Pyramidal neurons of cortical layer 5 provide the output of the information from each cortical column and can be divided into two major classes, defined by their firing type, morphology, and projection target. Regular spiking (RS) neurons have slender dendrites and project intratelencephalically (to neocortex and neostriatum). Intrinsic bursting (IB) neurons have thick-tufted, heavily arborizing dendrites and project to subcortical areas. To understand the role these subclasses play in processing of sensory information, it is important to know how their afferents might differ. Comparing to intracortical circuitry, long-range inputs onto RS and IB neurons have been poorly studied.

Auditory information enters mammalian neocortex through thalamus. Primary auditory (A1) cortices then projects contralaterally onto each other. We addressed the role of each input by expressing light-activated membrane protein, channelrhodopsin, in contralateral A1 and ipsilateral thalamus. We labeled the two projecting classes of neurons by njecting beads into the contralateral ACx and ipsilateral inferior colicullus or thalamus. To study the long-range afferents of the labeled RS and IB neurons, we optogenetically activated channelrhodopsin-positive colossal and thalamic fibers and recorded direct excitatory and feedforward inhibitory synaptic responses onto the two classes of neurons. We have discovered that CCOL and CCORT cells receive significantly different levels of excitatory input from thalamus and contralateral A1. These differences in local and long-range circuitry involving the two classes of Layer 5 projecting pyramidal neurons suggest that the latter participate in processing of different streams of sensory information.