A model of temporal response properties in primary auditory cortex

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Abstract

The temporal response properties of cells in primary auditory cortex differ markedly from those observed sub-cortically, in particular the ability to synchronise firing to amplitude modulations is restricted to modulations below 10-20 Hz (Schreiner et al 1997). In the thalamocortical transformation of incoming signals a great deal of the temporal fine structure is lost (Creutzfeldt et al 1980), and the effects of a masker on a probe tone can be detected up to 400 ms after masker offset (Brosch and Schreiner 1997). What gives rise to these phenomena and can they be explained by some common mechanism? Explanations in terms of intracortical inhibitory circuits have been proposed but inhibition does not provide an adequate account, at least in the case of forward masking which is unaffected by the application of a GABA antagonist. On the other hand, simple threshold neural models cannot replicate such behaviour without some form of inhibition. The purpose of this investigation was to explore to what extent synaptic depression at thalamocortical synapses could account for the temporal response properties observed in primary auditory cortex. A model of synaptic depression is described and its behaviour investigated in a number of experiments. The model is shown to successfully replicate many experimental observations. In addition, the model also provides a novel account of the effect of subthreshold stimuli.