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The detection of inharmonicity in complex tones by zebra finches (Taeniopygia guttata) and budgerigars (Melopsittacus undulatus)

**B. Lohr, R.J. Dooling (Department of Psychology, University of Maryland, College Park, MD)*

We compared the discrimination abilities of humans with two species of birds, the zebra finch (Taeniopygia guttata) and the budgerigar (Melopsittacus undulatus) for detection of inharmonicity in complex tones. We used a synthetic harmonic stimulus designed to simulate parameters of the female zebra finch "contact call." Contact calls are the most ubiquitous vocalization that zebra finches produce and they contain energy at multiple harmonically-related spectral peaks. In females, these calls exhibit relatively little frequency modulation. Budgerigars, in contrast, produce predominantly pure-tonal vocalizations with a high degree of modulation in frequency.
An operant conditioning procedure was used to test the birds in these experiments. Birds were trained to discriminate between a repeating background stimulus and target stimuli that varied incrementally with respect to the frequency of single spectral components. Synthetic harmonic stimuli were stored digitally and played back to birds at appropriate intervals. The standard background stimulus consisted of the first 16 harmonics of a 570 Hz tone with a duration of 280 ms. The frequency of the 2nd, 4th, 5th, or 7th harmonic was adjusted upwards in target stimuli, depending on the experiment. Several fundamental frequencies and different durations were also tested. Separate tests were performed with tones added in phase, and with the starting phase of each harmonic randomized. The ability of a listener to detect a mistuned harmonic in a complex harmonic stimulus has been well-studied in humans. Results for the detection of inharmonicity showed that the discrimination ability of birds was significantly better than humans across several different harmonics and fundamental frequencies. These results provide one of the largest species differences to date in the acoustic perceptual capabilities of birds and humans. Additionally, zebra finches performed better than budgerigars at harmonics above and below 2860 Hz. These results suggest not only that birds may be better than humans in detecting inharmonicity, but that this enhanced ability may be related to the natural vocalizations that each species produces.

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