JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR VOLUME 7, NUMBER 3 MAY, 1964

NOTE ON CHANGES IN RESPONSE LATENCY FOLLOWING DISCRIMINATION TRAINING IN THE MONKEY[1]

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Two monkeys were trained to press and hold down a telegraph key in the presence of a red light. Subsequent release of the key in response to a white cross superimposed on the red background was followed by reinforcement. Key release in response to a white circle on the red background was never reinforced. Latencies for the key release response to the reinforced stimulus (cross) were considerably shorter and less variable than those to the unreinforced stimulus (circle).

Earlier papers have described a technique for measuring response latency (Stebbins and Lanson, 1961) and the effects of reinforcement schedule (Stebbins and Lanson, 1962) and amount of reinforcement (Stebbins, 1962) on the response latency of the rat. Subjects learned to depress a key in response to one stimulus and to release the key after a second stimulus. In all these studies the dependent variable was the latency of key release to the second stimulus. In the present study, the technique was used with two monkeys and response latencies were examined after the acquisition of a visual discrimination. The contingencies are those of the classical simple reaction time experiment with humans, with the exception that short latencies are not selectively reinforced.

METHOD

Subjects

Two experimentally naive, adult, male monkeys (Nemestrina Macaque) were restrained throughout the experiment in a slight modification of the chair described by Young (1957). Subjects obtained about 150 0.7 g whole diet monkey pellets (Dietrich and Gambrill) per session. With the exception of a small vitamin C supplement, no other food was given. Water was always available.

Apparatus

The chaired *S*s were placed in a sound-deadened chamber (Industrial Acoustics SP402). A Grason-Stadler stimulus projector was placed directly in front of each chair about 12 in. from the *S*'s eye. A telegraph key affixed to the chair at about waist level was easily accessible. The food pellets were delivered by a Foringer pellet dispenser. A system of relays and timers outside the sound chamber programmed all experimental events automatically. Responses and reinforcements were recorded on counters; response latencies were recorded from a Standard Electric .01 sec timer.

Procedure

Preliminary training. Subjects were initially trained to depress a telegraph key in the presence of a red light on the stimulus projector. The circular light spot was 1 in. in diameter. Reinforcement followed release of the key. After approximately 200 reinforcements, the light was turned out, and its reappearance was contingent upon 30 sec of no responding on the key. When this criterion had been met, the light (S_1) was turned on; a key press (R_1) of at least 0.5 sec duration produced a white cross (S_2) superimposed on the red spot. A key release (R_2) in the presence of this visual stimulus complex was reinforced, and, at the same time, terminated

[1]This study was conducted while the authors were National Institute of Neurological Diseases and Blindness postdoctoral fellows in the Department of Physiology and Biophysics at the University of Washington School of Medicine. It was supported by grants Public Health Service 5T1-NB-5082-07 and BT 961.

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the stimulus complex. After reinforcement, the sequence began again with the requirement of 30 sec of no responding prior to the light. Initially, a key press lasting less than 0.5 sec had no effect on the experimental conditions. When *S*s responded appropriately to the above contingencies, two further conditions were added. The time interval between R_1 and S_2 was continuously variable between .05 sec and 5 sec. Subjects were required to hold down the key until S_2 appeared. At this stage, if a release response (R_2) occurred before S_2 onset, S_1 was turned off and the 30 sec response-free interval requirement in the dark was again in effect.

Discrimination training. When the frequency distributions of latencies (R_2 to S_2) became stable, and when *S*s learned to refrain from responding in the absence of the visual stimuli and to hold the key down in S_1 until S_2 onset, a new stimulus was added. A white circle was presented in place of the white cross (S_2) and before the release response (R_2) on 50% of the trials. The order of presentation was mixed with the stipulation that neither cross nor circle appeared on more than three successive trials. A key release in the presence of the cross produced reinforcement as before, but release to the white circle simply terminated the stimuli and was never followed by food.

RESULTS AND DISCUSSION

The development of a clear discrimination between cross and circle stimuli is evident in the frequency distributions of latencies in Fig. 1. Both *S*s released the key more quickly to the stimulus (cross) which preceded reinforcement. In comparison, latencies for the key release response to the unreinforced stimulus (circle) were consistently longer and more variable. The frequency distributions were obtained from the final session. Latency (or reaction time) is measured from the onset of either the cross or circle stimulus to the release of the key. The upper panel in Fig. 1 contains the data for monkey H, the lower panel for monkey F. R refers to the red light, and + and O to the cross and circle. For example, H-R+ indicates the frequency distribution of latencies for monkey H with the red light as the stimulus for key press followed by a white cross for key release. Those

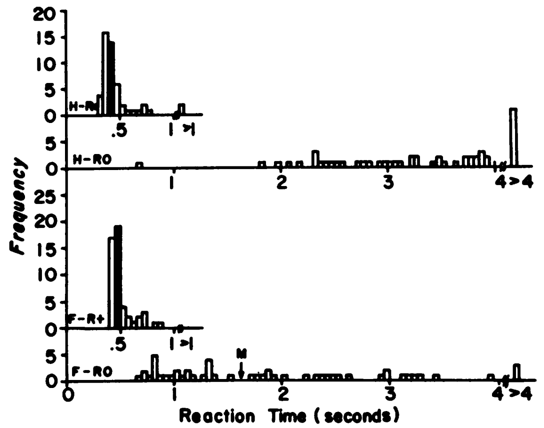

Fig. 1. Individual distributions of latencies for each subject for the final session. The two *S*s are labelled H and F. R+ indicates the frequency distributions of latencies for the sequence red light—white cross and RO for the sequence red light—white circle.

class intervals containing the medians of the distributions are shaded, with the exception of F-RO for which the class interval containing the median is empty and labelled M.

The distributions R+ are typical of those obtained in the first stage of the experiment when the only sequence in effect was red light–white cross (*e.g.* simple reaction time). The greatest number of latencies were included in the intervals between 350 and 450 msec for monkey H and between 400 and 500 msec for monkey F. The stimulus control was good; release responses to S_1 and before S_2 accounted for less than 3% of all the responses. In addition, the extinction (and perhaps punishment, since R_2 to S_1 produced a time out) of these responses to S_1 may have had some effect on behavior in the early portion of S_2. Thus, there were no responses with latencies to S_2 shorter than 300 msec (see Fig. 1). These results are in contrast to previous data for the rat (Stebbins, 1962; Stebbins and Lanson, 1962) for which these "anticipatory" release responses, even after extensive training, accounted for as much as 20% of the total responses, and the latency-frequency distributions contained latencies in the lowest class interval (0-50 msec). The reasons for these differences between rat and monkey are not clear and may possibly be due to slight differences in experimental procedure.

The data for the discrimination between cross and circle can be seen in the R+ and RO distributions for each *S* in Fig. 1. Introduction of the white circle in the experiment initially produced increased latencies to the white cross. In the first session with the circle, for example, the median latency to the white cross for one *S* increased by 150 msec. After about three sessions the + distributions had returned to the level attained before introduction of the circle. Median latencies to the white circle were as high as 14 sec in the first session in which it was introduced. Within five sessions, median latencies to the circle decreased to between 3 and 4 sec for one *S* and to between 1 and 2 sec for the other. The differences between the latency distributions for these two stimuli (cross and circle) were maintained for more than 20 experimental sessions.

The present results confirm that for a simple operant discrimination where clearly discriminable stimuli are used (in this experiment, the cross and the circle), stable differences are maintained with response latency as the dependent variable in the same manner as has been shown previously for response rate (Skinner, 1938) and force (Notterman and Block, 1960).

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Received July 31, 1963