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Analysis of the coding scheme in the olfactory bulb with NMF

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The olfactory bulb is an important information coding system in the informational pathway of the olfactory sense, but we still lack a good understanding of the coding mechanism in the bulb and how the odor information from the bulb is translated to the higher cerebral areas.

In the past years new knowledge was achieved on the field of the olfactory sensorial transmission from the olfactory receptors to the olfactory bulb: The mammalian nasal epithelium is separated in four regions and each receptor cell type exists just in one of the four areas [1]. Furthermore, olfactory receptors identify odorants based on the chemical features of the odor molecule [2] and receptor neurons of the same type converge to the same spot in the bulb, called glomerulus [3]. This knowledge leads to the assumption that the olfactory bulb might be also separated into four regions and that information coding in the bulb is organized by a chemotopic representation. By using the 2-DG-uptake- technique, odorant-specific activity patterns across the glomeruli in rat olfactory bulbs can be illustrated [4].

We used the non-negative matrix factorization (NMF) on 143 distinct uptake-images of the rat olfactory bulb in order to get insight in the chemotopic coding map. NMF is designed for revealing inherent structures and similarities in the data and creates a decomposition in parts which display common features of the data. Our analysis on the NMF parts result in four very stable regions of the bulb, which are hierarchically splitted in smaller regions when the number of parts increase. We found a good representation of our data with nine bulb regions, called modules. These modules show some analogy to previously reported regional structures in the bulb [5][6]. Furthermore, we demonstrate a linkage between typical odorant characteristics and our modules, so this speaks in favour of a chemotopic coding map in the bulb. We suggest to understand the modules as a coding character in a coding alphabet. After determining the codeword for each odorant, we designed an odor experiment to investigate whether our coding model can explain the human odor perception. We think our coding model can give new ideas and directions for further research on this topic and want to present our research with a poster.

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