

Cortical evoked responses to magnetic stimulation of macaque's abdominal wall in sleep-wake cycle

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EEG and eye movements (magnetic search coil method) were recorded in sleep and wakefulness in a monkey (*Macaca fascicularis*) while the animal was sitting in a primate chair. Single pulse magnetic stimulation was applied to the monkey's abdominal wall using a circular coil and a Magstim 200 stimulator. Magnetic stimuli did not wake the sleeping animal, and being applied during slow wave sleep evoked clear responses in EEG with a latency of 80–100 ms. These responses disappeared during wakefulness and rapid eye movement sleep. Control experiments confirmed that these responses were not caused by the acoustic clicks produced by the magnetic coil. Results of this study further confirm that during sleep, signals from visceral organs reach the cortical areas which in wakefulness process exteroceptive sensory information. This observation indicates that magnetic stimulation may be a useful tool for researching neural connectivity reorganization within the sleep-wake cycle.

Key words: Cortical evoked responses, magnetic stimulation, visceral stimulation, monkey, sleep

It was shown in cats that evoked responses to electrical stimulation of intestinal mucosa or directly of splanchnic nerve in cortical and subcortical projections of this nerve, increased during sleep (Kukorelli and Juhasz 1983). Later it was found that electrical stimulation applied during slow wave sleep (SW sleep) to the area of the stomach and small intestine in cats (Pigarev, 1994) evoked responses of neurons in visual cortical areas which in wakefulness process signals from the retina. These visceral responses disappeared in wakefulness. Recently it was shown that also in monkeys during slow wave sleep intraperitoneal electrical stimulation evoked responses in the occipital cortical area in monkeys (Pigarev et al. 2006a). This suggested that the same cortical areas which process signals from exteroceptors in sleep can be involved in analysis of incoming signals from interoceptors – a conclusion that opens a new and stimulating view of the possible function of sleep and neuronal control

of visceral functions. However, the research of viscerocortical interaction in sleep-wake cycle has several inherent technical problems. Firstly, in order to have naturally sleeping animals, experiments should be performed under chronic conditions. Similarly, most studies of visceral systems were performed in acute preparations, and known methods for controlled stimulation of visceral receptors in chronic experiments, as for example in the work (Kukorelli and Juhasz 1983) were connected with intraperitoneal operations. Direct intraperitoneal stimulation is not acceptable for studies of humans.

During the last years magnetic stimulation began to be widely used in physiological and medical practice (for review see Rothwell et al. 1991, Rossini and Rossi 1998). Being very similar in nature to electric stimulation (most likely that magnetic pulse induces the current which excites the tissue) magnetic stimulation perceptually is “softer”. By our own observations magnetic pulses applied by the coil located on the skin overlying the abdomen do not produce a painful sensation, and are felt as short and mild mechanical knocks.

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