

How does joint activity across a population of neurons influence the precision of coding in the cortex?

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The rat vibrissa (whisker) pathway has a high capacity for the transmission and processing of textural information. Until now, most studies have only considered how single neurons in the primary somatosensory cortex (SI) of the rat encode vibrissa information. In contrast, even the motion of a single vibrissa is represented by thousands of neurons at the input layer to the cortex (layer 4). Population activity is therefore expected to play an important role in the coding of vibrissa information. It has been shown previously that cortical neurons exhibit response suppression for stimuli with frequencies greater than approximately 4-8Hz. Since the effect of suppression is to lower both the magnitude and precision of the response, it is believed that weaker responses generally degrade the quality of coding by the cortex. Furthermore, mechanisms that confer response precision on single neurons have been identified. What has not been addressed is how joint activity between multiple neurons affects coding accuracy and precision. In this study we ask whether, and how, the precision of single neuron responses, observed over multiple trials, extends to precision across multiple neurons observed in a single trial. Specifically, we studied how the precision of joint coding changed with modulations in single-cell response precision and magnitude. Preliminary data suggest that the temporal precision of coding may be improved through joint observation of multiple cells. For simultaneously recorded pairs of neurons, time-locking of post-stimulus responses to each other within a single trial was on average larger than that due to the common stimulus across trials. There is evidence that this extra degree of time-locking is present for a wide range of single-cell response precision and magnitude. The observed correlations between groups of neurons are likely reflective of a common input process, presumably from the thalamic VPM nucleus. Both experimental and modeling studies of the functional properties of this shared source of noise promise to yield a more comprehensive picture of coding in the SI. Our previous work has shown that discrimination performance improves with increasing response precision of single neurons. It is therefore expected that temporally precise firings across multiple neurons can significantly lower discrimination error, and thus improve coding in SI.

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