BRIEF NOTE

PRELIMINARY STUDIES OF THE VOCAL RESPONSES OF TERRITORIAL CARDINALS (*CARDINALIS CARDINALIS*) TO SONGS OF A STRANGE MALE[1]

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The functions of bird song are considered to be quite variable, differing between species and at different phases of the breeding season. In many species, the song may not only function in male-female interactions, but may also be used as a source of recognition between neighboring males, thus reducing the incidence of direct confrontations (Weeden and Falls 1959; Falls 1969; Brooks and Falls 1975a). The pattern of differential responses to neighbors and non-neighbors has led to several investigations regarding the individual-specific and species-specific recognition aspects of songs. Too few species have been studied to make generalizations about the patterns of individual recognition, but pitch characteristics of songs may be an important parameter (Brooks and Falls 1975b). The species-specific characteristics of songs have been studied in a wider variety of species and have been found to vary from species to species (Dilger 1956; Falls 1963; Emlen 1972; Shiovitz 1975). Stereotyped aspects of song appear to be used for species recognition (Marler 1960; Wildenthal 1965; Emlen 1972).

An important but seemingly neglected area of research centers around how birds are able to communicate levels of motivation in male-male interactions. This note reports on preliminary experiments aimed at delineating changes in territorial cardinals' vocal patterns upon exposure to strange cardinal songs on the peripheries of their territories.

The study was conducted from 3 to 17 April, 1976 at locations in and around Oxford, Ohio. A one minute recording was made of the songs of a territorial male cardinal, and was used as the playback song in all experiments. The recording was eventually played to 7 territorial cardinals, which comprised the experimental population, located 2 km from the source of the recorded song.

The following procedures were used during all 7 experiments. The first minute of the experimental male's song was recorded by the senior author with a Uher 4000 Report IC tape-recorder and an 18″ Dan Gibson parabolic reflector. After the first minute, the junior author, concealed on the periphery of the territory, played the playback song on a Norelco portable tape-recorder for 1 min. During the 1 min of the playback, and for 1 additional minute thereafter, the senior author continued to tape the experimental cardinal's responses. Thus,

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3 distinct periods of the experimental male's vocal behavior (pre-playback, during-playback, and post-playback) were taped. The distance between the resident male and the speaker varied from 5–21 m. The senior author was positioned approximately 7 m from the speaker. All recordings were analyzed with a Kay Sonagraph (Model 7029A– 5–1600). An analysis of variance (Sokal and Rohlf 1969) was used to determine whether or not the songs of the experimental males changed significantly in the 3 phases of the experiment. Duncan's new multiple range test (Duncan 1955) was used to test the differences between phases.

We first examined differences in the gross-song parameters (song duration, number per 30 seconds, and the interval between songs) during the 3 periods. The duration of songs in the playback period were significantly shorter (2.08 sec) than those in the post- or pre-playback periods (3.95 and 3.33 sec; $F=9.37$, $P<0.05$). However, the number of songs per 30 sec and the interval between songs were not significantly related to the different playback periods (table 1). None of the experimental birds switched song types during or after the playback.

We examined the intra-song parameters (total number of notes, number of introductory notes, number of main notes, interval between notes, length of main notes, and frequency) in the 3 phases (table 1). The total number of notes were significantly fewer in the songs sung during the playback period (6.8) than in the other 2 periods ($F=3.65$, $P<0.05$). The change in the number of introductory notes was not significant during the 3 periods ($F=0.71$, $P<0.05$). The number of main notes, however, was significantly lower during the post-playback period (2.0) than in the other 2 periods ($F=4.41$, $P<0.05$). Thus, the number of main notes appears to be the primary factor causing the change in the total number of notes and song duration. The spacing, length, and frequency of notes did not significantly change during the 3 periods.

The changes in the experimental male's vocal behavior during the 3 playback periods may be the result of conflicting motivational states and motor patterns. During the playback period, the reduction in song duration and number of notes may be due to the experimental bird perceiving and interpreting the intruder's song to determine if it poses a threat (a strange song) or not (a neighbor's song). Movement toward the location of the intruder's song may also affect the song parameters. During the post-playback period, the experimental male has presumably recognized the intruder as a threat, resulting in longer songs with a greater number of main notes. These alterations may serve as an informational source for the intruding bird, informing as to whether the territory is being defended and how vigorously the defender plans on protecting it.

