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The effects of the activation of the inner-hair-cell basolateral K^+ channels on auditory nerve responses

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Abstract

The basolateral membrane of the mammalian inner hair cell (IHC) expresses large voltage and Ca^{2+} gated outward K^+ currents. To quantify how the voltage-dependent activation of the K^+ channels affects the functionality of the auditory nerve innervating the IHC, this study adopts a model of mechanical-to-neural transduction in which the basolateral K^+ conductances of the IHC can be made voltage-dependent or not. The model shows that the voltage-dependent activation of the K^+ channels (i) enhances the phase-locking properties of the auditory fiber (AF) responses; (ii) enables the auditory nerve to encode a large dynamic range of sound levels; (iii) enables the AF responses to synchronize precisely with the envelope of amplitude modulated stimuli; and (iv), is responsible for the steep offset responses of the AFs. These results suggest that the basolateral K^+ channels play a major role in determining the well-known response properties of the AFs and challenge the classical view that describes the IHC membrane as an electrical low-pass filter. In contrast to previous models of the IHC-AF complex, this study ascribes many of the

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