Investigation of dendritic spine morphology in Purkinje cells of rat cerebellum following motor learning

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Dendritic spines are major postsynaptic sites that transmit most excitatory inputs in a central nervous system. The density, size, and shape of dendritic spines change in response to various physiological or pathological states. To investigate the motor learning-induced structural changes of dendritic spines in the Purkinje cells of rat cerebellum, morphological analyses were conducted from the rats trained in acrobatic condition (AC) demanding motor coordination and balance using high-voltage electron microscopy. As a behavioral result, the AC group showed that the mean time to complete daily trials and the mean number of errors (foot faults) were reduced significantly as training progressed. This indicates that AC animals indeed learned the complex motor skill (Fig. 1, 2). For the morphological analyses of dendritic spines, the AC rats showed increase in spine density and length than control (MC) animals (For density, AC: 27.49±0.61/10㎛, MC: 22.82±0.51/10㎛, $p<0.05$; For length, AC: 1.12±0.01㎛, MC: 1.03±0.01㎛, $p<0.05$). Dendritic spines were also classified into *thin, mushroom, stubby, branched,* and *unclassified type* by their distinct morphological features. On the tertiary branches of Purkinje cell dendrites, AC animals exhibited increase in *thin* and *branched* type, whereas a slight decrease in mushroom and stubby type was observed (Fig. 3). These data of spine classification support the increase in spine length in AC group. These results suggest that motor learning increases the number of spines, implying that synaptogenesis occurs between parallel fibers and Purkinje cell spines. This study would provide useful information to understand the mechanism of cerebellar synaptic plasticity by the motor skill learning.

Keywords: *Learning, Cerebellum, Purkinje cell, Plasticity, HVEM*

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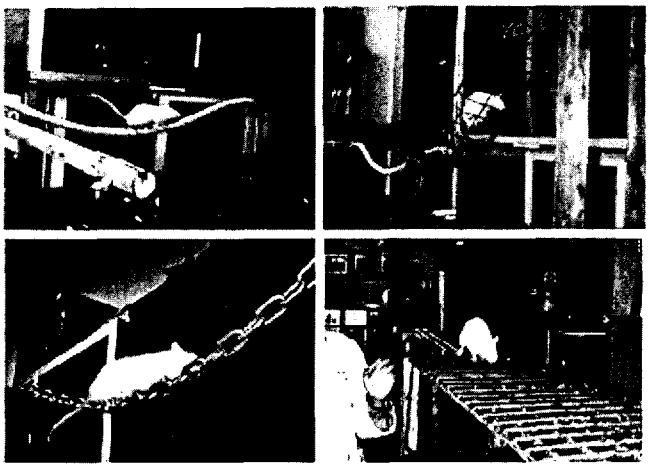

Fig. 1. Representative pictures of rats being trained in acrobat condition.

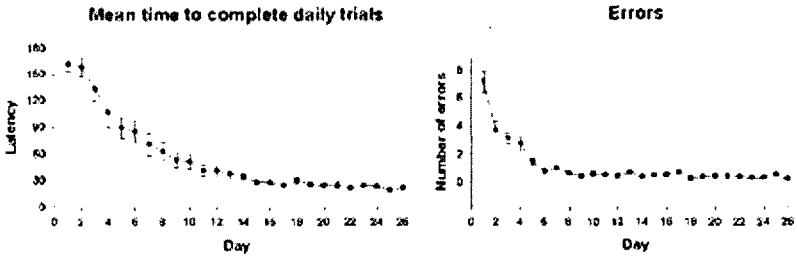

Fig. 2. Mean time and errors to complete daily trials.

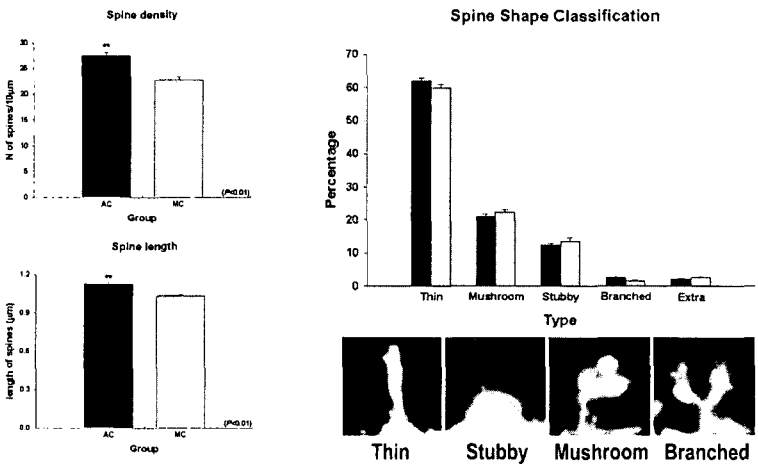

Fig. 3. Dendritic spine analyses of cerebellar Purkinje cells following motor learning.