Resting state correlations in visual cortex reflect fluctuations of cortical arousal

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Dynamic nature of resting state

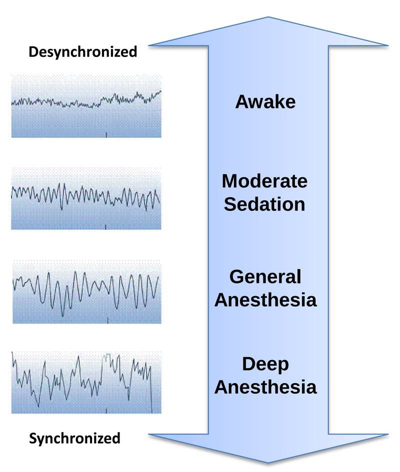
Resting state correlations fluctuate over time

The coherence of resting state local field potential (LFP) is compartmentalized along the **laminar** dimension and rapidly decreases with distance[1]. In addition to this property, inter-cortical correlations of spontaneous neural activity are not **static** but instead vary over time in a **dynamic** fashion[2].

What could be the cause of these dynamic changes?

Recent studies have explored several possible factors including noise artifacts, eye movements, attention, and arousal. Of these possible explanations, **arousal** continues to remain viable[3-5].

Possible explanations		
Noise	X	Ringach, 2009
Eye movements	X	Hutchison RM et al., 2013
Attention	X	Veselis RA, 2001
Arousal	?	

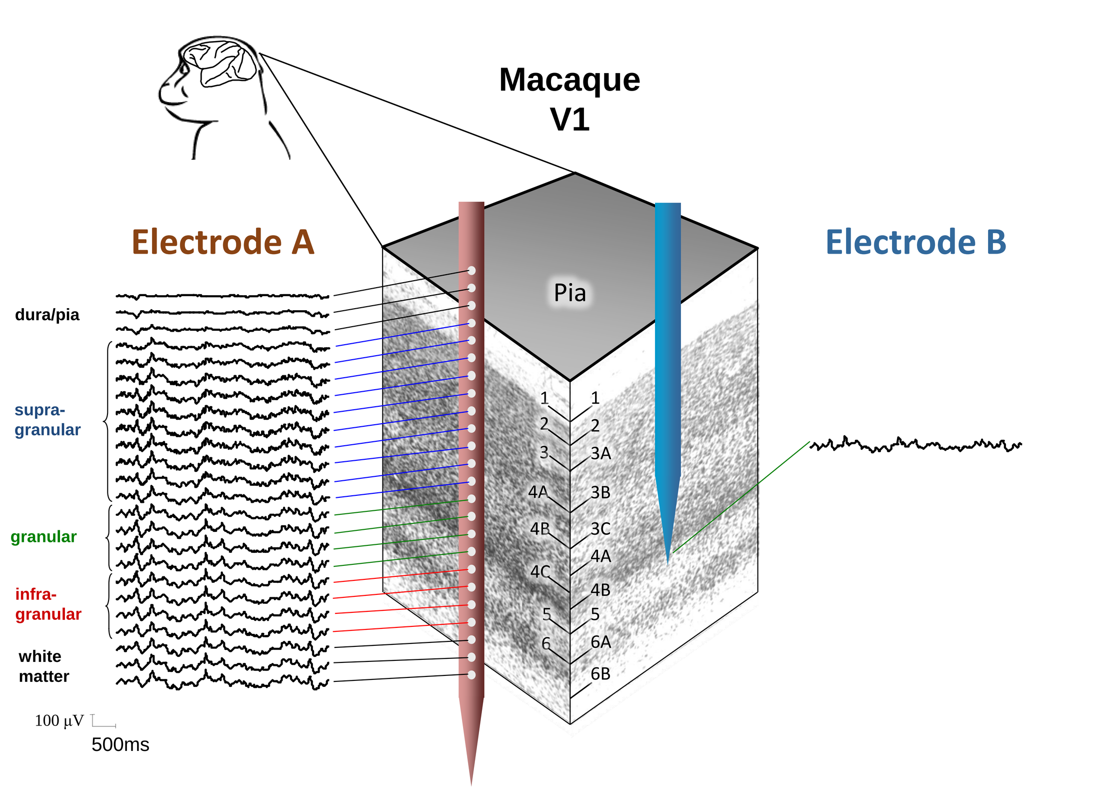


Arousal is defined as a continuum of cortical activity profiles that vary between low amplitude high frequency-dominated (**LAHF**) activity and high amplitude low frequency-dominated (**HALF**) activity.

