Dynamic Programming Matching Clusters Contact Calls into a Pattern Similar to that of Budgerigars' Behavioral Discrimination

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Budgerigars (*Melopsittacus undulatus*) have several distinct calls (Brockway, *Behaviour* 22:193, 1964), one of which is a contact call. They can discriminate contact calls from different individual cagemates (Brown *et al.*, *J.Comp.Psychol.* 102:236, 1987), although their calls are very similar. Measurement of physical properties of the calls with the aid of spectrograms has not been very successful in categorizing contact calls according to callers. We applied a dynamic programming (DP) matching method, as is used in automatic speech recognition, to discrimination and categorization of cagemate contact calls. The results were compared favorably to those of the behavioral tests with budgerigars.

Time series power spectra of contact calls were calculated and the frequencies of the three most intense peaks at each time slice made a feature vector. The arrays of those vectors were used for start-and-terminal free DP-matching. We compared several strategies of calculating a distance between vectors (intervector distance). The sum of intervector distances was calculated for every pair of calls (call distance). Calls were classified by cluster analysis of the resulting call distances. Response latencies of budgerigars obtained by a same-different task (Brown *et al.*, *ibid.*) were the measures of psychophysical similarity of calls subjected to cluster analysis.

DP-matching.results show that the contact calls of birds from different groups are clustered separately, and that more than one types of contact calls are shared by the members within each group. Twenty contact calls of one type, five each from four cagemates, were also analyzed. Visual inspection of spectrograms and various physical parameters of the calls did not cluster them according to the callers, as did the behavioral test results. Among several strategies to calculate intervector distances, the one that used the frequencies of the two most intense peaks as parameters resulted in the final call classification very similar to the one given by the behavioral tests.

Our results show the efficacy of the DP-matching method in classifying bird calls and may suggest the possibility of similar processing of conspecific calls in operation in the budgerigar brain.