【Grant-in-Aid for Scientific Research (S)】

Biological Sciences (Biological Sciences)

Title of Project： Decision Making in the Mouse Olfactory System

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Research Project Number：17H06160　Researcher Number：90262154

Research Area：　Neuroscience, Molecular Biology

Keyword：　neural circuit, olfactory, transgenic mice, optogenetics

【Purpose and Background of the Research】

The mammalian olfactory system recognizes a diverse repertoire of chemical information that induces distinct behavioral responses based on the odor qualities (Fig.1). In rodents, odor ligands are detected by olfactory sensory neurons (OSNs) in the olfactory epithelium (OE). Since OSNs expressing the same type of receptor send their axons to a specific target site, glomerulus, odor signals detected in the OE are converted into a topographic map of activated glomeruli. Odor information encoded in the olfactory bulb (OB) is then conveyed by projection neurons, mitral/tufted (M/T) cells, to various areas in the olfactory cortex (OC) to elicit odor responses. In this project, we plan to study how the neural circuits are formed for innate olfactory decisions. In adults, quality decisions of sensory inputs are made not only by the hard-wired circuits, but also by the memory-based learned circuits. However, these two decisions may differ: For example, the aversive odor quality of fermented foods could be converted to attractive one, once we experienced their good tastes. In this project, we will also study how the conflicted decisions, innate vs. learned, are balanced and modulated for behavioral responses.

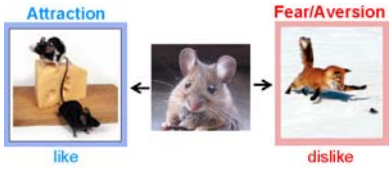

Fig.1 Olfactory perception

【Research Methods】

We have recently shown that photo-activation of a single glomerulus in the fear domain of dorsal OB induces immobility (freezing) in the channel-rhodopsin knock-in (KI) mouse. Similar mice will be generated for various innate responses, which will allow us to map functional domains in the OB. Using this photo-activation system, responsive OC regions will be identified. We will then study how the M/T cells connect the functional domains in the OB and particular OC regions to induce specific olfactory responses. We will identify specific sets of axon-guidance molecules for different subsets of M/T cells that convey particular odor information to responding OC regions. It has been reported that the aversive odor quality is processed by the cortical amygdala (CoA) to induce stress reactions, whereas the attractive odor quality is given in the anterior MeA (Fig.2). We will study how the two qualities are balanced between the CoA and MeA for decision making, when the innate quality of a particular odorant is aversive but the learned quality is attractive.

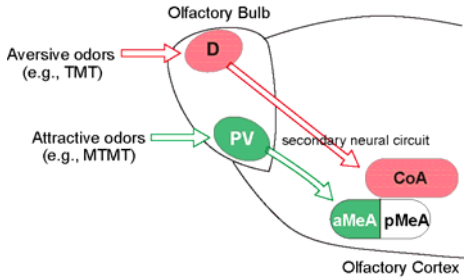

Fig.2 Hard-wired olfactory neural circuit

【Expected Research Achievements and Scientific Significance】

This research will reveal the domain organization of the olfactory map in the OB, circuit connections between the OB and OC, and functional sub-regions in the OC. This research will also give us a new insight into our understanding of decision making for sensory inputs to induce various behavioral responses.

【Publications Relevant to the Project】

Saito, H., *et al.*: Immobility responses are induced by photoactivation of single glomerular species responsive to fox odor TMT. *Nat. Comm.* 8, 16011 doi: 10.1038/ncomms16011 (2017)

Inokuchi, K., *et al.*: *Nrp2* is sufficient to instruct circuit formation of mitral cells to mediate odor-induced attractive social responses. *Nat. Comm.* 8, 15977 doi: 10.1038/ncomms15977 (2017)

【Term of Project】 FY2017-2021

【Budget Allocation】 158,800 Thousand Yen

【Homepage Address and Other Contact Information】

http://t-profile.ad.u-fukui.ac.jp/profile/ja.3c1e4d8f29d84458520e17560c007669.html