Lemon (1968) performed studies to

TABLE 1

Means of the Song Changes During the Three Experimental Periods.

Parameter	Pre-playback Songs	During-playback Songs	Post-playback Songs	F
Gross-Song Characteristics				
Duration (Sec.)	3.33±0.31**	2.08±0.43	3.95 0.30	9.38*
No. songs/30 sec.	4.00±0.26	3.80±0.86	4.50±0.43	0.48
Sec. between songs	5.93±0.75	5.12±0.74	5.45±0.83	0.26
Intra-Song Characteristics				
No. notes	13.83±2.21	6.82±1.77	16.33±3.10	3.65*
No. intro. notes	2.60±0.40	3.50±0.65	3.80±0.97	0.71
No. main notes	11.60±2.03	2.00±0.58	14.00±3.28	4.41*
Sec. between notes	0.06±0.02	0.04±0.01	0.07±0.02	0.81
Sec. duration notes	0.17±0.05	0.17±0.05	0.16±0.04	0.52

*Significant at $P<0.05$.
**Mean±Standard error of the mean.

determine the responses of territorial cardinals to taped songs on the periphery of their territories. His studies, however, were directed more toward song matching and organization, and measured fewer and different parameters. The length of cardinal singing bouts was found, by Lemon, to decline after the tape was played, but the data on the number of songs per bout were equivocal. The rate of singing increased (number per minute) and song matching to that type on the tape was evident. We found the number of songs per minute to increase after the playback, but not significantly. We did not record any incidence of song matching but this may be due to the short duration of our recordings.

Our preliminary findings suggest that aggression and ownership may be expressed by the number of main notes and consequently song duration and not by how frequently the individual sings. This finding was unexpected, because Lemon (1967) reported that taped cardinal vocalizations from the same population caused a greater response (in terms of number per minute) by a territorial male than did songs from a population 7 miles away.

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LITERATURE CITED

Brooks, R. J. and J. B. Falls 1975a Individual recognition by song in white-throated sparrows. I. Discrimination of songs of neighbors and strangers. Canadian J. Zool. 53: 879–888.

——— and ——— 1975b Individual recognition by song in white-throated sparrows. III. Song features used in individual recognition. Canadian J. Zool. 53: 1749–1761.

Dilger, W. C. 1956 Hostile behavior and reproductive isolating mechanisms in the avian genera Catharus and Hylocichla. Auk 73: 313–353.

Duncan, D. B. 1955 Multiple range and multiple F tests. Biometrica 11: 1–42.

Emlen, S. T. 1972 An experimental analysis of the parameters of bird song eliciting species recognition. Behaviour 41: 130–171.

Falls, J. B. 1963 Properties of bird song eliciting responses from territorial males. Proc. 13th Int. Ornithol. Congr., Ithaca, NY. p. 259–271.

——— 1969 Functions of territorial song in the white-throated sparrow. p. 207–232. *In:* R. A. Hinde (ed.). Bird Vocalizations. Cambridge Univ. Press, London.

Lemon, R. E. 1967 The response of cardinals to songs of different dialects. Anim. Behav. 15: 538–545.

——— 1968 The relationship between organization and function of songs in cardinals. Behaviour 32: 158–178.

Marler, P. 1960 Bird songs and mate selection. p. 348–367. *In:* W. E. Lanyon and W. N. Tavolga (eds.). Animal Sounds and Communication. Amer. Inst. Biol. Sci., Washington, D.C.

Shiovitz, K. A. 1975 The process of species-specific song recognition by the indigo bunting and its relationship to the organization of avian acoustical behavior. Behaviour 55: 128–179.

Sokal, R. R. and F. J. Rohlf 1969 Biometry. W. H. Freeman and Co., San Francisco.

Weeden, J. S. and J. B. Falls 1959 Differential responses of male ovenbirds to recorded songs of neighboring and more distant individuals. Auk 76: 343–351.

Wildenthal, J. 1965 Structures in primary song of the Mockingbird (*Mimus polyglottos*). Auk 82: 161–189.