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PHYSIOLOGICAL SIGNIFICANCE OF T-TYPE CALCIUM CURRENT REGULATION

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T-channels are well known to be highly sensitive to the precedingneuronal activity, a characteristic which directly arises from their peculiar biophysical properties. We recently demonstrated in sensory thalamocortical neurons that the dependence of the T-channel activity upon the preceding membrane potential is further complicated by the existence of a non-classical enzymatic mechanism that phosphorylates T-channels according to the channel conformation. This phosphorylation occurs when the channels are inactivated and induces a paradoxical potentiation of the T current that is progressively suppressed when the channels move out of the inactivated state and enter a closed state (Leresche et al. J. Neuroscience, 2004). Using a technique based on a rapid switch between the voltage-clamp and the current-clamp modes, we show that the modulation of this regulation by variations of the membrane potential within the physiological range affect neuronal excitability. We demonstrate that the potentiation of the T current drastically affect both the amplitude and the kinetics of the low-threshold calcium potential which underlies bursting activities in thalamocortical neurons. Furthermore, the ability of the synaptic inputs to generate a burst of action potentials is conditioned by the potentiated/non-potentiated states of the T-channels.

Key Words: calcium current, thalamus

S 20-3

ROLE OF THE LIMBIC SYSTEM IN EMOTION AND MEMORY

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This century is the era of the brain science. Although emotion is one of the most enigmatic processes, recent advance in this academic field has enabled us to approach neural basis of emotion. The hypothalamus is a key structure for emotional expression including emotional behaviors as well as autonomic and endocrine reaction, etc.; activity of the monkey and rat hypothalamic neurons indicated close relations to behavioral and autonomic responses during emotional expression. The nucleus accumbens integrates converging inputs from the limbic system, prefrontal cortex, and mesolimbic dopamine inputs from the ventral tegmental areas to predict reward or aversion, which is essential in emotional behaviors. D1 and/or D2 dopamine receptor knockout mice displayed various behavioral deficits in predicting reward in a place learning task, and accumbens neurons recorded from these mice indicated corresponding activity changes in the task. The amygdala plays a pivotal role in stimulus-affect association. Our data in monkeys indicated that the affective contingency of the object was the one of salient determinant for responsiveness of some amygdalar neurons. Furthermore, activity of the amygdalar neurons was not directly related to simple sensory inputs nor individual overt acts, although some neurons responded exclusively to one sensory modality. The hippocampal formation is crucial for episodic memory; monkey hippocampal neurons responded associatively to multiply related factors such as place, space, object, and behavioral response while the monkey navigated by controlling a motorized, movable device (cab). Finally, among various brain regions involved in emotional experience and behaviors, the prefrontal cortex is suggested to be important in prediction, evaluation, decision making, etc. to control the various areas noted above. Monkey prefrontal neurons displayed such activity related to prediction, evaluation, and decision making. In this symposium, the neural representation of emotional experience and behaviors in these brain regions is described and discussed, mainly based on the recent findings obtained in our laboratory using knockout mice, rats, and monkeys.

Key Words: hippocampal formation, nucleus accumbens, prefrontal cortex, amygdala