

Computational Neuroscience and Neurotheory: Homework 3

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May 29, 2025

1 Question 1.

For the first part where the conditioned stimulus comes before the unconditioned stimulus, this should lead to potentiation, as expected from classical conditioning. As expected, this happens through LTP (Figure 1). And once the unconditioned stimulus is not present any more, presenting just the conditioned stimulus also elicits a spike.

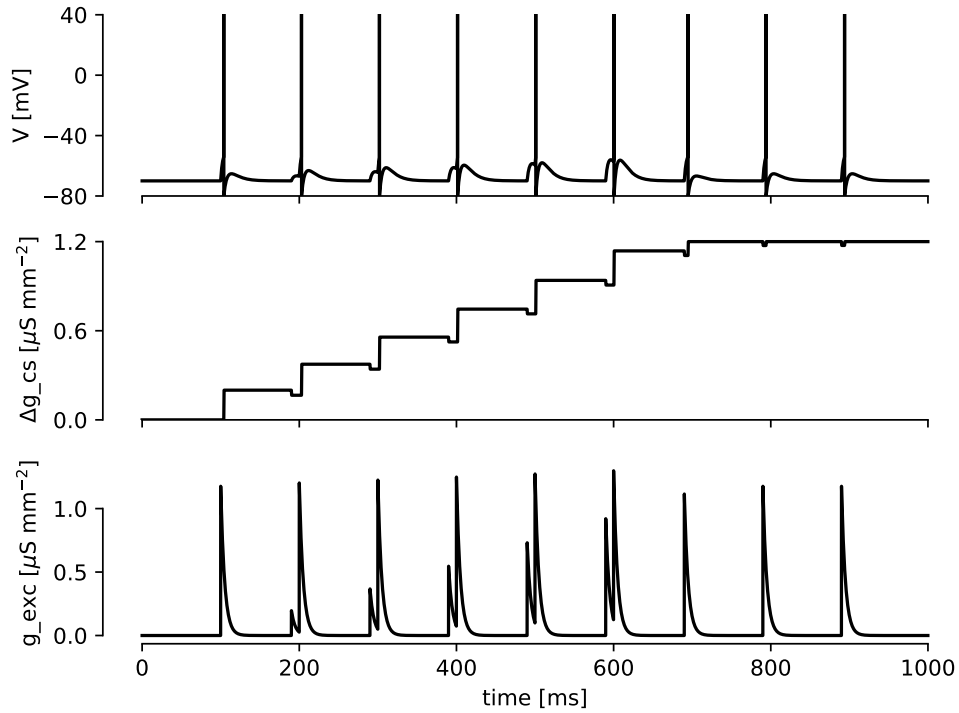


Figure 1: Conditioned stimulus followed by unconditioned stimulus.

In the next condition, where the unconditioned stimulus is presented before the conditioned stimulus, should lead to depression, as expected from classical conditioning. Again as expected, the synapse now weakens in strength via LTP (figure 2), and once the unconditioned stimulus is taken away a spike is not observed in the neuron.

