SCIENCE CHINA
Life Sciences

• INSIGHT •

November 2012 Vol.55 No.11: 1026–1028
doi: 10.1007/s11427-012-4402-z

Recent progress of sensory system research in China

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Received September 20, 2012; accepted October 11, 2012

Citation: Wang Y J, Liu L. Recent progress of sensory system research in China. Sci China Life Sci, 2012, 55: 1026−1028, doi: 10.1007/s11427- 012-4402-z

From human to insects, the sensory system is the part of the nervous system responsible for processing sensory information. Commonly recognized sensory systems include vision, hearing/auditory, smell/olfactory, taste/gustatory and somatic sensation. The research on sensory system investigates peripheral sensory neurons, neural pathways, and the more central brain involved in sensory perception. Chinese neuroscientists have been working to decode the sensory system for years. With improved fundings and research environment in recent years, significant progress has been made in neuroscience [1,2]. Here we review some recent advances in the basic research on sensory system in China.

A critical step to understand vision is to know how and where the visual perception is processed. Various Chinese research institutions and universities have made progress in vision research [3]. With fMRI and computational approaches, Fang and colleagues in Peking University have made a series of important findings on the neural mechanisms of human visual processes. Their findings suggested, for the first time, that the bottom-up saliency map is created in the V1 area, challenging the dominant view that the saliency map is generated in the parietal cortex [4]. They further found the effect of visual perceptual grouping—enhancing the high-level shape representation and attenuating the low-level feature representation [5].

Research on visual processing in the cortex by Li's group (Institute of Biophysics, Chinese Academy of Sciences) showed that the feedback projection from area posteromedial lateral suprasylvian (PMLS) can enhance the direction selectivity of striate neurons but exert little effect on the orientation tuning in cats, indicating an important role of PMLS in visual motion processing in the cerebral cortex [6]. Investigation on visual perception in mice by Zhu and coworkers (Southwest Forestry University, Kunming Institute of Zoology, Chinese Academy of Sciences) focused on the effects of different object properties. They took an interesting approach to use a behavioral paradigm to study the effect of different visual cues in visual perception [7], and found that mice could distinguish and extract topological properties of the objects [8].

The auditory system takes part in sound signal recognition and signal processing with central auditory neurons [9]. While previous studies of human sound level discrimination were always performed in monaural conditions, Zhang's group (East China Normal University) focused on preceding sound level discrimination in binaural conditions. Their results showed that the just noticeable difference (JND) of the low level preceding sound could not show significant effects compared with no sound (quiet), while moderate to high levels of preceding sound significantly increased the JND of the level of the successive sound [10]. Taking advantages of the hypertrophied auditory systems in bats, which are relatively easy to study, Chen and colleagues (Central China Normal University) investigated the inferior collicular (IC) neurons in CF-FM Bat, and revealed that the follow pulse repetition rate was determined by the recovery cycle of IC neurons [11].

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The ultrasonic communication in frogs was an interesting phenomenon first described by Shen and coworkers (Institute of Biophysics, Chinese Academy of Sciences; Beihang University) [12]. They further found that ultrasonic frogs displayed extraordinary sex differences in auditory frequency sensitivity with the females exhibit no ultrasonic sensitivity at all, suggesting ultrasonic hearing has evolved only in male anurans [13].

Different from visual or auditory system, the mammalian olfactory system collects olfactory information by detecting a large number of volatile chemicals with vastly diverse molecular structures [14,15]. As the first center to encode and process the peripheral olfactory inputs and a hub to rely the processed information to the olfactory cortices, olfactory bulb (OB) plays crucial roles in olfactory processing. Luo's group (National Institute of Biological Sciences) demonstrated that olfactory information carried by an odorant receptor is channeled to its corresponding mitral/tufted (M/T) cells in OB and supported the role of lateral inhibition via interneurons in sharpening the tuning of M/T cells [16]. Additionally, investigation by Xu and colleagues (Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences) indicated that the M/T cells can encode the odor locations [17]. Their further work suggested the neural representation of peripheral stimulation in rat OB is independent of brain state [18].

Along with the olfaction, the gustatory system allows animals to distinguish the properties of food. Working on how animals integrate the olfactory and gustatory cues of food, Xu's group (Institute of Biophysics, Chinese Academy of Sciences) found that *C. elegans* uses a flip-flop circuit to deal with contradictory olfactory and taste cues [19]. Moreover, an insulin-like signaling pathway constitutes an essential component for integration of both olfactory and gustatory information in *C. elegans* [20]. While the sensation of taste was traditionally categorized into five basic categories: sweet, bitter, sour, salty and umami, Wang's group (Institute of Neuroscience, Chinese Academy of Sciences) researched on a specific taste—water sensation. Using *Drosophila* as a model system to study sensation for liquid water, Wang and colleagues identified a potential gustatory water receptor—PPK28, a DEG/eNaC (degenerin /epithelial sodium channel) family member [21].

Pain sensation, as well as its inhibition, is perhaps the most concerned in somatosensory research due to its clinical implications. Zhang's group (Institute of Neuroscience, Chinese Academy of Sciences) is interested in the molecular and cellular mechanism of nociception and chronic pain. Building upon a series of important results on pain inhibition, Zhang and colleagues identified B-type natriuretic peptide (BNP) and its receptor involved in pain modulation. They demonstrated that activate BNP in nociceptive neurons could inhibit the inflammatory pain [22]. Later they revealed another protein, Activin C, is also required for inflammatory pain suppression. Their work would lead to potential strategies for inflammatory pain therapy [23].

As the integral part of neuroscience research, sensory neuroscience has been undergoing rapid development in China. Here we only briefly summarized some research by Chinese scientists in the past two years. Solid foundation has been established in broad areas of sensory research. With more funding support and more scientists joining the effort, we expect to witness tremendous progress in sensory research in China, in terms of both quality and quantity, in the near future.

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