Abstract:

Synaptic integration is modulated by inhibition onto the dendrites of postsynaptic cells. However, presynaptic inhibition at axonal terminals also plays a critical role in the regulation of neurotransmission. In contrast to the development of inhibitory synapses onto dendrites, GABAergic/glycinergic synaptogenesis onto axon terminals has not been widely studied. Because retinal bipolar cells receive subclass-specific patterns of GABAergic and glycinergic presynaptic inhibition, they are a good model for studying the development of inhibition at axon terminals. Here, using whole cell recording methods and transgenic mice in which subclasses of retinal bipolar cells are labeled, we determined the temporal sequence and patterning of functional GABAergic and glycinergic input onto the major subclasses of bipolar cells. We found that the maturation of GABAergic and glycinergic synapses onto the axons of rod bipolar cells (RBCs), on-cone bipolar cells (ON-CBCs) and off-cone bipolar cells (OFF-CBCs) were temporally distinct: spontaneous chloride-mediated currents are present in RBCs earlier in development compared with ON- and OFF-CBC, and RBCs receive GABAergic and glycinergic input simultaneously, whereas in OFF-CBCs, glycinergic transmission emerges before GABAergic transmission. Because on-CBCs show
little inhibitory activity, GABAergic and glycinergic events could not be pharmacologically
distinguished for these bipolar cells. The balance of GABAergic and glycinergic input that is unique to
RBCs and OFF-CBCs is established shortly after the onset of synapse formation and precedes visual
experience. Our data suggest that presynaptic modulation of glutamate transmission from bipolar
cells matures rapidly and is differentially coordinated for GABAergic and glycinergic synapses onto
distinct bipolar cell subclasses.