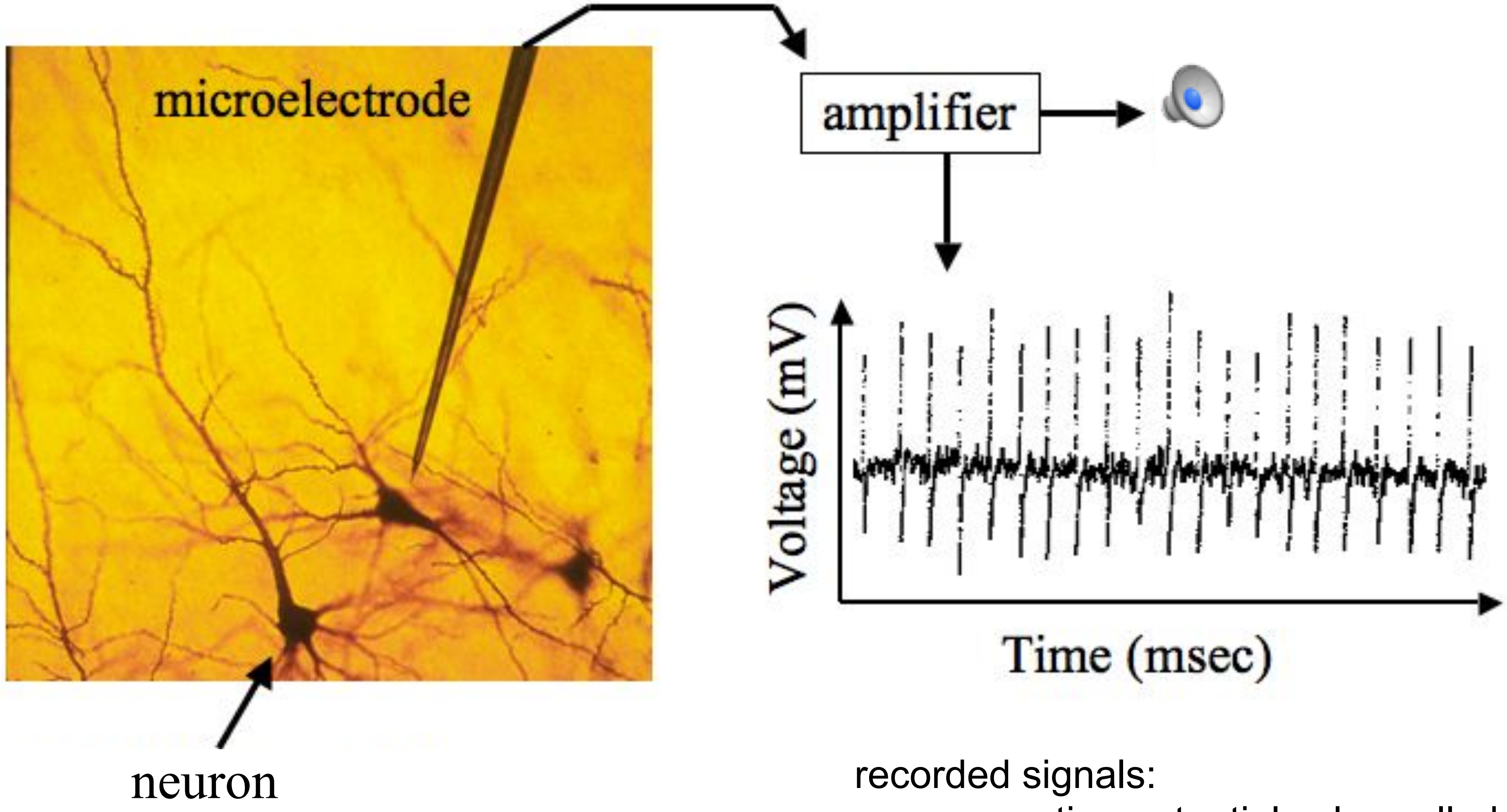
Outlines

- LFP (local field potential), as a signal conveying information about the state in which a neuron is, gets employed to better model the neural responses.

- Due to many behavioral covariates (here, rapid eye movements called saccade), the LFP-spike relationship varies over time.

- A model with a nonstationary assumption for the LFP-spike relationship outperforms the models without such an assumption (either with a stationary assumption or without any assumption) in encoding the stimuli as well as decoding the neural responses.