Arousal changes occur at **sub-second scales**[6]. Accordingly, there is a need to **quantify cortical arousal** at high temporal resolution. This can be done by determining the relationship between high vs. low frequency components of neural activity (such as with the clinically relevant bispectral index scale (BIS)[7]).

How does arousal relate to the dynamically changing resting state correlations within the microcircuit of primary visual cortex?

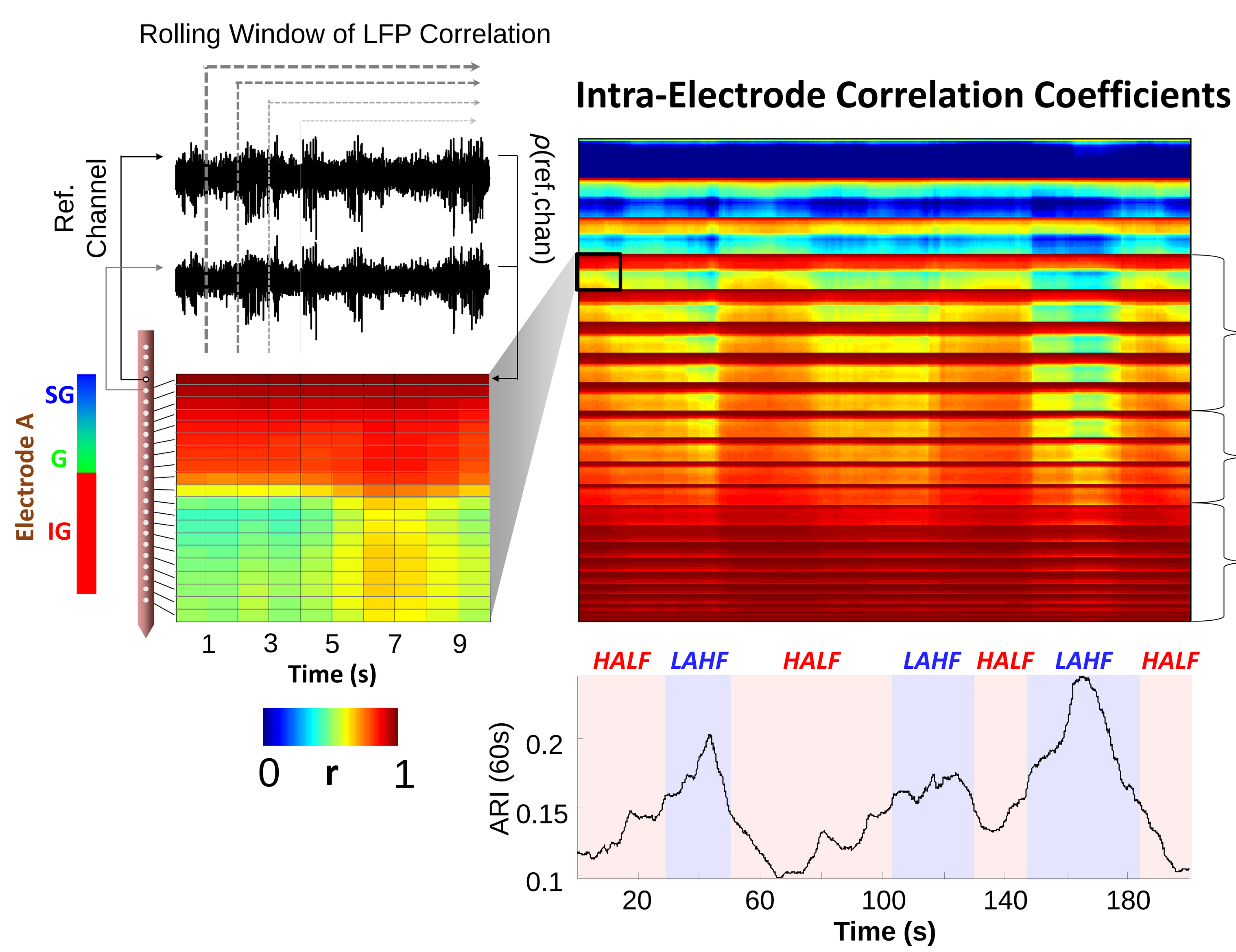
Laminar neurophysiology

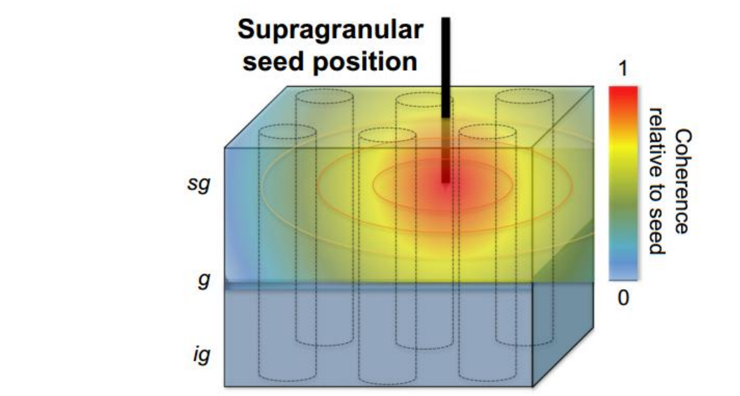


One electrode (Electrode B) is used to determine the subject's level of arousal while the other (Electrode A) is used to calculate resting state correlations along the laminar dimension.

Intralaminar recordings of LFP:
Two macaques (N_B=14, N_H=6)
Two **concurrent** penetrations

