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Information theoretic measures of tactile decisions in the rat somatosensory cortex

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Abstract

Information theory has been used as a suited mathematical framework to study neural coding in the last few decades. Here we address two problems related to this subject: 1) We develop a novel information measure, termed transmitted intersection information, to capture stimulus-specific information flow within neural networks. Although traditional tools such as Granger causality have been purposed to calculate directed information flow between neuronal populations, understanding sensory coding requires measuring the amount of exchanged information that is specifically about the stimulus. Using a simple neural network model, we show how our measure can discern between stimulus-specific and stimulus-unspecific information flow within the network. Moreover, we show how our measure meets the statistical requirements to be applied to the re al experimental data sets. 2) We analyze neural data recordings from rats' barrel cortex while they were performing a perceptual discrimination task. Rats were trained to compare the intensity of two vibrations delivered to their whiskers. The underling neuronal mechanism involves two stages of processing: mapping the external stimulus to patterns of neural activity, and reading out neural responses to form the behavioral choice. Information theoretic approach allows us to explore both stages in a unified framework. In particular, we examine the potential contribution of two different neural codes, namely the rate co de and the leaky integration co de, in representing the sensory information and behavioral choice. Using a Bayesian decoder, we also show how "faithful" and "misleading" neuronal information can lead to subsequent changes in animals' behavioral performance.

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