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Neural cross-correlation metrics to quantify envelope and fine-structure coding in auditory-nerve responses

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Fundamental questions about the relative perceptual importance of envelope and fine structure are often addressed using specialized acoustic stimuli, such as temporal-fine-structure speech or auditory chimaeras. Interpretation of these perceptual studies assumes envelope and fine structure can be isolated at the output of the cochlea. Narrowband cochlear filtering constrains the ability to isolate fine structure from envelope; however, envelope recovery from fine structure has been difficult to evaluate physiologically. Separate neural cross-correlation coefficients (CCCs) for envelope and fine-structure were developed based on shuffled auto- and cross-correlograms. Neural CCCs have a wide dynamic range for both within-fiber, cross-stimulus and cross-fiber, within-stimulus correlations based on both model and recorded spike-train data from auditory-nerve fibers. Results provide physiological evidence consistent with perceptual findings that envelope recovery is reduced as the number of analysis bands increases, but is not completely eliminated for 8- and 16-band conditions. Neural CCCs were also used to evaluate across-fiber temporal coding, which has been implicated in the difficulties that hearing-impaired listeners have in understanding speech in complex acoustic backgrounds. Results demonstrate the potential of these neural CCC metrics to quantitatively evaluate a wide range of perceptually significant temporal coding issues relevant to normal and impaired hearing. Supported by NIH-NIDCD.