Intra-cortical correlations fluctuate with arousal

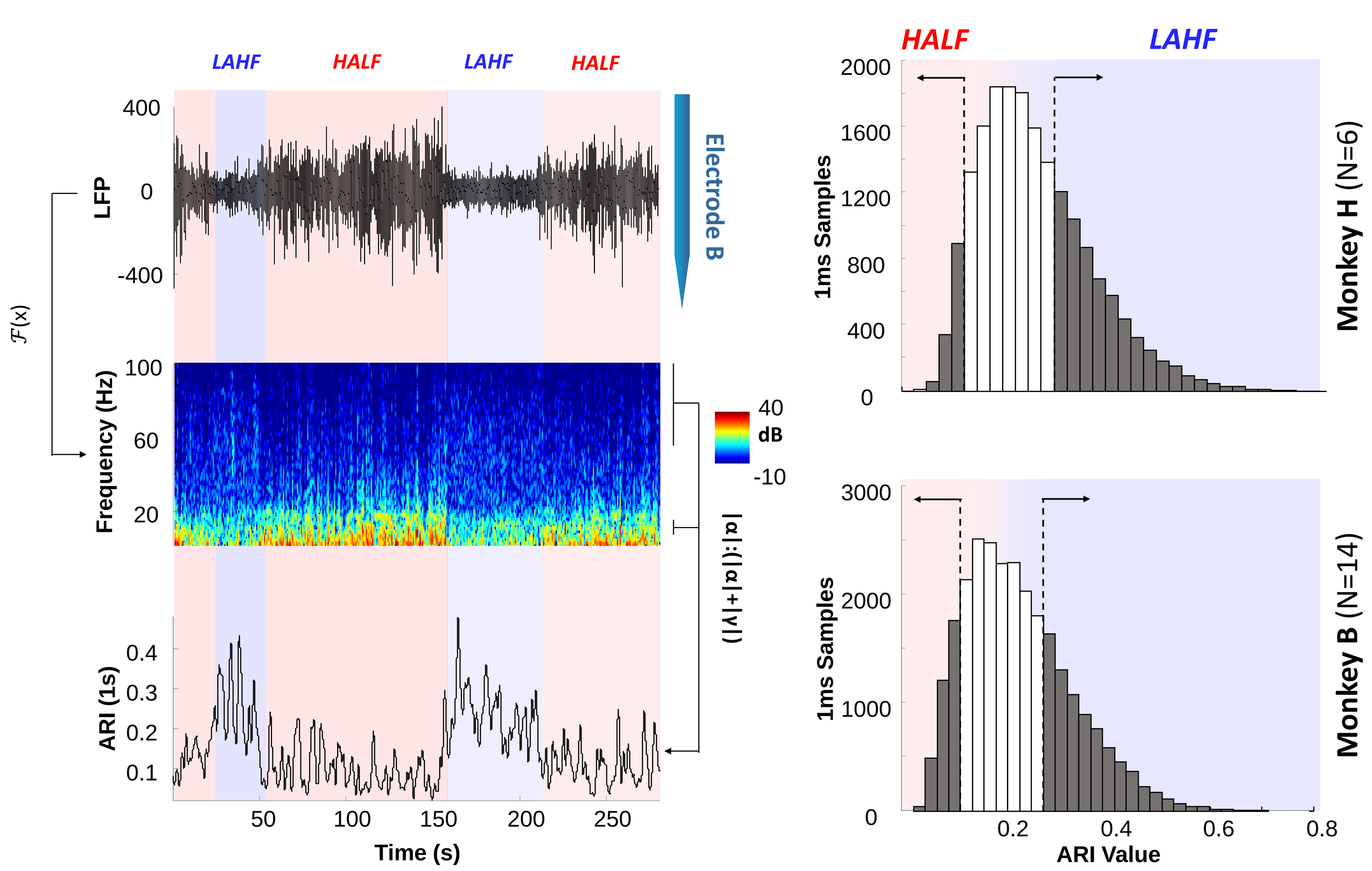


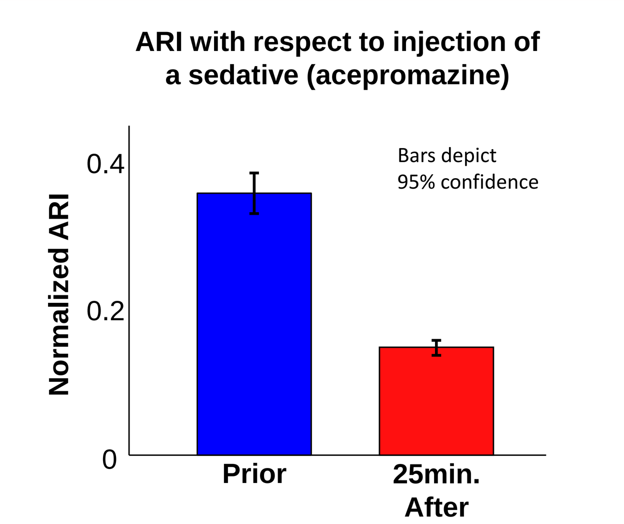


Resting state LFP coherence is laminarly compartmentalized[1].

LFP correlations are computed of each pairwise electrode channel combination for a rolling window of time.
The level of **correlation** across cortical layers is **inversely related** to **arousal**.

