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Bernoulli coding on the auditory nerve and its implications for central auditory processing

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The auditory periphery is well represented as a bank of band pass filter/inner hair cell (IHC) channels, with each IHC providing half wave rectification, amplitude compression, and conversion to firing probability on the auditory nerve (AN) fibers innervating that IHC. Frequency resolution varies dramatically with sound intensity, ranging from sharp tuning near threshold to very broad at high intensities. Cochlear filtering provides a satisfactory representation of broadband characteristics such as timbre but not the fine frequency resolution required for perceptual frequency discrimination. High resolution frequency analysis must, therefore, be provided by post-AN processes. We present a model of AN coding in which fine frequency analysis is carried out at central auditory stages. By this model the stochastic process on each AN fiber resulting from the IHC's firing probability is modeled by a Bernoulli process. As a result, the IHC output signal is transferred to the cochlear nucleus (CN) without further filtering, where it can be recovered by a simple summation over those AN fibers from the region of that IHC. We present a neurally plausible process for narrow band analysis at the CN using the regular pulses of chopper cells.