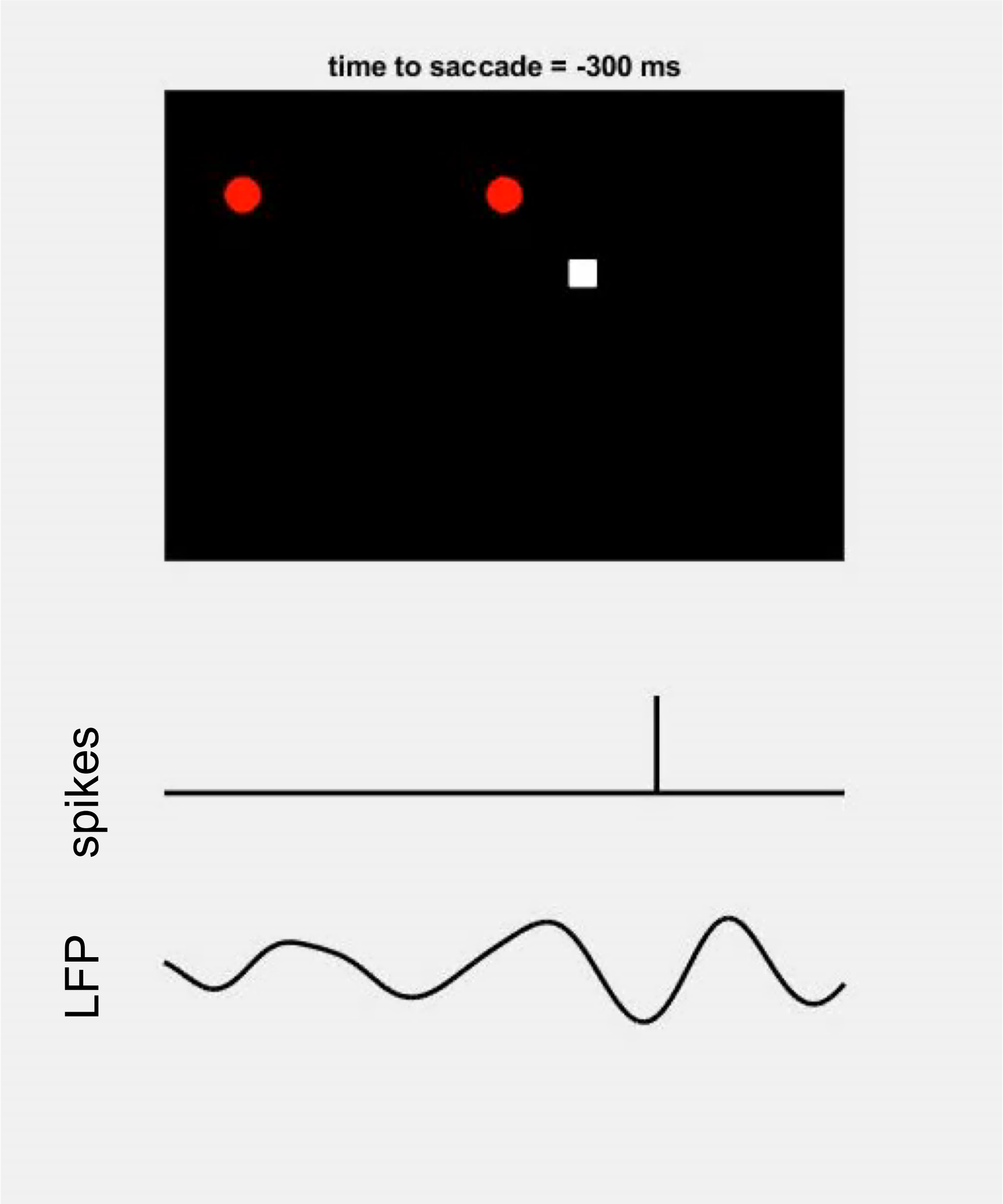
Recording from single neurons



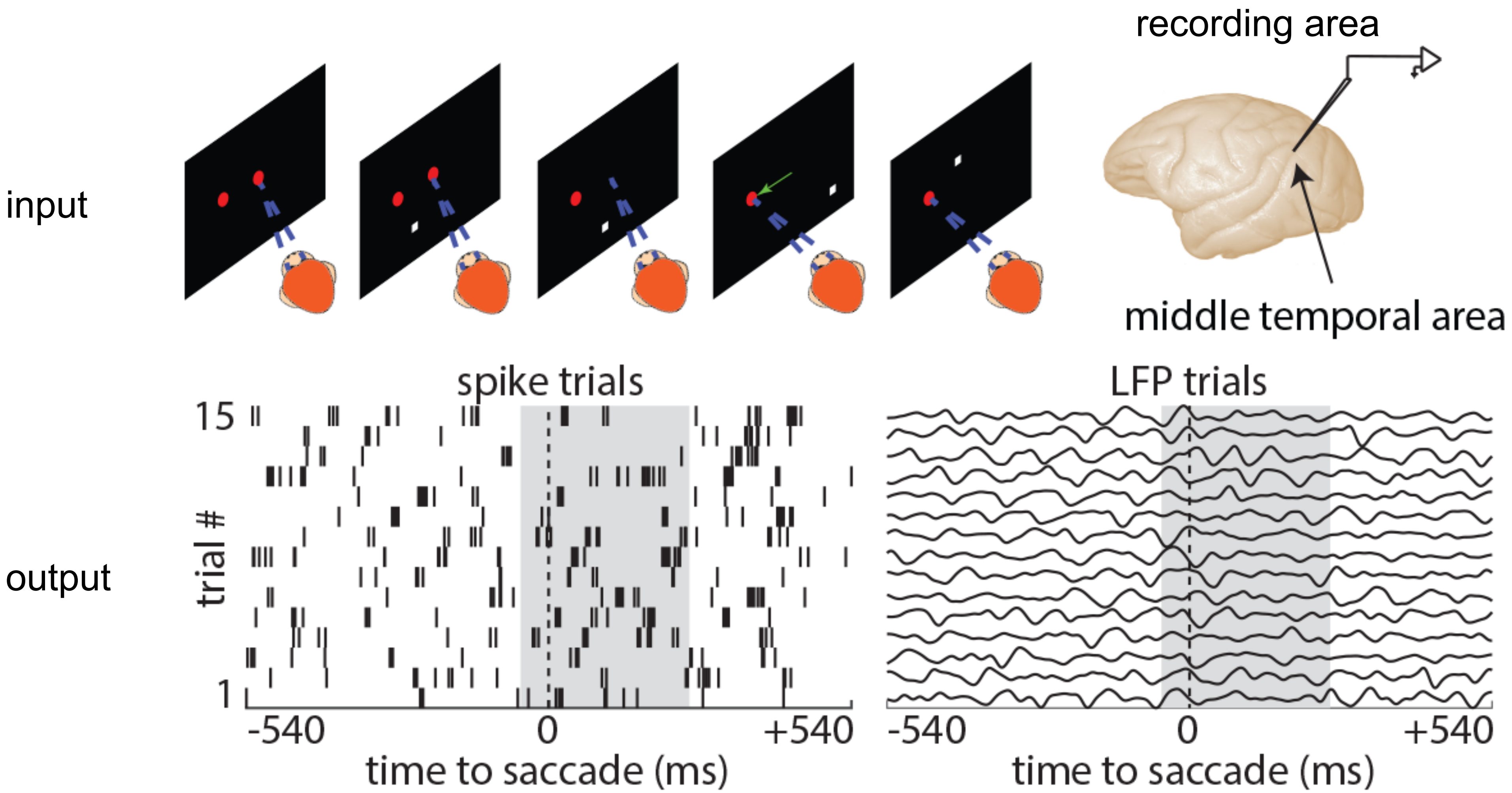
recorded signals:

- action potentials also called spikes
- local field potentials (LFPs)

