AN AUDIBILITY CURVE FOR TWO RING-NECKED PHEASANTS

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It was observed during World War I that ring-necked pheasants, *Phasianus colchicus* Linnaeus, seemed to be greatly disturbed by sounds which were inaudible to human ears (Leedy and Hicks, 1945). This observation suggested that perhaps an ultrasonic sound could be used to flush these birds ahead of the mowing machine. During 1953 an experiment was conducted in the Ornithological Laboratory at The Ohio State University to determine whether or not the ring-necked pheasant actually can hear ultrasonic sounds. Earlier attempts to ascertain the auditory thresholds of the ring-necked pheasant had been made by Trainer (1946) and Dowling (1952). These investigators attempted to condition pheasants to move from one end of their cages to the other end in response to the sounding of a tone followed by an electrical shock treatment. Both workers were unable to condition their subjects to give the desired response. Dowling, using pheasant chicks, was reasonably sure, however, that his birds were responding to signals up to 12,000 cycles per second.

EQUIPMENT AND TECHNIQUES

The birds used in this experiment were confined in a reasonably sound proof chamber when the hearing tests were being made. This chamber was constructed by inclosing a refrigerator shell in a large box so that the refrigerator shell was surrounded with a six-inch layer of sawdust. The sides and ceiling of the chamber were covered with ten or more sheets of burlap, and the floor was covered with a layer of damp sawdust. A wire grill was placed on the floor of the chamber. This grill was connected to the negative pole of a B Battery outside the chamber. A second wire, attached to the bird's leg above the heel joint, was touched against the positive pole of the B battery when it was desired to administer shock. The various wires passed through a small pipe in the wall of the chamber. An eight-inch Permoflux high fidelity speaker was mounted in the center of the ceiling of the chamber. The tones were generated with a Grason-Stadler audio-oscillator. The intensity at which the tones were presented was measured with a Hermon Hosmer Scott sound level meter, the microphone of which was placed near the usual position of the bird's head. The wave forms of the tones at the determined thresholds were examined with a Triplet oscilloscope.

The birds were in complete darkness when confined in the sound chamber, and they seldom moved in the absence of controlled stimuli. Observation of this fact suggested that perhaps the birds could be conditioned to give a simple movement in response to the sounding of an auditory signal. Through a conditioning period, a clearly audible tone was sounded and the birds were shocked if they did not otherwise give a reasonably vigorous jump within ten seconds after the tone was started. The insulated shock wire attached to the bird's leg was held in the operator's hand, and this was used to communicate information of the bird's movements to the outside of the sound chamber. The hand holding the wire was held firmly against the side of the chamber, and it would seem that the possibility of a secondary cue associated with the starting of the tone was thoroughly eliminated.

In order to avoid conditioning the birds to a given sound, the frequency and intensity of the tone was occasionally changed through the training period. The training program was continued until the birds were responding without shock about half of the times the tone was sounded. This point was reached by the

THE OHIO JOURNAL OF SCIENCE 55(2): 122, March, 1955.

two hen pheasants after 420 and 580 training treatments, respectively. After the 50 percent level of proficiency had been attained, test treatments were initiated. A continuation of the training treatments was made necessary by the fact that there was considerable variation in proficiency shown at different times. The test treatment consisted in the sounding of a weaker tone than that given in the training treatment. The presence or absence of responses to the test treatments was noted, but the bird was not shocked in the event of a failure to respond.

Twenty-five training treatments were given along with 25 test treatments at each oscillator setting. The test and training treatments were presented in a sequence specified by the Gellerman randomized series. The number of responses in the 25 test treatments was compared with the number of responses in the 25 training treatments. The chi-square test for independence in a two-way classification was used to ascertain the extent of similarity in the two treatments. Similarity was based on the 5 percent level of significance. As the interval of time during treatments was approximately equal in both treatments, false responses, or responses given independently of the stimuli, are considered equally probable in the test and training treatments. Tests were made at given tone frequencies with only intensities changed in two decibel steps until a single change of intensity was followed by a noticeable difference in the number of responses in the test and training treatments.

RESULTS

An attempt was first made to determine the upper and lower auditory thresholds of the ring-necked pheasant in regard to tone frequencies. Tests were then made at the various frequencies for which the hearing of college freshmen is tested by the Department of Speech and Hearing at The Ohio State University. This is at 125, 250, 500, 1,000, 2,000, 4,000, and 8,000 cycles per second. In addition, intensity thresholds were established at 9,000, 9,500, and 10,000 cycles per second. Intensity thresholds were established for two birds at several of the same tone frequencies, and thresholds were the same in each case. After the intensity thresholds were established at several different frequencies, intermediate points could usually be predicted with a reasonable degree of accuracy. Unfortunately, one well conditioned bird was accidentally killed before thresholds had been determined at all of the frequencies proposed.

It is unfortunate that additional tests were not conducted at 125 cycles per second. While a low value of chi-square was obtained in one series of tests, a very low proficiency is shown by the fact that only two responses were given to 25 clearly audible sound stimuli (table 1). The validity of the test is considered questionable if the expected values do not exceed five. It seems best to disregard the results obtained at 125 cycles per second, as they are supported by only these two responses. A somewhat similar situation occurred at 8 decibels and 500 cycles per second, but in this case significant values of chi-square were obtained in five series of 25 tests at higher tone intensities. This low value of chi-square is neglected because it is based on only one response in 25 test treatments. This single response is considered a false response. A significant value for chi-square was also obtained in one series of treatments at 18 decibels and 500 cycles per second, but the threshold at 16 decibels is supported by two series of test treatments. In one series of tests, a significant value of chi-square was obtained at 10,000 cycles per second and 12 decibels intensity, while another series of tests at this point gave a non-significant value of chi-square. The test with the significant value was the first of the 42 series of tests conducted, and it was made before the technique was well-formed. It may thus be ignored.

