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Monday, December 9, 2013
2:00 PM
Computer Studies Building 426

Detection of Tones in Reproducible Noises: Prediction of Listeners' Performance in Diotic and Dichotic Conditions

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Detection of tones in reproducible noises, a set of pre-generated random noises, has been studied for decades. These studies help us to understand how people detect signals in noise in everyday life. However, it is not clear what cues or combination of cues are used by listeners in these tasks. Previous studies have shown that energy and temporal cues could predict a significant amount of the variance in listeners' detection performance in the diotic condition, in which identical noise-alone and tone-plus-noise stimuli were presented at both ears. For the dichotic condition, in which identical noise and out-of-phase tones were presented, interaural level and time difference cues, and combinations of these two cues partially explain listeners' performance.

In this thesis, an optimal cue-combination model was proposed to explain listeners' performance in the diotic condition. This model combined energy and temporal cues nonlinearly, based on the logarithmic likelihood-ratio test. Predictions from this model explained a substantial amount of the variance in listeners' performance from three different sets of reproducible noises.

For the dichotic condition, two different models were proposed: one based on a linear combination of interaural level and time difference cues that included the relation between these two cues, and the other using a binaural envelope cue (slope of the interaural envelope difference). For the wideband noise condition, both models explained significant amounts of the variance in listeners' performance. In particular, predictions from the binaural envelope cue were significantly better than predictions from any available model. For the narrowband noise condition, it is likely that different listeners used envelope information from different frequency channels to detect tones in noise.

Finally, given the robustness of envelope cues in diotic and dichotic conditions, we investigated the reliability of physiological envelope cues in predicting listeners' performance. Responses from model inferior colliculus cells were analyzed in terms of average rate and response fluctuations. For diotic and dichotic conditions, predictions from the physiological envelope cues can explain a similar or larger amount of the variance in listeners' performance than stimulus-based envelope cues. Similar to results from the stimulus-based envelope cue in the dichotic narrowband condition, it was shown from physiological models that different listeners might use different frequency channels to detect tones in noise.