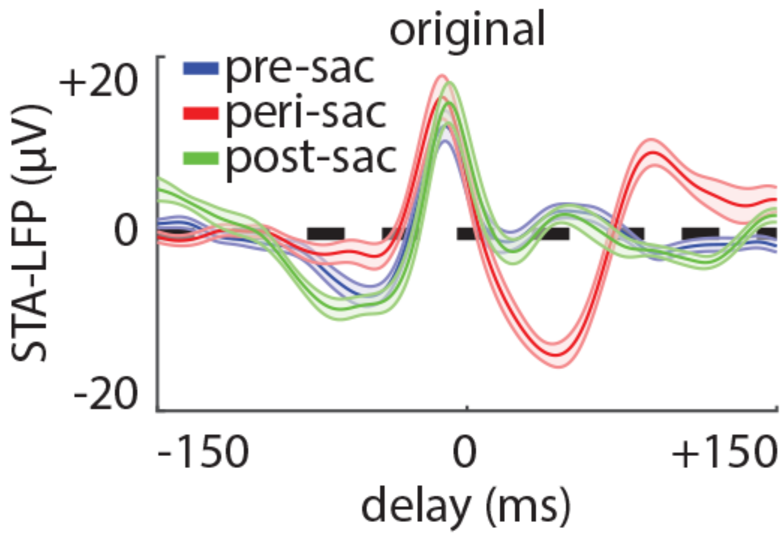
Experimental paradigm and data



Data structure used for the model estimation



The LFP-spike relationship changes during an eye movement



