NMDA Receptor-Dependent Long-Term Modification in Rat Visual Cortical Inhibitory Cells

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[Aim] Neocortical NMDA receptor-dependent long-term modification has been studied intensively in pyramidal cells, the major excitatory cells, but never in inhibitory non-pyramidal neurons. In this study I examined this type of modification in the latter cells in visual cortical slices of developing rats. **[Methods]** Whole-cell recording was conducted on layer 2/3 non-pyramidal cells under infrared differential interference contrast optics with patch electrodes containing neurobiotin, which was used for morphological cell type identification. Excitatory postsynaptic currents (EPSCs) were evoked by stimulation of presynaptic axons with metal electrodes placed in layer 4. To induce plastic changes, low-frequency stimulation was paired with postsynaptic depolarization (0 mV), which is commonly used to induce long-term potentiation (LTP) in pyramidal cells. **[Results]** Pairing stimulation induced LTP, long-term depression (LTD) or no change in EPSCs. Under a pharmacological blockade of NMDA receptors, LTP and LTD were rarely produced. Neither modification occurred in cells loaded with BAPTA, a Ca^{2+} chelator. Thus, the induction of LTP and LTD requires postsynaptic Ca^{2+} entry resulting from NMDA receptor activation. LTP occurred far more frequently than LTD in cells lacking spike frequency adaptation while LTP and LTD occurred with a similar incidence in non-adapting cells. **[Conclusion]** In inhibitory cells, pairing stimulation produces NMDA receptor-dependent LTD as well as LTP. These modifications seem considerably different between the inhibitory neuron subtypes.

Experience-Dependent Development of Visual Cortical Neural Connections Analyzed by Spontaneous Postsynaptic Currents

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[Aim] Experience-dependent development of excitatory and inhibitory connections was studied in visual cortical slices. **[Methods]** Developing and mature mice used were raised under a normal or dark environment from birth. Spontaneous excitatory and inhibitory postsynaptic currents (EPSCs and IPSCs) were recorded from layer 2/3 pyramidal cells under a whole-cell voltage clamp. These currents included miniature EPSCs and IPSCs (mEPSCs and mIPSCs), and unitary EPSCs and IPSCs (uEPSCs and uIPSCs) elicited by spontaneous presynaptic spikes. The frequency and amplitude of the miniature currents were determined under a tetrodotoxin spike blockade, and those for the unitary currents were estimated by the difference between the values in control and tetrodotoxin solutions. **[Results]** The frequency of the miniature and unitary currents was very low before eye opening and increased gradually to the adult level in both excitatory and inhibitory connections. In contrast, the amplitude of mEPSC and mIPSC were unchanged during the whole developmental period. The amplitude of uIPSC peaked outstandingly at the critical period of experience-dependent development, whereas no such change occurred for the uEPSCs. Compared with normal development, dark rearing reduced the frequency of mIPSC and uIPSC early, during the critical period, and that of mEPSC and uEPSC finally in adulthood, without affecting other current parameters. **[Conclusion]** It is likely that the effect of visual experience on development starts earlier in inhibitory connections, compared with excitatory connections.