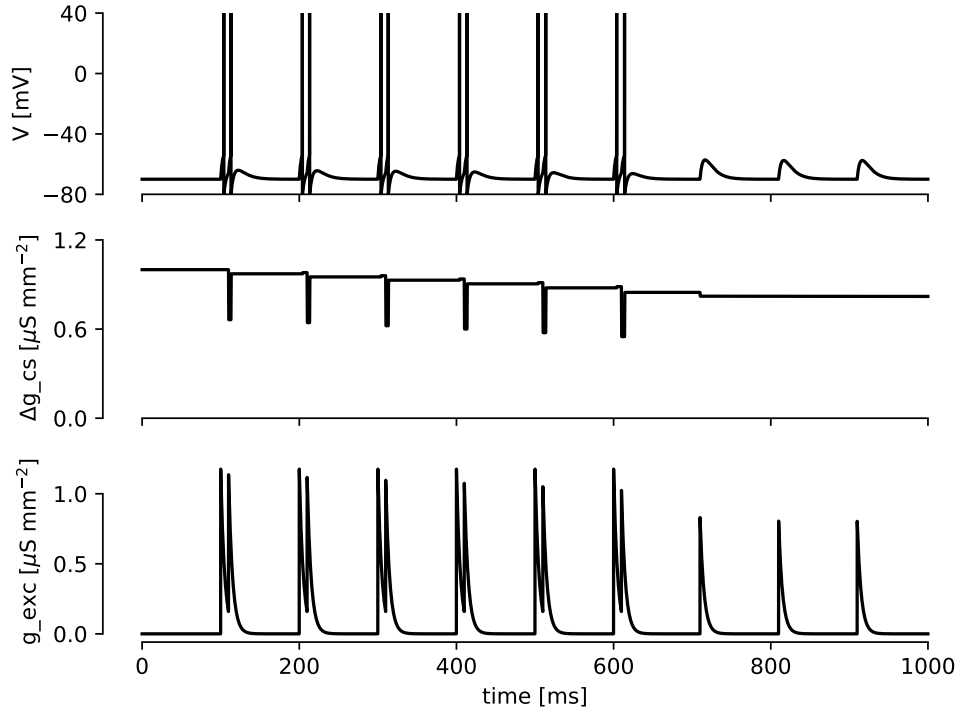


Figure 2: Unconditioned stimulus followed by conditioned stimulus.

2 Question 2.

At low firing rates, the depressing synapse transmits more spikes than the facilitating synapse (see Figure 3 for the 10 Hz firing rate), and as the firing rate increases, the facilitating synapse transmits more spikes (see Figures 5 and Figure 4 for the 50 and 100 Hz firing rate). This is further supported by the transmission rate as a function of the firing rate (Figure 7), where, as the firing rate increases, the facilitating synapse increases the transmission rate, and the depressing synapse decreases it. Additionally, this can be seen in the probability of facilitating and depressing synapse, where the probability of transmission increases slowly and requires more spikes to reach chance-level transmission at the facilitating synapse. On the other hand, in the depressing synapse, the probability is 1 and even after transmission of one spike, the probability begins to return back to 1.

