Wiring Specificity for GABAergic Synapses in an Amygdala Inhibitory Microcircuit

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The central amygdala (CeA), which consists of mostly γ-aminobutyric acid-releasing (GABAergic) inhibitory neurons, controls the expression of conditioned fear via projections to downstream targets in the hypothalamus and brainstem. The CeA is further divided into the lateral (CeL) and medial (CeM) divisions. The CeL gates activity of the CeM, the main output station of the amygdala, to modulate the fear responses. Although intra-CeL inhibition strongly impacts information transfer across CeL-to-CeM connections, little is known about the connectivity pattern and functional properties of unitary inhibitory synapses between CeL neurons. Using hierarchical cluster analysis, we identified two major physiologically distinct CeL neuron classes, early-spiking (ES) and late-spiking (LS) neurons, in acute mouse amygdala slices. Both of them form functionally distinct autaptic transmission. Recordings from pairs or triplets showed that all these CeL neurons make chemical but not electrical synapses. Analysis of individual connections revealed that synaptic efficacy at ES→LS or LS→ES synapse was approximately 2-fold stronger than that at LS→LS or ES→ES synapse. The temporal dynamics of GABAergic transmission when tested at 20 Hz showed that synapses between different but not same type of neurons were strongly depressing. Higher probability of functional connection was also found between different cell types. Our results indicate that both pre- and postsynaptic cell types dictate the synaptic property and connection probability of CeL inhibitory neurons. Such cell-type specific interactions between inhibitory neurons may be relevant to the development and function of local inhibitory circuits within the CeL.