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Mechanisms of High Sensitivity and Active Amplification in Sensory Hair Cells MAHVAND KHAMESIAN, Saginaw Valley State University, ALEXANDER NEIMAN, Ohio University — Hair cells mediating the senses of hearing and balance rely on active mechanisms for amplification of mechanical signals. In amphibians, hair cells exhibit spontaneous self-sustained mechanical oscillations of their hair bundles. We study the response of the mechanical oscillations to perturbation of the cells membrane potential in a model for hair bundle of bullfrog saccular hair cells. Our results indicate that the fast adaptation is necessary to account for an increase of the amplitude of the hair bundle oscillation with the increase of the membrane potential, observed in voltage clamp experiments. In vivo, hair bundles of the bullfrog sacculus are coupled by an overlying otolithic membrane across a significant fraction of epithelium. We develop a model for coupled hair bundles in which non-identical hair cells are distributed on a regular grid and coupled mechanically via elastic springs connected to the hair bundles. Our simulations of coupled hair bundles identify two distinct regimes of collective spontaneous dynamics: oscillation quenching and synchronization. We show that variations of the membrane potential alter mechanical response significantly and thus may yield an effective mechanism of sensitivity enhancement and gain control.

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