544.19/S17. Firing synchrony in networks of dorsal cochlear nucleus cartwheel cells

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P. B. MANIS, J. G. MANCILLA;
Dept Otolaryngol/Head & Neck Surg, Univ N Carolina-Chapel Hill, Chapel Hill, NC.

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The dorsal cochlear nucleus (DCN) contains multiple networks of inhibitory interneurons that play critical roles in sensory processing. The most numerous inhibitory cells in the DCN are the cartwheel (CW) cells. These cells are known to synapse with each other, as well as provide inhibition to the projection cells, the pyramidal cells. Inhibitory neurons can generate synchronized, antisynchronized, or desynchronized patterns within a network depending on the strength, time course, and sign of their interactions. Furthermore synchronized inhibition can affect the firing patterns of other cells. CW cells have been reported to interact via depolarizing glycinergic synaptic potentials (GPSPs) due to elevated intracellular chloride, whereas they produce hyperpolarizing PSPs in pyramidal cells (Golding and Oertel, J. Neurosci. 16:2208, 1996). We used dynamic clamp to create artificial synapses between pairs of cartwheel cells in the rat DCN brain slice, in order to analyze how synaptic coupling among cartwheel cells affects their mutual spiking patterns. We found that when the GPSPs are hyperpolarizing, pairs of CW cells tend to fire in an antisynchronous pattern, whereas when the GPSPs are depolarizing, the CW cells tend to fire nearly synchronously (within 10-20 msec). Synchronous patterns can include brief (500 msec) bursts of synchronized firing, followed by a long pause in both cells before firing resumes. Either cell of the pair can initiate the synchronized firing, but subsequently either cell of the pair can lead the remainder of the burst. To investigate the effects of this synchrony on the pyramidal cells, we created a network model of an isofrequency sheet of the DCN. The model includes biophysically realistic pyramidal cell that receive spontaneous excitatory input from the auditory nerve and granule cell systems and cartwheel cells that only receive input from the granule cell system.. We found that pyramidal cells in this model can show synchronized firing due to shared excitatory inputs, and that the strength of this synchronization is affected by activity in the cartwheel cell network. These results suggest that the CW cells can modulate sensory coding in an isofrequency sheet of the DCN by regulating pyramidal cell synchronization, and also suggest that CW cells might participate in generating phantom sensory perceptions such as tinnitus.

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