Phenomenological modelling of electrically stimulated auditory nerve fibers: A review

Abstract:
Auditory nerve fibers (ANFs) play a crucial role in hearing by encoding and transporting the synaptic input from inner hair cells into afferent spiking information for higher stages of the auditory system. If the inner hair cells are degenerated, cochlear implants may restore hearing by directly stimulating the ANFs. The response of an ANF is affected by several characteristics of the electrical stimulus and of the ANF, and neurophysiological measurements are needed to know how the ANF responds to a particular stimulus. However, recording from individual nerve fibers in humans is not feasible and obtaining compound neural or psychophysical responses is often time-consuming. This motivates the design and use of models to estimate the ANF response to the electrical stimulation. Phenomenological models reproduce the ANF response based on a simplified description of ANF functionality and on a limited parameter space by not directly describing detailed biophysical mechanisms. Here, we give an overview of phenomenological models published to date and demonstrate how different modeling approaches can account for the diverse phenomena affecting the ANF response. To highlight the success achieved in designing such models, we also describe a number of applications of phenomenological models to predict percepts of cochlear implant listeners.