Inhibitory and modulatory inputs influence the input-output function of gerbil spherical bushy cells

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Low-frequency spherical bushy cells of the rostral anteroventral cochlear nucleus of gerbils are specialized for coding the fine-structure of the sound, forming the first stage of the pathway of sound-localization with interaural timing information. They receive powerful auditory nerve inputs via one or very few giant terminals, the so called Endbulbs of Held. These main auditory nerve inputs have been studied extensively, however fewer studies tried to address the function and roles of secondary, inhibitory or modulatory inputs to SBC. Most notably, AVCN bushy cells receive numerous glycinergic synapses that mediate stimulus-driven inhibition.

In the first part of the talk I will present results from an in-vivo study performed in anesthetized gerbils that show how the interaction of endbulb-inputs with stimulus driven inhibition shapes the response of low-frequency SBC. In these stimulus conditions the threshold of the SBC was altered, causing strongly increased failure rates and thus non-monotonic rate-level functions. Interestingly, spikes caused by the remaining EPSP were better phase-locked. Thus SBC traded output spike rate for increased temporal precision.

In the second part of the talk I will present results from an in-silico study where we looked at interactions of inhibition and excitation in SBC over a wide range of synaptic parameters. We explored the inhibitory properties necessary to cause non-monotonic rate-level functions, using auditory-nerve spiketimes recorded in vivo to drive the synaptic processes. The modeling results suggested that slow IPSC, summating to powerful but tonic inhibition, are needed to match the model output to the recorded data. In-vitro measurements of glycinergic IPSC performed in gerbil brain slices indeed demonstrated slow decay kinetics and strong summation.

In the final part of the talk I will report on our most recent recordings in gerbil brain slices of posthearing animals (P15-21) that showed that locally applied acetylcholine has three effects on SBC. First, ACh caused a transient depolarization which was followed by a long lasting change in resting membrane potential in the SBC. Third, an additional presynaptic effect is suggested by an increase in mEPSC frequency upon ACh application. Effects of these long-lasting cholinergic currents on SBC excitability and input-output function will also be explored in the SBC model.