

Coding of tactile features by layer 4 of the rat S1 cortex

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Sensory neurons, especially at the early stages of the pathway, are often characterized by their selectivity to particular features of the stimulus. Nevertheless, it is often a challenge to relate this feature sensitivity to the encoding of naturalistic stimuli. In the rat vibrissa pathway, thalamocortical neurons selectively respond to velocity transients. However, impinging suppressive influences on thalamocortical neurons further complicate this selectivity by causing a highly nonlinear dependence of single-cell responses on stimulus history. The high capacity of the vibrissa pathway for encoding textural information indicates that feature selectivity is an important property of this tactile sensory system. The main goal of this study was therefore to quantify the feature-selectivity of S1 neurons in the vibrissa pathway. We found that these neurons encode higher velocities with greater spike counts, higher temporal precision, and shorter response latencies. Furthermore, high-velocity stimuli were shown to evoke stronger post-stimulus response suppression, but also recovered from a given amount of suppression more quickly. We hypothesize that a model based on responses to paired deflections at various velocities can accurately predict single-cell responses to more complex, naturalistic stimuli. We are subsequently developing a dimensionality-reduction transformation that maps continuous vibrissa deflections into simplified pulse sequences such that both stimuli evoke very similar single-cell responses. Used with naturalistic stimuli obtained via high-speed videography of behaving animals, this transformation provides insight into the computations carried out by single neurons in the layer 4 of the vibrissa cortex. It also provides a basis on which studies of population coding can further develop our understanding of the coding of tactile textures by this brain area.

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Dimensionality reduction, naturalistic stimuli, dynamic model, velocity, suppression