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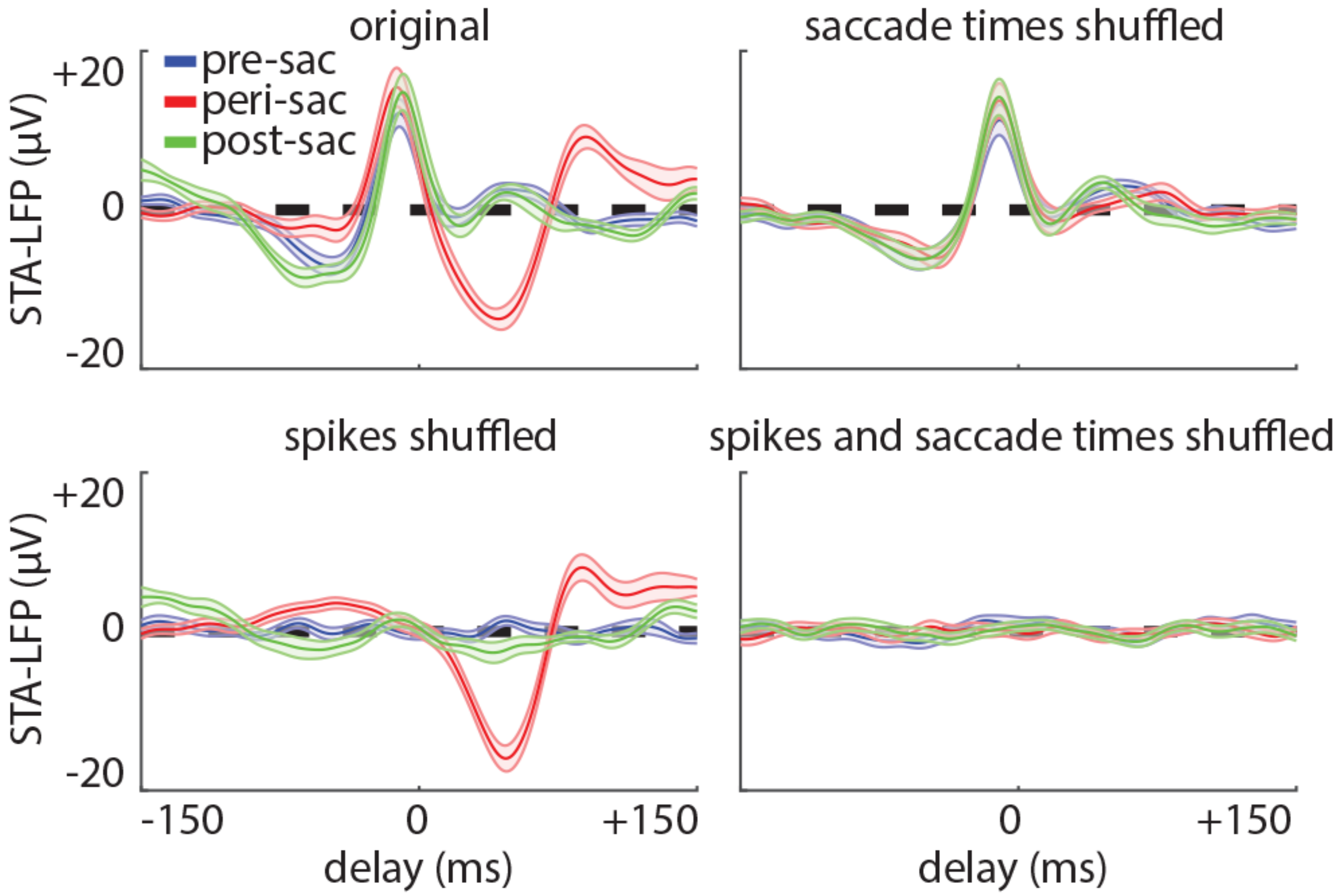
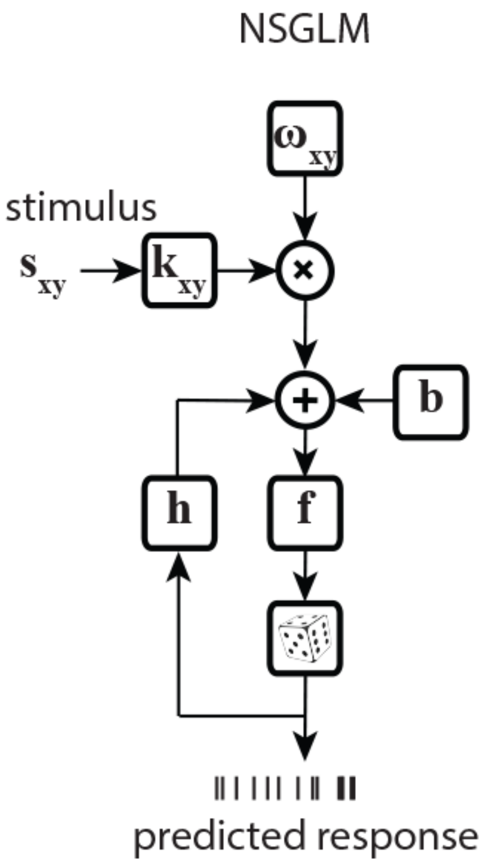
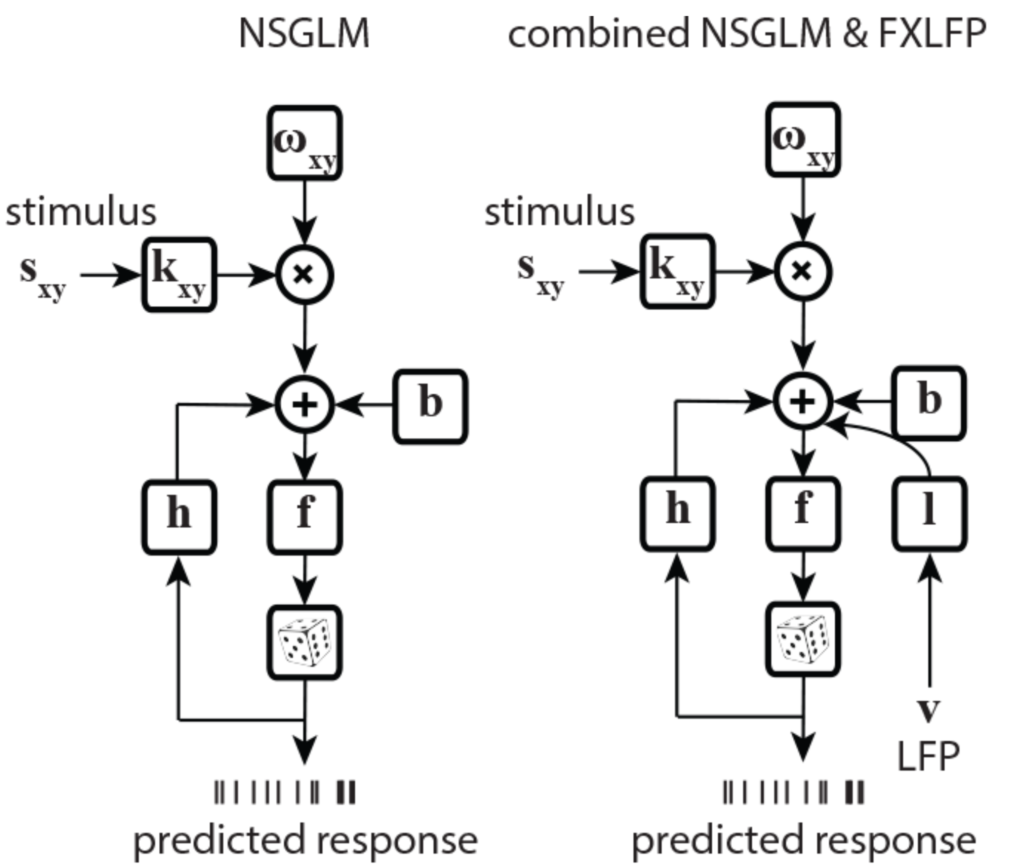