Cortical arousal changes during rest

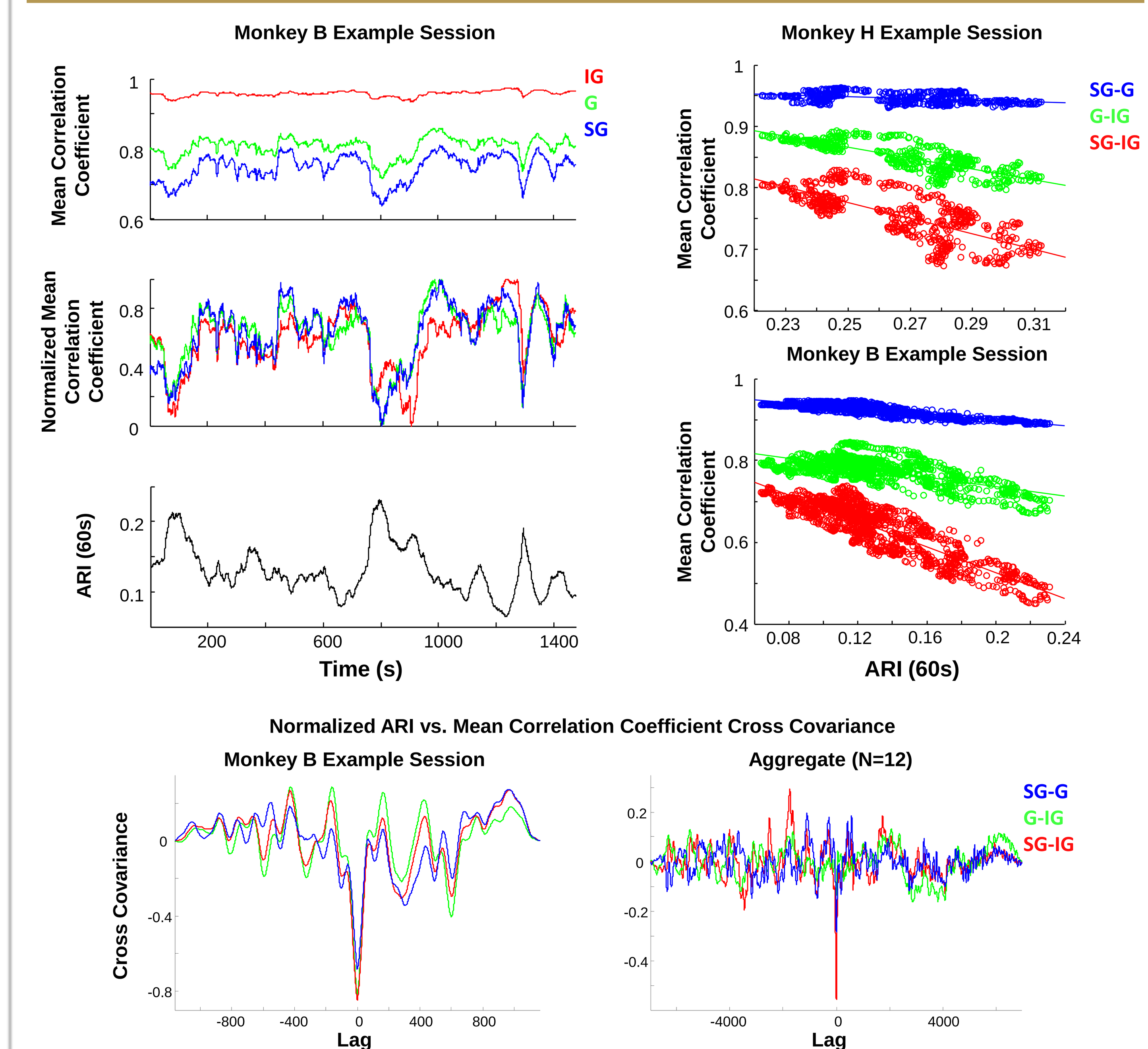




Arousal is quantified using a novel rational index that compares **α (5-10Hz)** and **high γ (60-100Hz)** LFP **power** for a rolling window of time.

Fluctuations in measured resting state cortical arousal correspond to changes in **LAHF** and **HALF** activity.

Layer specific dynamics



Resting state correlations **decrease** as cortical arousal **increases**.
These effects are magnified as distance between inter-laminar comparisons increases.

Summary

- **Increases** in cortical arousal result in a correlated **decrease** in the magnitude of resting state correlations within the V1 columnar microcircuit.
- The correlation between V1's laminar compartments **decreases** with arousal at a **faster rate** as the radial distance between these compartments increases.

Possible explanations		
Noise	X	Ringach, 2009
Eye movements	X	Hutchison RM et al., 2013
Attention	X	Veselis RA, 2001
Arousal	✓	

References & Acknowledgements

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