THE DEVELOPMENT OF AN INSTRUMENTAL SKILL SEQUENCE IN THE CHIMPANZEE

FREDERICK H. ROHLES, JR.

HOLLOMAN AFB, NEW MEXICO

A previous study described a method for measuring higher cognitive functioning in animals during space flight (Rohles, Belleville, & Grunzke, 1961). The work reported in this paper is an extension of this study, which describes the development of an instrumental skill sequence in the chimpanzee.

METHOD

Subject

The subject (S) was one adult female chimpanzee.

Apparatus

The apparatus consisted of a steel chamber that served the dual purpose of living quarters and test chamber. Except for daily cleaning, S remained in the chamber throughout the investigation. The chamber was 37 inches long, 29 inches wide, and 51 inches high (interior dimensions), and was illuminated by a 25-watt houselight; an exhaust fan was mounted on top of the chamber. Four In-line Digital Displays¹ spaced 2.75 inches apart were arranged in a horizontal row 21 inches above the chamber floor. A fifth display was mounted 4 inches above this row, as Fig. 1 shows. In this study, however, neither this display nor the first display in the horizontal row was used. (The ad-

¹The In-line Digital Display is manufactured by Industrial Electronic Engineers, Inc., 5528 Vineland Avenue, North Hollywood, California.

Fig. 1. Chimpanzee test chamber.

ditional displays can be used in matching problems.) All displays could present either a circle, triangle, or square on the 1- by 1.25-inch dark, ground-glass surface. A lever 0.875 inch in diameter and extending 3.25 inches from the chamber wall was mounted 2.5 inches below each of the three displays that were used. To the left of the displays and 14.5 inches above the chamber floor was a food well for receiving food pellets. Deitrich and Gambrell food pellets (0.67 gram) served as the reward. Water was continuously available, and could be obtained by sucking on the lip-lever drinking tube (Grunzke, 1960).

All the procedures were programmed automatically. The sequence consisted of 18 different patterns; these were in random order and were arranged so that each of the three symbols were "odd" with respect to the other two "like" or "distractor" symbols in all three display positions.

Procedure

Following food deprivation for 30 hours, S was given magazine training for 1 day. This consisted of presenting a single symbol for 5 seconds, turning off the display, and delivering a food pellet. This procedure was repeated once every 60 seconds until S received 103 pellets.

For the next 4 days, the symbol presentations were the same as during the magazine training; however, the symbol remained illuminated until S pressed the lever under the display on which it appeared. When this response was made, a food pellet was delivered and the next symbol presented. Responses on either of the other two levers turned off the display for 0.5 second and then on again without moving to the next set. Using this procedure, S was given 450 food pellets per day.

Following this period, and throughout the remainder of the experiment, symbols were presented on all three displays. A response on the lever under the display having the "odd" symbol was rewarded with a food pellet; 2 seconds later, the next set was presented. When a response was made on either of the two levers under the displays having "like" symbols, no pellet was delivered and all displays were turned off for 1 minute; following this period, the same set of symbols was presented again.

A correct response was required for each set of symbols before the next set was presented. During the early stage of training, the sequence of 18 stimulus sets was repeated 25 times daily; this amounted to 450 reinforcements. Because it was observed that the accuracy of the discriminations appeared to diminish toward the end of the test session, the number of

Fig 2. Performance on an FR 3 schedule showing discrimination errors.

trials was reduced to 20 repetitions of the sequence. This, in turn, reduced the number of reinforcements to 360 per day. By the end of 50 days, the subject was responding correctly to between 98 and 99.8% of the presentations. At this time, the reinforcement schedule was changed from CRF to FR. The ratio was gradually increased to FR 19 (19 correct discriminations for one pellet of food) and the "time out" for incorrect responses was reduced to 5 seconds. The ratio was not reset for wrong discriminations. Performance was recorded on a cumulative recorder in two ways: Each correct discrimination moved the response pen one step; and wrong discriminations or errors were recorded on the event pen.

RESULTS AND DISCUSSION

To demonstrate performance, cumulative records are presented during both the early and late stages of acquisition. Figure 2 shows performance on an FR 3 reinforcement schedule in which the subject made 1242 discriminations with 162 errors. This level of discrimination is considerably above chance and shows a stable rate of 0.25 response per second.

In contrast, the cumulative record in Fig. 3 shows the performance during the terminal stages of acquisition. Here, the subject was on an FR 19 reinforcement schedule and made approximately 7200 discriminations in 42 minutes with only 15 errors. The record illustrates stable responding at a rate of approximately 3.0 discriminations per second; the accuracy of the discriminations is near perfect. The effect of increasing the ratio becomes apparent when the two records are compared. Basically, both the response rate and accuracy of discriminations were increased as the ratio was increased. However, the terminal performance level suggested that the subject was responding in a serial manner to the entire sequence of 18 sets instead

of to the odd display in each individual set. This was entirely possible since the sound of the resetting of the stepping switch could provide a cue that all 18 sets had been presented and would be repeated; the delivery of the reward could not provide this cue because with the FR 19 reinforcement schedule, a different set was rewarded in each presentation of the group.

Although the validity of this finding must be tested in future studies, an observation was made that further led to the belief that the subject had learned the order of lever presses. While the animal was responding, it was observed to look away from the displays and make as many as four or five correct lever presses before looking back; then, the subject would appear to attend the displays for several discriminations and look away again. Also, following an incorrect response, the subject was observed to scan the set when it was

Fig. 3. Performance on an FR 19 schedule showing discrimination errors.

presented. This appeared to anchor the discrimination in the response chain since it was immediately followed by rapid, serial-type responding.

Although these findings suggest several theoretical issues, the testing apparatus permits the study of a problem with automatic equipment which heretofore had demanded large quantities of the experimenter's time. Moreover, matching problems can be investigated with more rigid controls in terms of times between trials and times between the presentation of the sample and choice stimuli. Studies currently underway are directed toward investigating problems of transfer with the Wisconsin General Test Apparatus and this apparatus; and placing both oddity and matching problems under different reinforcement schedules is the subject of other studies.

Thus, in conclusion, this study not only has demonstrated the development of an instrumental skill sequence in the chimpanzee, but has suggested a variety of cognitive problems which can be studied with equipment of this type.

SUMMARY AND CONCLUSIONS

Reward was presented to a chimpanzee each time it pressed the lever under the odd (different) stimulus in a three-stimulus situation in which two of the stimuli were alike and one was different. When the accuracy of the discriminations increased, an FR schedule was introduced and increased until 19 correct discriminations were required for each reward. The results were an increased response rate and an increased accuracy of discriminations and suggested that the subject had learned the serial order of stimulus presentations.

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