Pure tones could not be generated with the available equipment at frequencies below 120 cycles per second, and it was not possible to determine the lower auditory threshold of ring-necked pheasants. As determined by an oscilloscope, there was no visible distortion in the wave forms of all the tones where the data were accepted. Only one response was given in 75 test treatments at 11,000 cycles per second and at the maximum intensity generated by the oscillator. This single response must be regarded as a false response. The upper auditory threshold

TABLE 1

Responses of Two Ring-necked Pheasants in 25 Test Treatments Compared with 25 Training Treatments at Various Oscillator Settings

Band No.	Frequency in cps	Db above background	Responses in training treatments	Responses in test treatments	Chi-square values*
2150	125	6	10	3	7.02
2150	125	8	2	2	0.0
2150	250	9	12	4	5.88
2150	250	11	9	8	0.09
2150	500	4	13	0	17.57
2140	500	4	10	1	9.44
2150	500	6	15	1	18.01
2150	500	6	15	0	21.43
2140	500	8	5	1	3.03
2150	500	8	12	2	9.92
2150	500	10	15	1	18.01
2150	500	12	12	0	15.79
2150	500	14	11	0	14.10
2150	500	14	9	1	8.00
2150	500	16	10	5	2.38
2140	500	16	9	6	0.86
2140	500	18	13	6	4.16
2150	500	20	10	9	0.08
2150	500	22	10	10	0.0
2140	1,000	12	9	0	10.98
2140	1,000	14	5	4	0.14
2150	2,000	8	6	1	4.15
2150	2,000	10	7	5	0.44
2150	4,000	5	4	0	4.35
2150	4,000	7	7	8	0.10
2150	8,000	7	9	2	5.71
2150	8,000	9	4	8	1.75
2150	9,000	8	11	1	10.96
2150	9,000	10	9	6	0.86
2140	9,500	5	11	2	8.42
2140	9,500	7	10	5	2.38
2140	10,000	6	7	0	8.14
2140	10,000	8	7	5	0.44
2140	10,000	12	9	4	2.60
2150	10,000	12	13	0	17.57
2140	10,000	14	3	3	0.0
2150	10,000	14	6	3	1.22
2140	10,500	17	8	1	6.64
2140	10,500	19	10	9	0.08
2140	11,000	19	6	0	6.82
2140	11,000	21	4	0	4.35
2150	11,000	23	12	1	12.58

*Chi-square values exceeding 3.84 significant at 5 percent level.
Chi-square values exceeding 6.63 significant at one percent level.

was determined to be 10,500 cycles per second at an intensity of 19 decibels above the average background noise. An audibility curve for the two ring-necked pheasants is presented in figure 1. Thresholds were established at each of the points indicated by small circles. While Dowling's (1952) birds gave responses at frequencies up to 12,000 cycles per second, it should be noted that he used chicks instead of adult birds as were used in this study. The results of the two studies, therefore, are not directly comparable.

SUMMARY

A shock avoidance technique was used to test the auditory acuity of two ring-necked pheasants. An audibility curve is presented for these birds. It was not possible, with the available equipment, to generate harmonic-free tones below 120 cycles per second, and the lower auditory threshold could not be determined. The upper auditory threshold was established at 10,500 cycles per second at an intensity of 19 decibels above the average background noise.

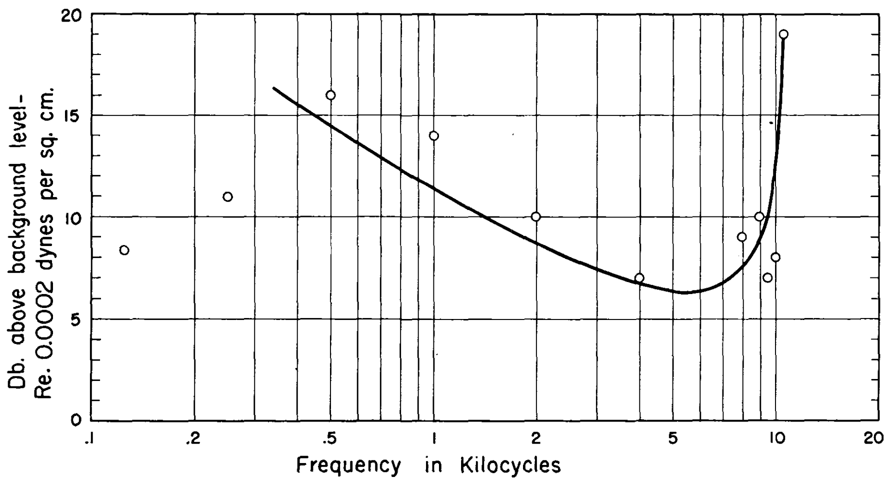

FIGURE 1. Audibility Curve for Two Ring-necked Pheasants (The curve has been fitted visually through empirical points).

ACKNOWLEDGMENTS

This paper is a contribution of the Ohio Cooperative Wildlife Research Unit: Ohio Division of Wildlife, Wildlife Management Institute, U. S. Fish and Wildlife Service, and The Ohio State University cooperating. The author is grateful for the constant guidance and encouragement throughout the course of this study provided by Eugene H. Dustman, Leader of the Ohio Cooperative Wildlife Research Unit. Specialized assistance was given by the following faculty members of The Ohio State University: Loren S. Putnam and Donald J. Borror, Department of Zoology and Entomology; Donald R. Meyer, Philburn Ratoosh, and Raymond C. Miles, Department of Psychology; and John J. Dreher, Department of Speech and Hearing. The statistical analysis was conducted under the direction of D. R. Whitney, Statistics Laboratory, The Ohio State University.

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