Developmental mechanism underlying sensorimotor control of orienting behavior

Ying-Shing Chan[1*], Francisco P. Botelho[1,2], Wen-Qiang Chen[1,2], Chun-Wai Ma[1,2], Wei Shi[1,2], Daisy Kwok-Yan Shum[2]

Departments of [1]Physiology and [2]Biochemistry, Li Ka Shing Faculty of Medicine, The University of Hong Kong, Sassoon Road, Hong Kong SAR, China

Activity-dependent synaptic plasticity plays a key role in the refinement of neural circuits and expression of behaviors during development. We demonstrated that LTP of glutamatergic synapses at interneurons in the vestibular nucleus (VN) enabled postnatal emergence of graviceptive behavior in rats. Given that many of the interneurons are GABAergic, we asked if synaptic plasticity of GABAergic transmission in the developing vestibular circuit also impacts on behavioral outcome. Perforated whole-cell patch-clamp recording performed on VN slices indicated that GABAergic transmission was excitatory in the first postnatal week but switched to inhibitory during the second postnatal week. Throughout these two weeks, theta-burst stimulation delivered to vestibular afferents induced LTD of GABA transmission that could be modulated by treatment of the VN with endocannabinoid and/or BDNF. With neonatal treatment of the VN with $GABA_A$ receptor agonist, we found that the proportion of neurons expressing LTD was reduced and the emergence of negative geotaxis, a gravity-detection orienting behavior, was advanced. On the other hand, neonatal blockade of VN neurons with $GABA_A$ receptor antagonist delayed developmental emergence of negative geotaxis. When these rats reached maturity, they exhibited deranged internal spatial maps and deficits in spatial navigation. Altogether, tuning the vestibular network for spatial coding during a neonatal period of plasticity is critical for orchestrating orienting behaviors. [*HKRGC-GRF 761711, 761812, 762313, N_HKU735/14.*]

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Properties of tactile stimulation evoked synaptic responses and long-term plasticity in cerebellar cortex

Yan-Hua Bing, Chun-Ping Chu，De-Lai Qiu*

Cellular Function Research Center, Yanbian University; Department of Physiology and Pathophysiology, College of Medicine, Yanbian University, Yanji, Jilin Province, China.

* Corresponding Author. E-mail: dlqiu@ybu.edu.cn; dlqiu_neuron@hotmail.com

Sensory information comes from climbing fiber and mossy fiber-granule cell pathways, which induces plasticity of synaptic transmission and generates motor-related outputs in the cerebellar cortex. However, the properties of sensory information evoked synaptic responses and plasticity in cerebellar cortex are currently unclear. Recently, we studied the dynamic properties of sensory stimulation-evoked responses and synaptic plasticity in the cerebellar cortex by electrophysiological recording and pharmacological methods. We found that the cerebellar granule cells transfer the high fidelity sensory information, which was low-pass filtered by molecular layer interneurons, and the Purkinje cells respond preferentially to low-frequency sensory stimulation regardless $GABA_A$ receptor activity. Importantly, 1 Hz facial stimulation induced a long-term depression (LTD) of GABAergic transmission at MLI–PC synapses, but did not induce a significant change in the properties of the sensory-evoked spike events of MLIs. The MLI–PC GABAergic LTD could be prevented by blocking cannabinoid type 1 (CB1) receptors, and could be pharmacologically induced by a CB1 receptor agonist. Additionally, 1 Hz facial stimulation delivered in the presence of a metabotropic glutamate receptor 1 antagonist, still induced the MLI–PC GABAergic LTD, whereas blocking N-methyl-D-aspartate (NMDA) receptors during 1 Hz