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Modeling the mechanism and neural substrate for aural categorization of sonar echoes

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Previously, human perception of impulsive active-sonar echoes was investigated through paired- comparison ratings and multidimensional scaling (MDS). In the resulting MDS configuration, stimuli formed clusters representing aurally distinct categories. An interpretation is presented which suggests that dissimilarity judgments reflect separate processes for within- and between- category comparisons. The process of categorization is not based on decision boundaries in a low- dimensional space of ordinal-scale perceptual features, while within-category judgments do reflect such features. A class-specific paradigm seems appropriate as a model of human categorization: signals are compared to category archetypes, each described by a set of features that may be unique to that category. Regardless of the specific mechanism, listeners must carry out categorization on a particular signal representation: the neural substrate of the process. The suitability of various temporal, spectral, and time-frequency signal representations are investigated through observing categories formed by hierarchical clustering. A signal-processing model of the spectrotemporal receptive fields of the auditory cortex and the processing of the auditory periphery [T. Chi et al., J. Acoust. Soc. Am. 118, 887-906 (2005)] is shown to yield good agreement with human categorization. Techniques for feature selection from this representation are discussed. [Work supported by ONR.]