NEURAL SIGNATURES OF VARIABLE BELIEFS INCREASE WITH TASK LEARNING IN V1

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Previous work has suggested that top-down, especially task-dependent, sources of variability are some of the dominant modes of trial-to-trial variability in sensory neuron responses. It has also been hypothesized that such top-down modulators can be understood as representing *variable beliefs* about task-relevant features of the stimulus in a probabilistic inference (PI) framework of perception, where task-based expectations act as a prior [1].

A stronger test of this hypothesis would be to measure (*i*) the emergence of task-dependent correlations over the course of learning a task, and (*ii*) a change in the correlation structure on short time scales as the task context is changed [2]. The PI framework predicts the task-dependent component of correlations should be proportional to the product of neural sensitivities to the stimulus. This means that such correlations would *increase* over the course of learning, while a purely feedforward framework would predict the opposite trend (assuming perceptual learning reduces these information-limiting correlations [3]).

We present preliminary results from two macaque monkeys learning two versions of an orientation-discrimination task. V1 neurons were recorded over the course of training. Training included four phases: cardinal discrimination, oblique discrimination, interleaved task-switching, and finally task-switching with V2 reversibly inactivated by cooling each day.

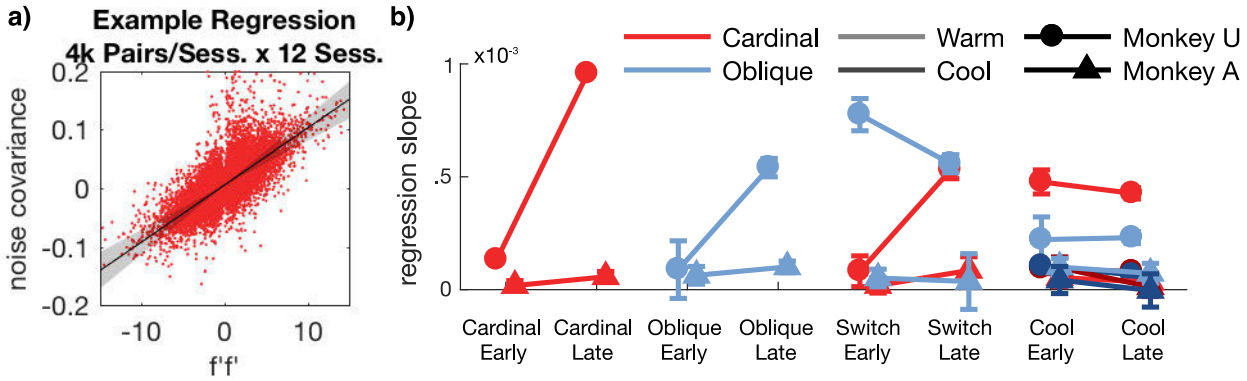

Figure 1. (**a**) We quantify the amount of task-dependent correlations as the slope of the relationship between pairs of neurons' noise-covariance and the product of their sensitivities. (**b**) Amount of task-dependent correlations increases from early to late half of cardinal and oblique phases, and again when monkeys re-learn the cardinal task, indicating a consistent positive relationship between performance and differential correlations across learning. Difference in effect magnitude between monkeys may be explained by laminar differences (ongoing).

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References

1. Haefner, Berkes, Fiser, 2016, *Neuron*, 90(1), 10.1016/j.neuron.2016.03.020
2. Cohen, Newsome, 2008, *Neuron*, 60(1), 10.1016/j.neuron.2008.08.007
3. Moreno-Bote, Beck, Kanitscheider, *et al.*, 2014, *Nat Neurosci*, 17(10) 10.1038/nn.3807