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Title: Investigating artificial neural networks optimized for ecological auditory tasks as a normative model of pitch perception

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Abstract: Pitch perception is an important aspect of human hearing thought to underlie complex auditory tasks, such as separating concurrent sounds, recognizing voices, and following melodies. While pitch is traditionally considered the perceptual correlate of fundamental frequency, naturally-behaving listeners are rarely asked to explicitly report the pitch of a sound. Thus, in order to investigate how human pitch perception may have been shaped by the demands of ecologically-important tasks, we trained deep artificial neural networks to perform different combinations of three tasks that are ecologically important to humans (speech, voice, and environmental sound recognition) using simulated cochlear representations of speech excerpts superimposed on recorded auditory scenes. We then interrogated networks for learned representations of pitch by training linear classifiers on the networks' internal activations to perform psychophysical experiments, such as two-tone pitch discrimination. These classifiers enabled us to measure thresholds from networks trained to perform arbitrary tasks. We compared the effect of stimulus manipulations previously used in psychoacoustic experiments (e.g. inharmonic vs. harmonic tones, low vs. high-numbered harmonics, sine vs. random phase) between network and human listeners. These comparisons can shed light onto how pitch perception facilitates everyday auditory tasks. Comparisons between networks trained on different tasks also provide hypotheses for potentially distinct pitch mechanisms specialized for different aspects of audition.