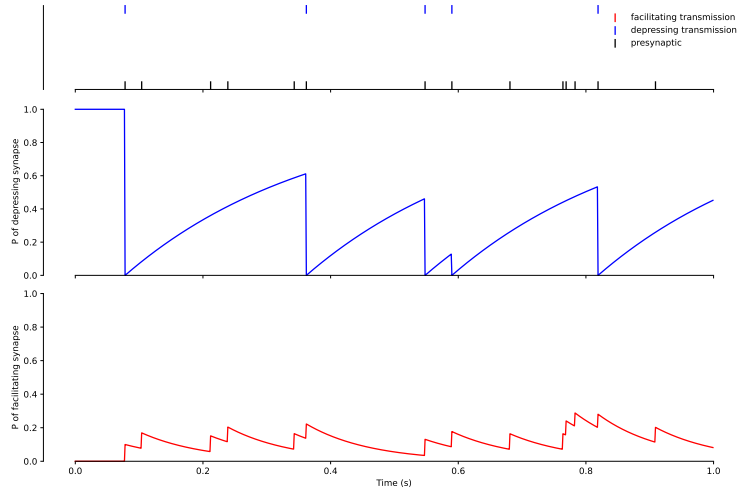


Figure 3: Firing rate at 10 Hz

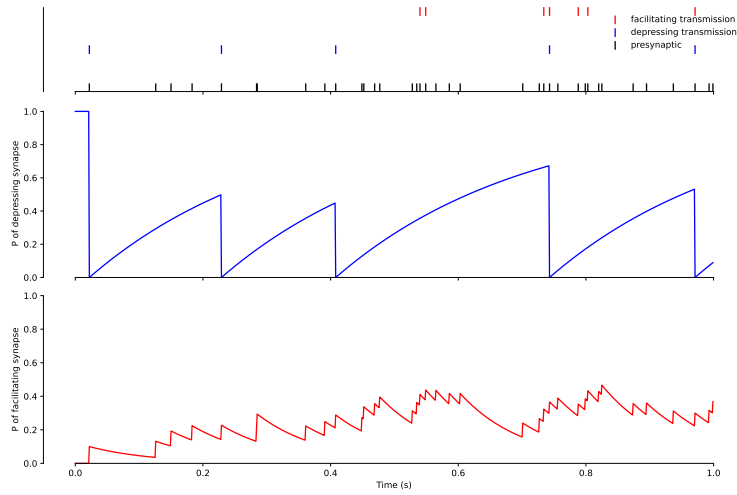


Figure 4: Firing rate at 50 Hz

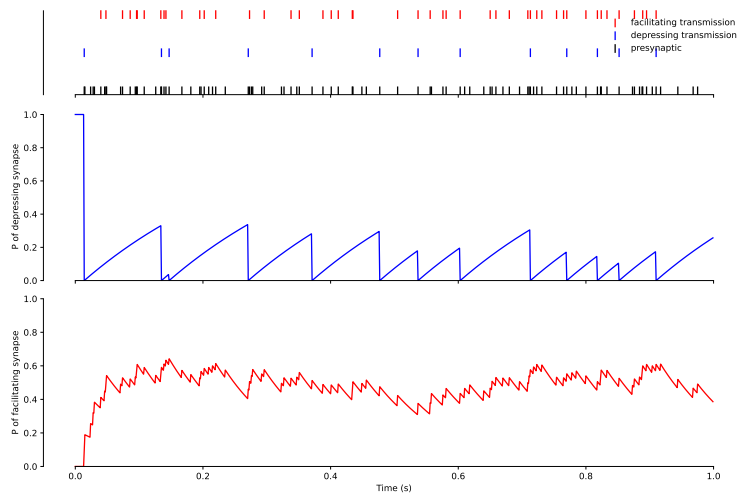


Figure 5: Firing rate at 100 Hz

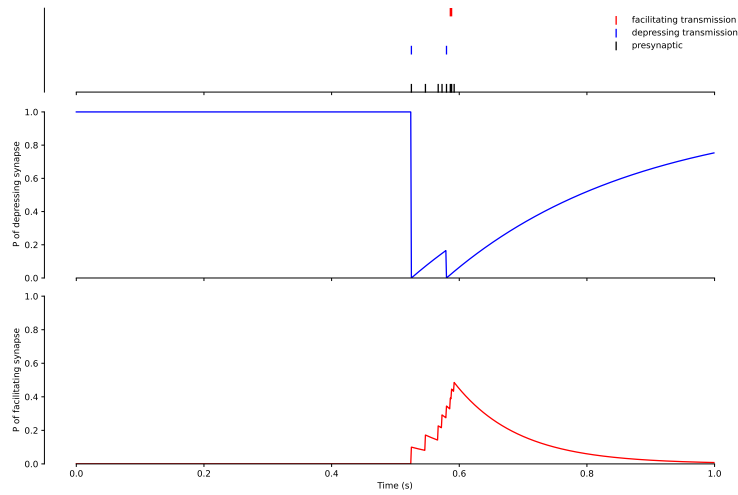


Figure 6: Burst of spikes at 100 Hz

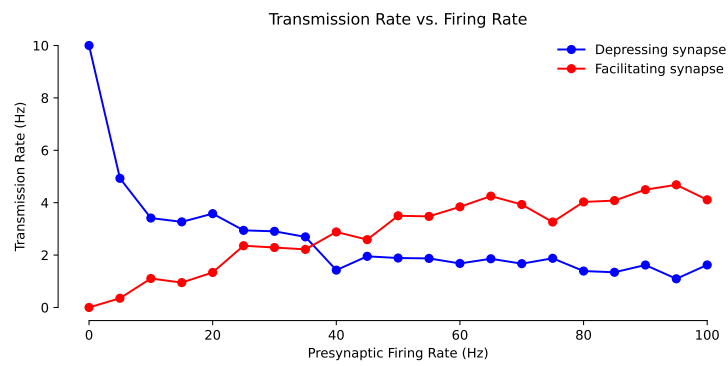


Figure 7: Transmission versus firing rate.