

Extrapolative Role of Facilitatory Synapses in the Compensation of Neural Delay

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Delay in the nervous system is a serious issue for an organism that needs to act in realtime. For example, in the macaque, the mean latency (from stimulus onset) in spike arrival in the prefrontal cortex can be near 130 ms [1], thus putting the internal clock steadily behind the environmental clock. Such a lag can be critical when we consider that many animals need to deal with objects moving at high velocity. Thus, it may be critical to compensate for such a delay. Two questions arise at this point: (1) does the nervous system perform delay compensation, and (2) if so, what is the neural basis for that mechanism? There is strong experimental support for the first question, especially in flash-lag effect research [2]. However, the second question has not been fully investigated. One potential mechanism for delay compensation is dynamic synapses. Dynamic synapses (facilitating or depressing) have drawn much attention due to their implicated functional role in memory and temporal information processing [3]. In this abstract, we will focus on facilitating synapses, and present a case that they may be serving yet another important function, i.e. compensation for neural delays by extrapolating on the past input history. Existing models of facilitating synapses can implement extrapolation, but only partly, since they can only deal with cases with change in neural activity the increasing direction but not in the decreasing direction. We propose an extended model which can account for extrapolation in both directions. For this, we propose that the synaptic efficacy in the model should be dynamically modulated by the history of interspike intervals. Computational results indicate that the extended model can perform extrapolation in both directions. We expect our framework to shed new light on the functional role of facilitating synapses.

[1] Thorpe and Fabre-Thorpe. *Science* 291:260-263, 2001.

[2] Nijhawan. *Nature* 370:256-257, 1994.

[3] Markram, Wang, and Tsodyks. *PNAS* 95:5323-5328, 1998.

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