Nonstationary generalized linear model (NSGLM) framework



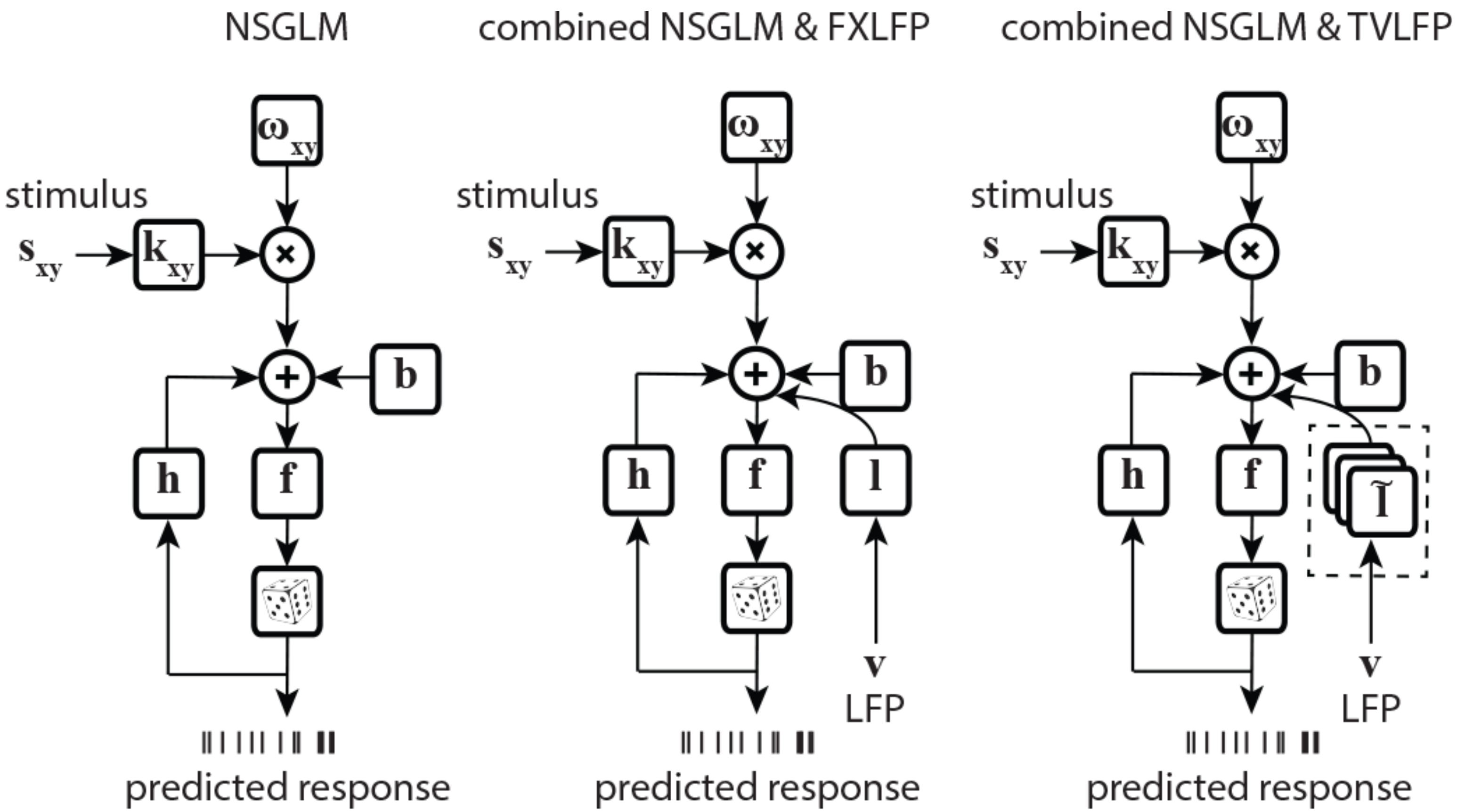
(Akbarian et al. IEEE TBME 2018)

