Organization of Thalamic and Callosal Synaptic Inputs to Projecting Neurons of Auditory Cortex

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During auditory processing, sensory information enters the auditory cortex (ACx) through the thalamus and leaves through efferents to intratelencephalic and subcortical targets. The contribution of the specific circuit elements in this long-range functional connectivity is poorly understood. Pyramidal neurons of layer 5 are the major output class of the neocortex and can be classified based on their projection targets, morphology, and firing type. Regular spiking (RS) neurons have slender dendrites and project intratelencephalically. Intrinsic bursting (IB) neurons have thick-tufted, heavily arborizing dendrites and project to subcortical areas. To investigate the synaptic mechanisms of long-range afferents onto these neuronal classes, we recorded light-evoked responses from channelrhodopsin-positive transcallosal and thalamic fibers.

We discovered that, compared to IB neurons, RS neurons receive significantly stronger monosynaptic excitatory input from both thalamic and callosal fibers. Moreover, layer 5 RS neurons received thalamic input comparable in strength and latency to those to layer-4 neurons (traditionally thought of as the primary target of thalamic input) and greater than those to layer 2/3 and layer 5 IB neurons. These data suggest that in auditory cortex, intracortical flow of information, mediated by activation of RS neurons, is driven more strongly by thalamic and callosal synaptic inputs than the subcortical output from IB neurons.