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CATEGORY ENCODING WITH NON-CATEGORY SPECIFIC NEURONS IN THE INFERIOR TEMPORAL CORTEX

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In order to understand how the brain codes natural categories, e.g., trees and fish, recordings were made in the anterior part of the macaque inferior temporal (IT) cortex while the animal was performing a tree/non-tree categorization task (Vogels 1999a, b). Most single cells responded to exemplars of more than one category while other neurons responded only to a restricted set of exemplars of a given category. Since it is still not known 1) which type of cells contribute and 2) what is the nature of the code used for categorization in IT, we have performed an analysis on the single-cell data. A Kohonen self organizing map (SOM), which uses an unsupervised (competitive) learning algorithm, was used to study the single cell responses to tree and non-tree images. Results from the Kohonen SOM indicated that the collected neuronal data consisting of spike counts was sufficient to account for a good level of categorization success (approximately 83%) when categorizing a group of 200 trees and non-trees (Thomas et al, 2000). Due to experimental difficulties the neuronal response matrix was more than 80% empty. The ability of the Kohonen SOM to cluster the neuronal responses into tree and non-tree responses despite this problem indicates an encoding which is extremely redundant and robust to noise.

Contrary to intuition, the results of the investigation suggest that the population of category specific neurons (neurons that respond only to trees or only to non-trees) was unimportant to the categorization. Instead, a large majority of the neurons which were most important to the categorization, was found to belong to a class of more broadly tuned cells, namely, cells that responded to both categories but that favored one category over the other by seven or more images. A simple algebraic operation (without the Kohonen SOM) between the above mentioned non-category specific neurons confirmed the contribution of these neurons to categorization. Thus, the modeling results suggest (1) that broadly tuned neurons are critical for categorization, and (2) that only one additional layer of processing is required to extract the categories from a population of inferior temporal neurons.

References

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