NSGLM augmented with simultaneously recorded LFP signal through a time-invariant kernel

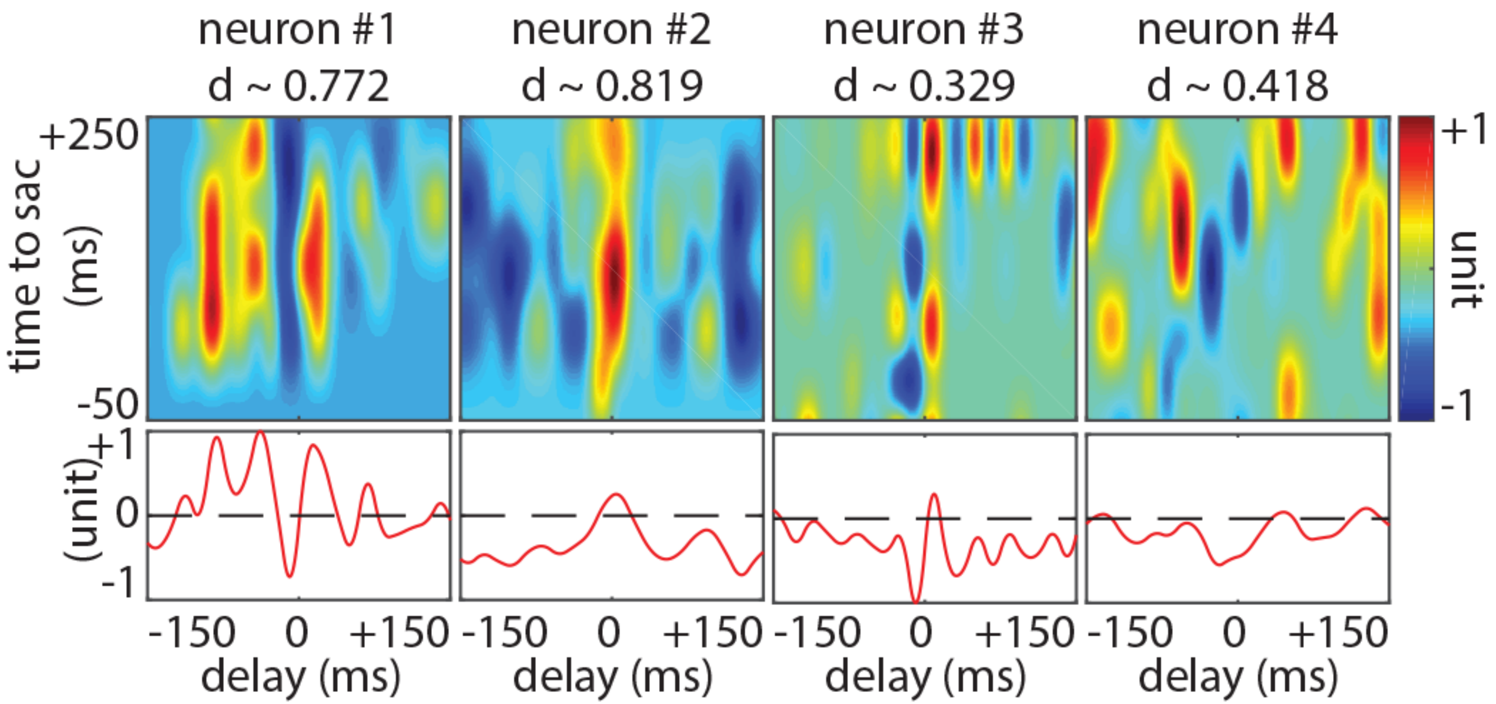


(Niknam et al. NER 2017)
(Niknam et al. Asilomar 2017)

NSGLM augmented with simultaneously recorded LFP signal through a time-variant kernel



