

Sparse Representation in the Human Medial Temporal Lobe

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Single unit recordings from the human MTL have revealed the existence of highly selective cells that may, for example, respond strongly to different images of a single celebrity, but not to 100 pictures of other people or objects. These results suggest a sparse and invariant encoding in MTL and seem to imply the existence of *grandmother* cells that respond to only a single concept, individual or object. However, due to limitations on the sampling of MTL neurons and on the sampling of the stimulus space, it is unclear how many stimuli a given neuron will respond to on average and conversely, how many MTL neurons are involved in the representation of a given object. Given the number of stimuli we present and the number of neurons from which we record, we here use probabilistic reasoning to explore these issues. In our model, we consider a neuron to respond to a stimulus with a probability a , known as the *sparseness*, and derive the probability density function for a given the experimental data. This analysis leads us to conclude that MTL neurons respond on average to 0.2–1% of all represented stimuli. While certainly a sparse code, this still corresponds to an individual neuron responding to dozens of stimuli or more, and to perhaps 2 million MTL neurons responding to each stimulus.

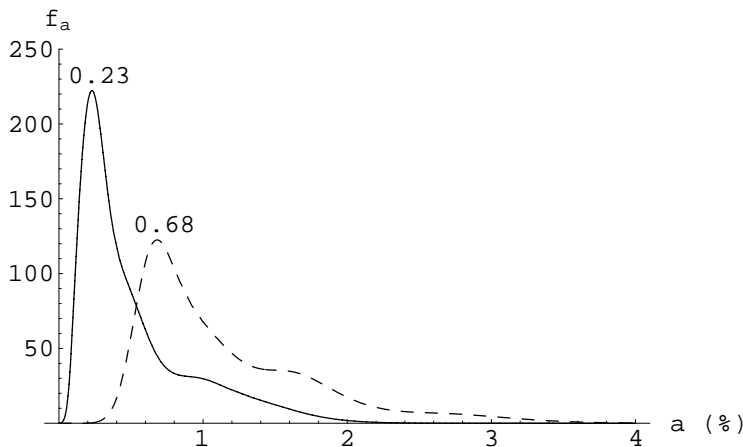


Figure 1: Average probability density function for sparseness a associated with 34 experimental sessions that yielded spiking responses from 1571 units. Two different thresholds for defining significant responses are considered: five (solid curve) and three (dashed) standard deviations above baseline. The peaks of the distributions, corresponding to the most likely values for a , are labeled, and the value below which a is likely to lie with 95% probability are $a = 1.5\%$ and 2.7% . The average number of simultaneously recorded units per session, N , is 46.2 and the mean number of images shown, S , is 88.4.