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Reprinted from THE JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA, Vol. 43, No. 1, 162–163, January 1968


# Acquisition of Successive Auditory Discrimination in Monkeys

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Six monkeys, conditioned with positive reinforcement techniques on a successive auditory discrimination, required about 1100 trials for acquisition (range: 950–1200 trials). The discriminative stimuli were a tone and a noise of equal intensity and duration. Retention was measured after a 30-day layoff. The procedure described in this letter is unique in auditory conditioning methodology in that an "OBSERVING" response is required of the animal in order for him to gain access to the stimuli.

THIS LETTER DESCRIBES A METHOD BY WHICH MONKEYS MAY BE rapidly conditioned by positive reinforcement techniques, on a successive auditory discrimination problem; in this paradigm, a different response is reinforced in the presence of each of two different auditory stimuli ("GO LEFT/GO RIGHT"). Such discrimination by monkeys has previously been found to be difficult and lengthy when compared to the rate of response acquisition on visual discrimination tasks, and also on auditory discriminations in which one sound is the signal to respond, and another sound is the signal to withhold response ("GO/NO GO").

Our training procedure was developed principally because rapid conditioning would be of great practical value when animals' performance must be evaluated before and after surgery (Dewson, 1966), or other procedures that are time consuming and often require the use of large numbers of animals. Another consideration that led to the development of the present conditioning technique was that we wished to utilize positive reinforcing stimuli to control the animal's behavior. Findings presented in a recent comprehensive literature review strongly suggest that heretofore only negative reinforcement, such as electric shock, has been effective in producing efficient learning in the GO LEFT/GO RIGHT situation (Wegener, 1964).

***Subjects.*** The final procedure was extensively tested with six rhesus monkeys (*macaca mulatta*), approximately 24-mo. old at the onset of experimentation. The animals' weights ranged from 1.8 to 2.3 kg, with a mean weight of 2.1 kg. They were individually housed and maintained on a daily diet of 8–12 standard-size Purina Monkey Chow pellets, with access to water at all times.

***General Conditioning Procedures.*** A "trial" began when the monkey pressed Lever X, which was one of three levers in the testing chamber (Fig. 1). A response on Lever X connected one of two sides of a prerecorded magnetic-tape loop to a loudspeaker located just outside the testing chamber. Each of the two sounds on the tape loop constituted a discriminative stimulus for which a response on one of the other two levers (A or B) was "correct," and would thus produce food reinforcement (CIBA 190-mg banana-flake pellet). After reinforcement, the house lights would dim for a time out of 6 sec. The brightening of the lights after time out signaled that a response on Lever X would again produce one of the sounds. An incorrect response would immediately initiate a 6-sec time out during which the house lights were completely extinguished.

Each monkey was conditioned for 50 trials per day on consecutive days until 45 correct responses (90%) occurred on two successive days. The auditory stimuli throughout this period were unequal in over-all intensity. Intensities were then equated, and the monkeys were tested until one session of 90% correct responses again occurred. The animals were then taken off the training regimen for 30 days. At the end of this period, they were tested for retention on equal intensityst imuli and reconditioned, if necessary, to achieve one session of 90% correct response.

***Stimuli.*** The two sounds, programmed to alternate irregularly on a modified Gellerman schedule, were a tone and a noise. The tone was at a frequency of 800 Hz and was presented for 0.5-sec intervals separated by 0.5-sec intervals of silence. The noise was a white-noise burst presented with the same on and off times as the tone. During most of the training period, the tone intensity was 68-dB SPL, and the noise intensity was 78-dB SPL. In the final testing sessions, however, the intensities were equated at 73-dB SPL. Stimulus intensities were measured with a General Radio 1551-B sound-level meter (C scale), with the microphone placed in the approximate location of the head of the monkey when he pressed Lever X. Each stimulus occurred 50 times in every 100 presentations. The correct response in the presence of the tone was a press on the left-hand lever (A), and during the noise, it was a press on the right-hand lever (B).

***Testing Apparatus.*** In the design of the experimental chamber, our aim was to maximize the differentiability of the several lever-press response alternatives. To insure a low ambient noise level, the 24×22×24-in. wire-mesh cage was housed in an Industrial Acoustics Co. 401-A sound-shielded audiometric testing booth. At the far end of the chamber were Levers A and B and a centrally located food cup. Lever A was mounted 12 in. above the bottom of the panel, while Lever B was at a height of 6 in. A partition the height of the cage and jutting 12 in. out from the panel was placed midway between the two levers; a small hole in this partition allowed access to the food cup from either side. This partition made the two sides of the panel appear more different visually, prevented the monkey from pressing both levers simultaneously, and introduced a marked changeover delay period between responses on either lever.

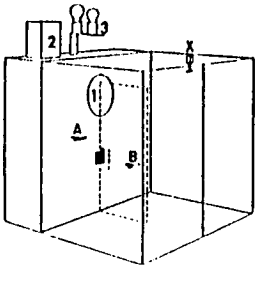


FIG. 1. Testing apparatus. Levers A, B, and X, as well as the loudspeaker (1), pellet dispenser (2), and bright and dim house lights (3) are labeled. Dashed line shows the position of the center partition that juts out 12 in. from the panel.

TABLE I. Trials to criterion (exclusive of trials at criterion) for original learning, and for retention after 30 days.

| Monkey No. | Number of trials: Original learning | Retention |
|---|---|---|
| 261 | 1200 | 150 |
| 262 | 1150 | 200 |
| 263 | 1200 | 0 |
| 264 | 1150 | 300[a] |
| 265 | 950 | 50 |
| 267 | 1150 | 50 |

[a] Scores for the last three of the six daily sessions required by this monkey were above 80% but below criterion.

*Results and Discussion:* Table I presents the total number of trials to criterion for both original learning and retention of the discrimination task. These results point up the efficacy of the conditioning technique in showing the consistently rapid response acquisition for all the monkeys.

One important advantage of the present procedure is that, because the monkey's head was in a relatively fixed position at the onset of a sound stimulus, any problems concerning stimulus specification due to sound-field differences within the testing chamber itself (Worden, Marsh, and Hicks, 1962) were kept to a minimum. A major factor contributing to the success of the method, however, is probably that we required the animal to emit an OBSERVING response. That is, in order to gain access to the auditory stimuli, a stereotyped response pattern (a press on Lever X) had to be emitted. This requirement has not been part of previous *auditory*-discrimination testing procedures, although OBSERVING responses involving relatively fixed postures are often required in experiments that use *visual* discriminative stimuli (D'amato and Fazzaro, 1966; Kelleher, 1962). Therefore, although visual discriminations have been much more rapidly acquired than auditory discriminations, it is probably erroneous to conclude from such experiments that "auditory cues may have much lower attention-getting value than visual cues" (Wegener, 1964). It is more likely that, in these previous studies, the sounds occurred while the animals were engaged in a large variety of behavior patterns. Since these response patterns were intermittently reinforced by the onset of the sounds, it is not surprising that the animals frequently emitted these behaviors and, thus, appeared to engage in a great deal of extraneous activity.

*Acknowledgments:* We gratefully acknowledge the encouragement and cooperation given by Professor Karl H. Pribram.

Our research was supported in part by a National Science Foundation Grant, and by the U. S. Army.

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