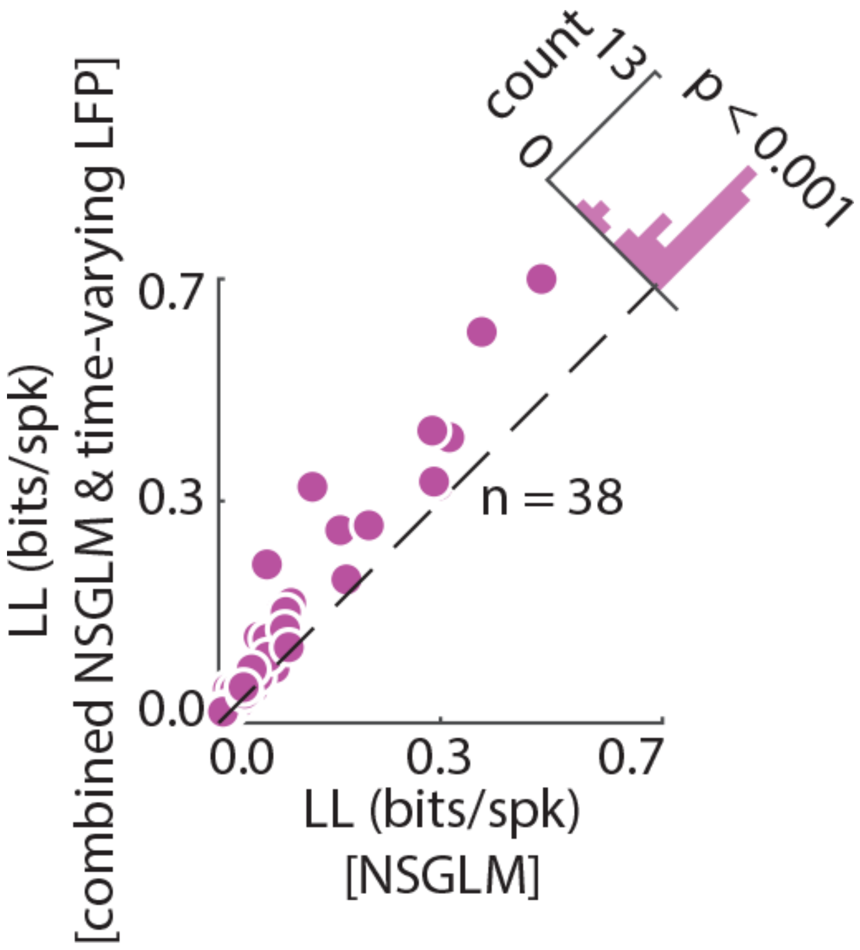
The time-invariant vs. time-variant LFP kernels for 4 sample MT neurons



$$d = \sqrt{2\frac{\sum_{t,\tau}\left(\tilde{l}[t,\tau] - l[\tau]\right)^2}{\sum_{t,\tau}\left(\tilde{l}^2[t,\tau] + l^2[\tau]\right)}}$$

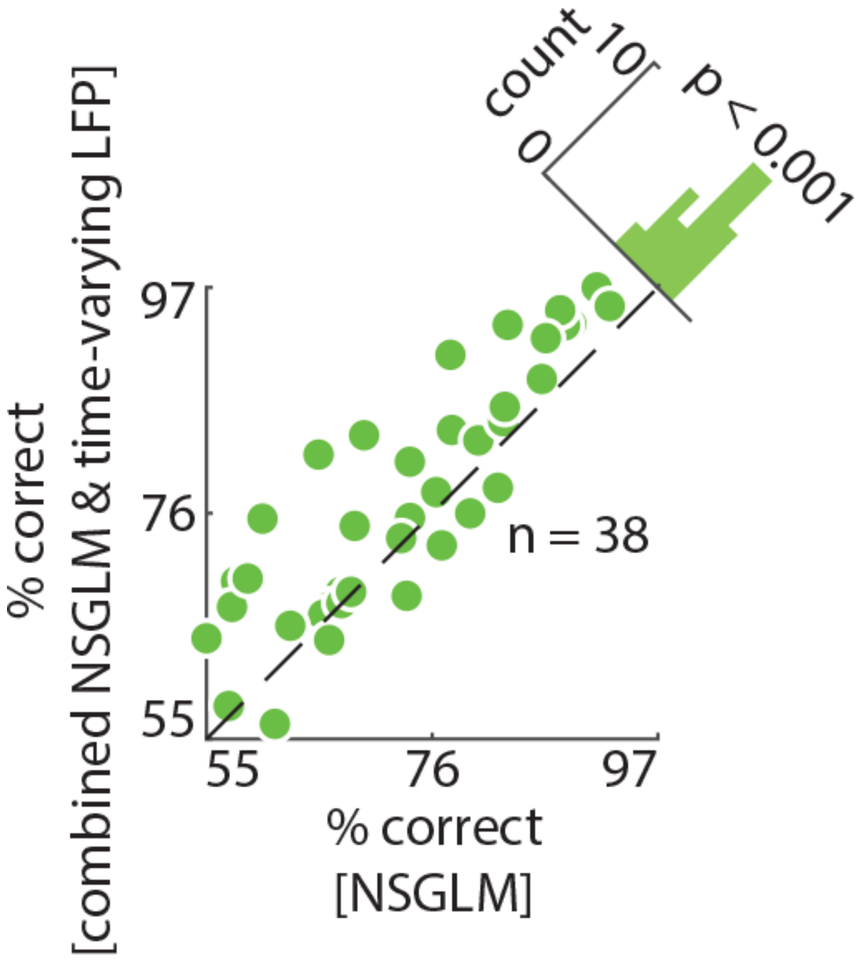
Incorporating the time-varying LFP information provides greater accuracy in response prediction
NSGLM vs. combined NSGLM & time-varying LFP

