Public Abstract

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Sound duration is an important acoustic parameter that contributes to the distinct spectral and temporal attributes of individual biological sounds and is therefore important for sound recognition in human speech, animal communication and bat echolocation. In the past, many studies have examined duration selectivity of auditory neurons in different animal species using single pulses as stimuli. These studies show that auditory neurons behave as band-, short-, long- and all-pass filters to sound duration. However, naturally occurring sound pulses often are in temporally patterned pulse trains rather than in temporal isolation and previous studies have shown that a neuron's response to a single pulse is often suppressed when the single pulse is positioned within a pulse train. Therefore, a neuron's duration selectivity to single pulses in temporal isolation may not predict well its response to real-world complex temporal sounds.

The main objective of this thesis is to examine the duration selectivity of neurons in the central nucleus of the midbrain inferior colliculus (IC) using bats as the mammalian model system under stimulation conditions of single pulses, temporally patterned pulse trains and pulse-echo (P-E) pairs. Because GABA is one of the major inhibitory transmitters in the IC, this thesis also studies the role of GABAergic inhibition in shaping the duration selectivity of IC neurons using iontophoretic application of GABA or bicuculline, which is an antagonist for $GABA_A$ receptors.

The data obtained from these studies show the following. (1) Neurons at upper IC have sharper duration selectivity than neurons in the deeper IC. (2) GABAergic inhibition contributes to sharpening of duration selectivity of IC neurons to sound pulses in rapid sequences. (3) Duration selectivity of IC neurons progressively improves with the pulse repetition rate (PRR) of pulse trains. (4) Bicuculline application decreases and GABA application increases echo duration selectivity of IC neurons. The effect of bicuculline application on duration selectivity is more pronounced at high than at low PRR while the opposite is true during GABA application. (5) Echo duration selectivity of IC neurons is sharper when determined with echo pulses of P-E pairs than with single echo pulses. Echo duration selectivity also sharpens with shortening of pulse duration and P-E gap.

These data suggest that duration selectivity of IC neurons systematically varies with $GABA_A$ receptor distribution gradient within the IC. During echolocation, the improvement of duration selectivity of IC neurons by GABAergic inhibition with PRR facilitates echo recognition throughout the course of hunting.