Form 1-5-2

Japan-U.S. Brain Research Cooperation Program
Researchers Dispatched to the U.S. Program FY2016: Report

Field: Behavioral/ Systems/ Cognitive

1. Researcher

Name Daisuke Miyamoto
Title JSPS Postdoctoral Research Fellow
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2. Research Title:

Local circuits for memory consolidation during sleep.

3. U.S. Joint Researchers/Institutes

University of Wisconsin-Madison, Professor, Giulio Tononi

4. Research Period, from/to (mm/dd/yyyy):

From 10/9/2016 to 3/27/2017

5. Abstract, Results, and Research Significance (300 Words):

Sleep has important roles in memory consolidation. However, its neural circuitry mechanisms remain largely unknown. Synaptic plasticity is a well-known mechanism of learning and memory. Motor learning potentiates a subset of synapses in motor cortex and allocates them for motor memory information. Meanwhile, in the population level, net synaptic strength in cerebral cortex is potentiated during wakefulness and is depressed during sleep. In individual synapses, two hypotheses are suggested for sleep synaptic depression. Global downscaling hypothesis says all the synapses depress multiplicatively. However, global downscaling is difficult to explain sleep memory consolidation. In contrast, down-selection hypothesis says sleep depresses a part of synapses selectively. If sleep depresses memory non-allocated synapses but not memory allocated synapses, it enhances signal-to-noise ratio and may support memory consolidation. To examine these hypotheses, here we evaluated synaptic strength at single-synapse resolution through motor learning and following sleep in mice. First, in utero electroporation was applied to express SEP (super-ecliptic pHluorin)-GluR1 and dsRed2 in layer II/III pyramidal neurons. SEP-GluR1 was used for assessing the amount of AMPA receptor, which is a good index of synaptic strength. dsRed2 was used for visualizing the structure of dendrites and spines. Next, in adult mice, *in vivo* two-photon imaging was performed at single synapse resolution. Repeated imaging was performed at pre-, post-learning, and after following sleeping periods. Motor learning was assessed with complex-wheel task, which is dependent on post-learning sleep. Motor skill was improved through trials even if isoflurane anesthesia and a small head-fixation bar (0.2 g) were applied for *in vivo* imaging. This in vivo imaging method is helpful to reveal synaptic plasticity at single synapse resolution.

6. Other (Research concerns, particular points of note):

*Please attach any reference materials as necessary.