

## Comparing Glomerular Maps in the Olfactory Bulbs of Mice and Rats

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Mice and rats use 1000-1500 odorant receptor types to probe chemical space. The receptor neurons in the nose project their axons to the olfactory bulb and form anatomical units called glomeruli. Each glomerulus receives input from a single type of receptor. Thus each point on the surface of the bulb has a specific chemical response spectrum, derived from the associated odor receptor. This map of odors to glomeruli has been a subject of great interest, because it forms the physical layout on which neural computation takes place in the olfactory bulb. On this background, we would like to understand: How precise is the glomerular layout? What is the variability across the two hemispheres and across animals? Is the layout different for the two species? Are there functionally identical glomeruli in mice and rats?

To examine these issues, we recorded the odor response spectra of many glomeruli to a diverse battery of 100 odors at low concentration. We imaged neural activity in the dorsal olfactory bulb by two methods: (1) Intrinsic optical signals under deep red illumination can be used in both mice and rats, but their physiological origin is somewhat uncertain. (2) Synaptotagmin is a fluorescent reporter of synaptic activity in olfactory receptor neurons of genetically engineered mice. Its output is tied specifically to synaptic release, but it is not available in the rat. To test the correspondence between the two probes, we recorded the same odor response in a mouse using both methods, by rapidly interleaving blue and red excitation light. We found an excellent match between the two imaging methods in both the pattern of glomeruli activated and their relative response amplitudes. Therefore, the intrinsic optical signal correlates well with synaptic activity in olfactory receptor terminals and can be used in rats to investigate receptor neuron responses.

In both mice and rats, our odor set allowed stimulation of ~80 glomeruli on the dorsal surface of the olfactory bulb. Many glomeruli can be identified uniquely by their odor response spectra. Thus one can recognize the corresponding glomerulus across hemispheres of the bulb and across animals. We found that the placement of glomeruli is precisely controlled. The location of a given glomerulus in the map varies by only ~1 glomerular diameter across hemispheres and ~2 diameters across animals. In rats, placement was more precise along the medial-lateral axis of the bulb than in the anterior-posterior direction (~0.9 diameters vs ~1.8 diameters). No such anisotropy was seen in the mouse.

Several glomeruli in the mouse have a partner in the rat with the identical odor response spectrum. Since there are no matching receptor genes in the two species, it appears that different receptor proteins can produce almost indistinguishable function. Presumably these two species, with similar ecological environments, have a need for some of the same chemical sensors. However, the spatial distribution of these glomeruli on the olfactory bulb was entirely different in mouse and rat. This suggests that the layout of glomeruli, though it is precisely controlled among individuals of the same species, is not an essential determinant of subsequent computations.