The '*why*' question of auditory peripheral processing.

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A great deal of work over many years has led to the characterization of a very large number response types in the early stages of auditory processing [3]. This work has provided some idea, at a cellular level, of the answer to the important question; *what do cells in the auditory periphery do?* The answer to the more general question; *what does auditory peripheral processing achieve?* is however less clear.

The evidence strongly suggests that a) the auditory system performs a spectral decomposition in to a number of frequency bands, b) there is enhancement of transients both onset and offset, and c) that many cells of a large number of different types have well defined characteristic frequencies [6, 2, 1, 7]. The results imply that there is a role for within-frequency-band, temporal-edge-sensitive preprocessing. This is consistent with results from psychophysics (e.g. [8, 9]) which examine the intelligibility of speech with limited numbers of bands and manipulated temporal envelopes. In addition another strand of evidence [4, 10] suggests that parallel frequency channels may be processed on varying, frequency dependant, time scales.

This of course does not represent the whole picture, but if it is at least a partial answer to the *what* question then it is germane to ask the *why* question. To investigate what the advantages of such processing might be, we implemented a simple model consisting of a cochlear filter bank followed by transient detection based on the skewness of energy distribution in overlapping frequency dependant time windows [11]. The output of this model was found to be broadly consistent with experimental first spike timings [5] as well as latencies and amplitudes of auditory brainstem responses [12].

Analysis of the resulting representations of sound showed that this pre-processing exhibited a) considerable rejection of stimuli (such as white noise, and other types of synthetic noise) with characteristics not found in natural stimuli, b) significant level independence, and c) a significant de-correlation of energy in both the spectral and temporal domain which can be described as a *whitening* of the stimulus. This whitening effect was most marked when processing natural sounds, or mixtures of natural sounds.

Clearly all three of these effects are related to the goal of efficient coding of naturalistic, behaviourally relevant stimuli. The ability of a system to transmit information about the signal is degraded if it is encoding information about the noise in the signal as well, therefore it is useful to use a method that reduces the noise response. A degree of level independence is desirable as it enables the full use of the dynamic range of the system in the context of stimuli that vary in intensity with time. Lastly, the whitening of the signal implies statistical independence of the outputs from the frequency channels thereby reducing redundancy while preserving information in the representation.

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