



Fig. 1.11 The shape of postsynaptic potentials depends on the momentary level of depolarization. (a) A presynaptic spike that arrives at time t_i^f at an inhibitory synapse has hardly any effect on the membrane potential when the neuron is at rest, but a large effect if the membrane potential u is above the resting potential. If the membrane is hyperpolarized below the reversal potential of the inhibitory synapse, the response to the presynaptic input changes sign. (b) A spike at an excitatory synapse evokes a postsynaptic potential with an amplitude that depends only slightly on the momentary voltage u . For large depolarizations the amplitude saturates and becomes smaller. (Schematic figure.)

synapses are often located on the soma or on the shaft of the dendritic tree. Owing to their strategic position, a few inhibitory input spikes can “shunt” the whole input that is gathered by the dendritic tree from hundreds of excitatory synapses. This phenomenon is called “shunting inhibition.”

The reversal potential for excitatory synapses is usually significantly above the resting potential. If the membrane is depolarized $u_0 \gg u_{rest}$ the amplitude of an excitatory postsynaptic potential is reduced, but the effect is not as pronounced as for inhibition. For very high levels of depolarization a saturation of the EPSPs can be observed; see Fig. 1.11b.

1.4.3 Conductance changes after a spike

The shape of the postsynaptic potentials depends not only on the level of depolarization but, more generally, on the internal state of the neuron, e.g., on the timing relative to previous action potentials.

Suppose that an action potential has occurred at time t_i^f and that a presynaptic spike arrives at a time $t_j^f > t_i^f$ at the synapse j . The form of the postsynaptic potential depends now on the time $t_j^f - t_i^f$; see Fig. 1.12. If the presynaptic spike arrives during or shortly after a postsynaptic action potential, it has little effect because some of the ion channels that were involved in firing the action potential are still open. If the input spike arrives much later, it generates a postsynaptic potential of the usual size. We will return to this effect in Chapter 2.

1.4.4 Spatial structure

The form of postsynaptic potentials also depends on the location of the synapse on the dendritic tree. Synapses that are located far away from the soma are expected to evoke a

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