Psychophysical mechanisms underlying detection and discrimination of auditory spectrotemporal modulations

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Natural sounds such are speech contain lots of amplitude and frequency modulations. The auditory system is found to be remarkably sensitive to these modulations, and there is now physiological as well as psychophysical evidence for a dedicated machinery, composed of processing channels characterized as bandpass filters in the spectrotemporal modulation space. However, the mechanisms underlying the detection and the discrimination of such modulations in noisy signals remain largely unknown, albeit fundamental to our understanding of how the auditory system make use of these channels to extract information from natural sounds (a lot of studies showing that such mechanisms do govern speech in noise intelligibility in both normal and hearing-impaired listeners). Here, we used psychophysical reverse-correlation to probe these mechanisms over the two dimensions (i.e., scale, rate) of the spectrotemporal modulation space. In two experiments, we asked normal-hearing subjects (1) to detect a specific ripple " target " [1 cycl/oct , - 8 Hz] or (2) to discriminate between an upward ripple [1 cycl/oct , - 8 Hz] and its symmetric downward version [1 cycl/oct , + 8 Hz] over several days (∼ 10 one-hour sessions in each task). These target signals were embedded in ripple noise (i.e. noise made of the superposition of ripples of different scales and rates randomly changing in level trial-by-trial) and the overall level of this noise was adjusted to target appropriate performance levels (d' ∼ 1). This methodology allowed us to obtain a fine characterization of the perceptual filters engaged in both tasks. We found evidence for highly tuned processing that were dynamically retuned across sessions, i.e. through practice, allowing the listeners to extract targeted spectrotemporal modulations with improved efficiency. We will discuss these results as well as the perspectives they offer.