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

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Abstract: 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 facial stimulation abolished the expression of MLI–PC GABAergic LTD. These results indicate that sensory
stimulation can induce an endocannabinoid (eCB)-dependent LTD of GABAergic transmission at MLI–PC synapses via activation of NMDA receptors in cerebellar cortical Crus II in vivo in mice. Collectively, our results suggest that the MLI network acts as a low-pass filter during the high-frequency sensory information processing, and play a critical role on the sensory-related outputs of Purkinje cells in the mouse cerebellar cortex, and the sensory stimulation-evoked MLI–PC GABAergic synaptic plasticity may play a critical role in motor learning in animals. (This work was supported by the National Natural Science Foundation of China. 31060138; 81260208; 81160142; 31460261).