A framework is presented that measures the effectiveness of noise-band representations for modeling intra-cochlear stimulation and that also proposes improved acoustic representations. This framework is developed around comparisons made between neural encodings in the auditory nerve; these encodings encompass the effects of auditory scenarios like sensori-neural hearing loss and peripheral assist devices (e.g., the cochlear implant, which stimulates the auditory nerve directly). Neural activation in the auditory nerve is viewed as a pattern in both space (the distance along the cochlea) and time. This pattern is generated by an appropriate forward model (e.g., the Auditory Image Model of Patterson, et al.) that represents a specific acoustic pathway leading to the auditory nerve for a given scenario. Thus, a neural activation pattern (NAP) completely describes an auditory input and a specific auditory scenario. Beginning with an auditory input, NAPs are first generated by models for two different scenarios. Then the NAPs are transformed by a "perceptual mapping" and the perceptual difference is computed. The "perceptual mapping" is taken from a set of functions developed within this framework to map perceivable differences to measurable distances in the transformed NAP vector space.

In this work, NAPs are generated under the normal-hearing scenario from normal and noise-band auditory inputs and a model of the cochlear implant is developed to generate a cochlear implant-induced NAP for comparison. Several distinct "perceptual mapping" functions and a representative set of phoneme syllables are used in this study. Results across all functions and inputs demonstrate potential shortcomings in the noise-band representations of the cochlear implant for normal-hearing subjects. Further, the framework is used to develop an alternative acoustic representation that more adequately models the cochlear implant under a given "perceptual mapping."