Late responses of V2 neurons are enhanced by global scene context of natural movies

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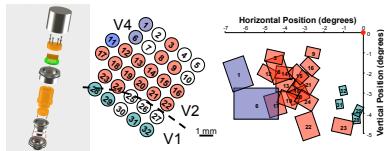
MOTIVATION

Perception is an active process and the visual system must dynamically interpret and make predictions about incoming visual inputs. In natural viewing, objects typically occur within the context of complex backgrounds and history. The center and surround receptive fields (RFs) of neurons are constantly dynamically stimulated.

Predictive networks suppress neural activity in early visual areas when they are predicted by global context (Mumford, 1992; Rao & Ballard, 1999).
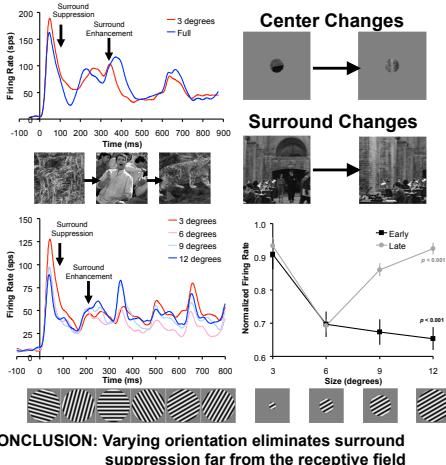
Association networks reinforce elements that are likely to co-occur based on past experiences (Field et al., 1993).

We tested how V2 center and surround RF responses were effected by context and history, as well as how they were related to these two mechanisms.
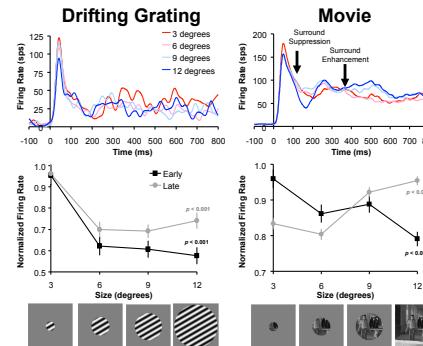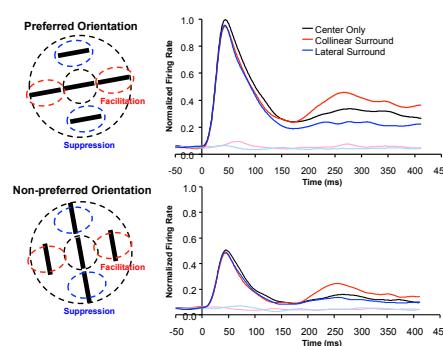
NEUROPHYSIOLOGICAL METHODS

FEATURES ARE DYNAMIC IN MOVIES

CONCLUSION: Varying orientation eliminates surround suppression far from the receptive field

GENERAL SURROUND PROPERTIES

CONCLUSION: Spatial integration differs substantially between gratings and movies

CENTER DEPENDENCE ON HISTORY

CONCLUSION: Soon after response onset (early), neurons respond most to stimuli with orientation and size differing from the past stimuli.

DETAILED SURROUND PROPERTIES

CONCLUSION: Global structure at the preferred orientation enhances responses
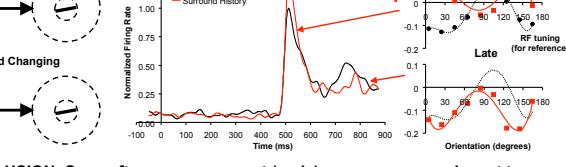
SURROUND DEPENDENCE ON HISTORY

CONCLUSION: Late surround facilitation is strongest when orientation changes and late surround suppression is strongest when orientation is constant.

SUMMARY

Predictive networks suppress responses as size increases and over time to static stimuli because the error between hypotheses and the input is reduced. For dynamic stimuli, features within the receptive field, and especially the surround field, constantly change and are therefore less predictable. For large apertures, hypotheses are more certain, with narrower probability distributions compared to small apertures. Therefore, changes in the surround field lead to bigger distribution differences and larger errors compared to changes within the receptive field.

Interestingly, the largest error signals were not at the largest differences in orientation in temporal context, but rather were at intermediate differences in orientation.

At larger aperture sizes, more complex surround facilitative interactions also occur, such as those predicted by association networks (collinearity).
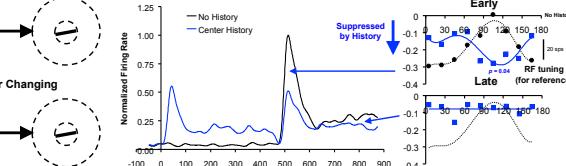
The predictive interactions appear to happen faster than association interactions, but predictive modulations can be propagated within the association networks.

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