THE AUDITORY RANGE OF A HAIRY WOODPECKER

By WARREN K. RAMP

An experiment was conducted to determine the auditory range of a Hairy Woodpecker (*Dendrocopos villosus*) through means of a conditioned response. The bird used had been taught to respond to sounds emitted from a pure tone audiometer by flying to an artificial feeding hole in a spruce log. This response then served to indicate whether or not the bird was hearing a given frequency.

A survey of the literature shows that no determination of the hearing range of the Hairy Woodpecker has been made previously. Similar studies utilizing conditioned response have been made on other birds. Brand and Kellogg (Wilson Bull., 51, 1939:38–41) have reported the range in the English Sparrow (*Passer domesticus*) as 675–11,500 cycles per second (c.p.s.) and in the Domestic Pigeon (*Columba livia*) as 200–7500 c.p.s. The upper limit of hearing of the Starling (*Sturnus vulgaris*) has been shown to be 16,000 c.p.s. (Frings and Cook, Condor, 66, 1964:56–60).

These and other studies have failed to indicate an accurate measurement of the sound pressure level used. It is felt that, unless the sound level is measured in air at a constant distance from the sound source, the validity of the results is questionable. In terms of amplitude, a speaker system has a frequency range through which it responds best. Hence, even if the output to the speakers is calibrated, a true evaluation of sound levels received by the bird cannot be obtained unless a sound level meter is used.

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METHOD

The woodpecker used was a ten-month-old male raised from a nestling. Using pure tones as stimuli and meal worms as reinforcement, a Pavlovian response was conditioned. This response consisted of a flight to a specially prepared log with a feeding hole through which the meal worms were presented to the bird.

Relatively few trials were necessary for conditioning. Other studies have implied that considerably more trials were necessary to condition, using electric shock as reinforcement for sound stimuli. It is possible that the feeding reinforcement used on the woodpecker, being a desirable reward and satisfying a physiological need, might have led to faster learning.

The testing was run at the bird's feeding time, approximately 10:00 a.m. His diet consisted of meal worms and a mixture of Pablum and raw liver chips. The experiment was set up in a soundproof chamber, Industrial Acoustics Company, model 403. Even this chamber was not entirely free from outside noises.

The pure tone audiometer used as the stimulator consisted of the following: a beat frequency oscillator, Brüel and Kjaer, type 1014; a speech audiometer, Grason-Stradler, model 162; and a speaker system, Grason-Stradler, model 162-4. The oscillator was equipped with a remote control switch that could be obscured from the bird's view and gave no "click" when opened or closed. Stimulation was presented only when this switch was closed. The output of the oscillator was fed to the speech audiometer which was used as a combination amplifier-attenuator. This signal was then fed to the speakers. Both the amplitude and the frequency of the stimuli could be controlled from the oscillator.

TABLE 1

UPPER AND LOWER LIMITS OF HEARING TAKEN AT THREE SOUND PRESSURE LEVELS

Testing date	Sound pressure level (decibels)	Auditory range (cycles/second) Lower limit	Upper limit
April 6, 1964	90 ±3	38	—
April 8, 1964	90 ±3	34	—
April 9, 1964	90 ±3	—	18,000
April 10, 1964	90 ±3	—	18,400
April 14, 1964	70 ±3	40	—
April 15, 1964	70 ±3	—	17,400
April 16, 1964	70 ±3	41	—
April 17, 1964	70 ±3	—	17,500
April 18, 1964	50 ±5	—	17,000
April 20, 1964	50 ±5	57	—
April 21, 1964	50 ±5	55	—
April 22, 1964	50 ±5	—	16,800

The cage and the feeding hole mechanism were identical to those used for the conditioning, but the cage was smaller for portability (2 feet cubed as opposed to 3 feet cubed). During the experiment, the cage was kept a constant distance from the speakers by placing one side of the cage flush with the front of the speaker cabinet.

