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# Temporal dynamics of neural representation of odors in the olfactory bulb

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Olfaction is one of the sensory systems that developed early in evolution and is widespread throughout many species; as such research in this area can provide valuable insight into the functioning of the brain. Information processing in the rat olfactory bulb (OB) is a complex network process that is characterized by an intricate temporal structure. Using optical imaging from awake behaving rats, earlier work in the Wachowiak lab collected data reflecting the activities of olfactory receptor neurons at their convergence onto glomeruli of the olfactory bulb (approximately 20-40 glomerular units) at a temporal resolution of around 10 msec. One aim of this collaborative project is to quantitatively describe how odorant identity and intensity is represented across ORNs and how this representation is modulated by different sampling behaviors (e.g. - sniffing and regular breathing) in the behaving animal.

We used subspace projection analysis, such as Principal Component Analysis (PCA) and Multiple Discriminant Analysis (MDA), allows us to enhance our intuition about relevant timescales of perception at the neural population level. This statistical model maps the neural activity from its original high-dimensional space to a lower-dimensional subspace where visualization is facilitated and classification is performed. We find that the clusters corresponding to the sniffing of different training odors typically form distinct ensemble representations.

Using these mapped odor representations we can monitor and visualize the whole-population activity by examining their low-dimensional projections over the entire duration of the trials. We find that the odorant inhalation induces transitions in the low-dimensional encoding subspace, starting from a base state and ending at the corresponding odor cluster, over durations of around 130 ms. We also determine that during high-frequency sampling the population activity is significantly reduced toward baseline levels and, furthermore, that subsequent odor presentations elicit normal responses.

In addition we use the experimental data as input for computational models of endogenously bursting external tufted cells or mitral/tufted cells to investigate the structure of the input/output in the olfactory neural network. The model considered here focuses on the mitral cell layer as the output of the olfactory bulb processing network, where synchronization of a subset of the mitral cells during specific phases of an underlying gamma rhythm constitutes a code for recognition of a specific odor. Our results suggest that the neural codes used in this model are too sensitive to the variation in the real data.