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Higher sensitivity of human auditory nerve fibers to positive electrical currents

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Most contemporary cochlear implants (CIs) stimulate the auditory nerve with trains of amplitude-modulated, symmetric biphasic pulses. Although both polarities of a pulse can depolarize the nerve fibers and generate action potentials, it remains unknown which of the two (positive or negative) phases has the stronger effect. Animal experiments have shown that cathodic (negative) current flows are more effective than anodic (positive) ones in eliciting neural responses, and this finding has motivated the development of novel speech-processing algorithms. Here we show electrophysiologically and psychophysically that the human auditory system exhibits the opposite pattern, being more sensitive to anodic stimulation. We measured electrically evoked compound action potentials in CI listeners for phase-separated pulses, allowing us to tease out the responses to each of the two opposite-polarity phases. At an equal stimulus level, the anodic phase yielded the larger response. This finding was corroborated by a measure of psychophysical masking patterns and may relate to a particular orientation of the nerve fibers relative to the electrode or to a substantial degeneration/demyelination of the peripheral processes. Potential applications to improve CI speech-processing strategies are discussed.