Sound pressure levels were measured by a Brüel and Kjaer sound level meter, type 2203, equipped with an octave filter set, type 1613. The distance of this instrument from the speakers was kept at 2 feet, and the instrument was placed to give an accurate approximation of the sound pressure level inside the cage.

The testing procedures were run from April 6, 1964, to April 23, 1964. The hearing range was determined for three sound pressure levels—90 decibels (db.), 70 db. and 50 db. Only one end of a range was tested per day.

If four out of five definite responses were obtained at one frequency, it was assumed that the bird was hearing that frequency. Some responses were obtained above the upper limits and below the lower limits, but it was not possible to make any conclusions as to whether or not the bird was hearing these frequencies. These responses may have been flights to the feeding hole that were independent of the sound stimuli.

For each sound pressure level, two tests were made at the upper end of the range and two were made at the lower end. Testing could not be accurately conducted below 50 db. because outside sounds and noises made by movements of the bird interfered with the sound pressure level readings. These noises also made it necessary to include a tolerance with all the readings.

RESULTS

The data obtained at the three levels are shown in table 1. It can be seen that as the sound pressure decreased, there was a corresponding shortening of the auditory range with the upper limit decreasing and the lower limit increasing in c.p.s. (fig. 1). Only the maximal and minimal frequencies are plotted for each sound level.

The direct relationship between hearing range and sound pressure level served as verification of the data procured. If there had been an increase in range with decreased sound pressure, the testing procedure would have been suspect.

The greater changes in frequencies at the upper ends of the range as compared

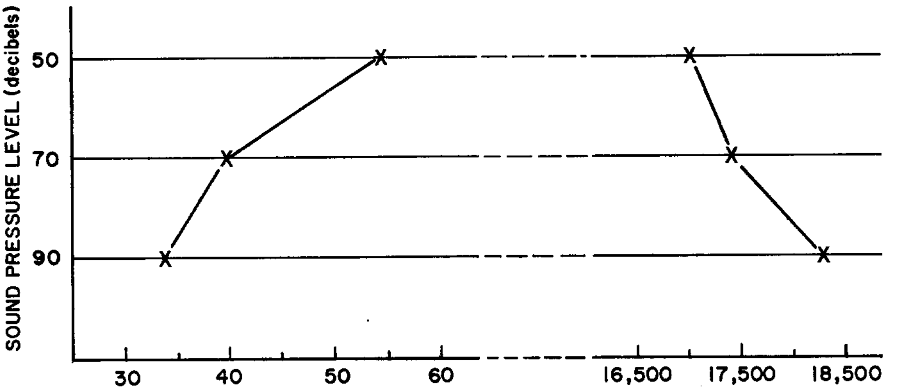

Fig. 1. Maximal and minimal frequencies obtained at each of the three sound pressure levels.

to the lower ends were expected since equal changes in pitch at high and low frequencies do not imply equal changes in frequency. This is so because an octave is produced by doubling any frequency.

As the extremes of the ranges were approached, the bird exhibited a noticeable increase in attentiveness before flying to the feeding hole. It was assumed that the tones were becoming more difficult to hear at these extremes. A similar response has been reported in Starlings by Brand and Kellogg (*op. cit.*:39).

Schwartzkopff (Auk, 72, 1955:340–347) has reported that after conditioning most birds hear a minimum of about 50 c.p.s. The upper limit is usually reached around 20,000 c.p.s. It should be noted that the hearing of the Hairy Woodpecker seemed to correspond to this general range. It seems likely that the Hairy Woodpecker not only hears its own vocalizations but also hears sounds of unknown frequencies produced by many of the insects that it seeks as food. The woodpecker's ability to locate these insects may be augmented by being able to hear their stridulations and chewing noises. Future experimentation concerning these speculations could include measuring the frequencies and sound pressure levels of the insect sounds and testing the bird's response to these measurements.

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