encoding performance

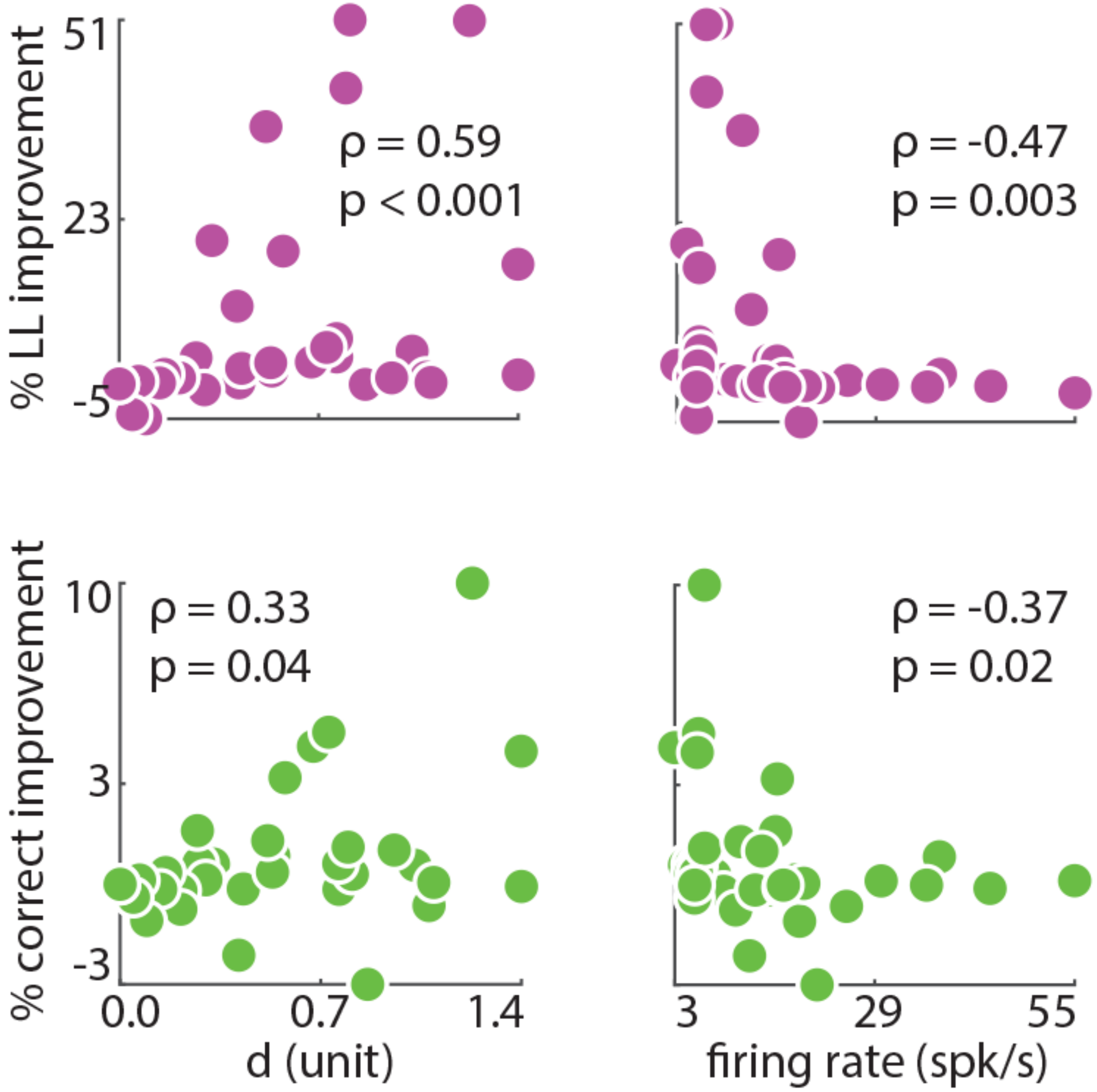


Incorporating the time-varying LFP information provides greater accuracy in decoding responses
NSGLM vs. combined NSGLM & time-varying LFP

decoding performance



The time-variant LFP kernels accounts for more information about the stimulus and response compared to the time-invariant LFP



Summary

- Incorporating time-varying LFP signals associated with time-varying states of the brain (here, due to saccade) enables a modeling framework with greater encoding and decoding performance.

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- Incorporating time-varying LFP signals associated with time-varying states of the brain (here, due to saccade) enables a modeling framework with greater encoding and decoding performance.

- The models incorporating information about the state of the brain modulating the stimulus-response relationship provides more accurate input decoding, and therefore promise enhancing the neural response decoder systems, for example in the brain-machine interface applications.