Changes following asymptotic instrumental performance as a function of shifts in drive

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The effects of shifts in drive level upon instrumental behavior were evaluated in 12 albino rats after asymptotic training at a medium level (12 h) of food deprivation. After training at 12-h deprivation, Ss received 100 trials each at 3-, 22-, and finally 3-h deprivation. Every drive shift produced a significant performance change in the predicted direction within five trials following the shift and no further significant changes in performance at that drive level. At asymptote, the different drive levels produced significantly different response speeds in the expected direction and some evidence of reduced differences between the drive levels after extensive training.

In 1958, Estes offered a tentative theory of motivation based upon the assumption that "drive stimuli are simply stimuli with no special properties whatsoever [p. 42]." Estes offered several predictions based upon this theory, including the assumption that differences in performance at different drive levels are due to different numbers of competing response (cf. Cotton, 1953; Porter, Madison, & Senkowski, 1968).

Another set of predictions generated by Estes's drive stimulus theory concerns the changes in performance produced with repeated shifts in drive. A change to a lower drive level following asymptotic performance at higher drive level should lead to an initial decrease in performance, below the asymptote eventually reached, followed by a return to this asymptote. A shift upward in drive, following asymptotic performance at a lower drive, may or may not lead to such an initial performance decrement before reaching a new higher asymptote, depending upon the overlap between the sets of drive stimulus elements characteristic of the pre- and postshift drive levels.

Most closely related to these predictions are studies by Deese & Carpenter (1951) and Hillman, Hunter, & Kimble (1953). Deese and Carpenter trained Ss for 24 trials at both 22- and 3-h deprivation, and then shifted the groups to the alternate drive condition for an additional 8 trials. They found that the performance of Ss trained

under low drive rose rapidly to the asymptote established by the high-drive Ss, and that this change occurred on the first trial following the shift. However, Ss originally trained at high drive showed only a slight decrement in performance, never declining to the level established by the low-drive group prior to the shift.

Hillman, Hunter, and Kimble, using water deprivation as the measure of drive, shifted drive conditions for two of four groups of Ss after only 10 trials in a T-maze. The group that was shifted from high to low drive showed an immediate drop in performance on Trial 11 to the level maintained by the unshifted low-drive group. The group shifted from low to high drive showed a significant increase in performance on Trial 12.

The small number of training trials in these two studies suggested that an asymptotic performance level was not attained under the original drive. Further, only one drive change occurred. Thus, neither study provided data suitable for evaluating Estes's theory. Further, neither study obtained a useful picture of behavior under the potentially useful conditions of repeated drive shifts, or suitable data for understanding the effects of drive shifts upon appetitive needs. The present study was designed to gather information on the effects of drive shifts upon instrumental behavior after Ss had been trained to asymptote at an intermediate deprivation level. A secondary objective was to test predictions for drive shifts based upon Estes's drive theory.

SUBJECTS AND APPARATUS

Twelve Holtzman male albino rats, 80-110 days old, were used. The Ss were tested in a Hunter modular animal runway, 60 in. long, with 12-in. start- and goalboxes. Time from opening of the start door to a photocell mounted 1 ft down the alley defined start time. A second photocell, mounted 2 ft from the start door, and a third, located 1 in. within the goalbox, measured Alley Times 1 and 2, respectively. The fourth photocell, located 1½ in. from the rear wall of the goalbox, immediately above the food receptacle, measured goalbox time. All time measures were converted to reciprocals before analysis.

PROCEDURE

All Ss were food deprived for 7 days, during which each S was given 5 min of

unrewarded exploratory activity, while at each of 3-, 12-, and 22-h deprivation. Following pretraining, Ss were switched to 12-h deprivation and experimental training began. All Ss were rewarded in the goalbox with one 97-mg Noyes pellet on each of their 10 daily trials. The intertrial interval was approximately 15 min.

After 100 trials at each deprivation level, Ss were immediately shifted to the next deprivation level and run for 100 further trials. This procedure was followed until all Ss were exposed to three levels of deprivation, in the sequence of 12, 3, 22, and 3 h. Thus, each S received a total of 400 trials.

RESULTS

Preshift and postshift response speeds were analyzed by means of correlated *t* tests over 5 and 10 trial blocks. Since pre-post shift performance was similar for 5- and 10-trial blocks, only the 5-trial blocks were reported.

Figure 1 presents performance in terms of the 5 trials preceding drive shifts and the 20 trials immediately following these shifts. Analysis of performance over the five trials immediately before and after a drive shift revealed a significant performance change in the direction of the shift, with one exception: the start measure for the first shift from 12- to 3-h deprivation. For this shift, both alley and goalbox speeds did decrease significantly, $t(11) = 6.72$, and 6.19 , $p < .01$, respectively. For the second shift from 3- to 22-h deprivation, running speed for all three measures increased significantly, $t(11) = 3.87$, 6.41 , 3.83 , $p < .01$, for start, alley, and goal speeds, respectively. For the final shift, from 22- to 3-h deprivation, running speed for all three measures again decreased significantly, $t(11) = 2.78$, $p < .05$, 2.88 , $p < .05$, and 4.20 , $p < .01$, respectively, in the same order as above.

To assess the performance trend following each drive shift, the first four blocks of trials immediately following each shift (see Fig. 1) were examined. Only the start measure for the shift from 3- to 22-h deprivation showed a significant change, but, as was apparent from Fig. 1, the changes evident for this measure really constituted an oscillation between slow and fast speeds from block to block and did not represent a consistent performance trend.

Analysis of variance comparing the final 20 trials at each of the first three deprivation levels (12, 3, and 22 h) demonstrated that they differed significantly for start and alley speeds, $F(2, 22) = 5.61$, $p < .05$ and $F(2, 22) = 7.80$, $p < .01$, respectively, but not in goal speed. For start speed,

Fig. 1. Mean start, alley, and goal speed over the 5 trials preceding each drive shift and the 20 trials immediately following each shift. The numbers in the figure represent the hours of deprivation before and after each drive shift.

Newman-Keuls tests showed that the 22-h deprivation level was significantly faster than both the 12- and 3-h deprivation levels ($p < .05$; r , 22), but that the 12- and 3-h levels did not differ significantly. For alley speed, both the 12- and 22-h deprivation levels resulted in significantly faster running than the 3-h deprivation level, $p < .01$ (r , 22) and $p < .05$ (r , 22), respectively. But the 12- and 22-h groups did not differ significantly.

Analysis of variance comparing the last 20 trials for the 12-, 22-, and the final 3-h deprivation conditions showed a significant difference only for the alley measure, $F(2,22) = 6.97$, $p < .01$. Newman-Keuls tests showed that the overall F was due to a significant difference between the 12- and 3-h deprivation levels (r , 22), $p < .01$. Finally, a separate comparison of the two 3-h deprivation levels indicated that start speed at the second 3-h level was significantly faster than that of the first 3-h condition, $t(11) = 2.38$, $p < .05$. For the other running measures there was no significant difference in response speeds at 3-h deprivation.

DISCUSSION

In general, performance changed rapidly following each shift in drive. This change was in evidence on the very first postshift trial, but the analysis was not performed on data involving fewer than five trials due to the relatively small N used in this study and the between-trials variability.

Terminal asymptotic performance was positively related to deprivation level when the first three deprivation levels were compared, but the relationship of performance to drive level was much weakened when the final 3-h deprivation was compared with the 12- and 22-h levels. The fact that the second 3-h level immediately followed a 22-h deprivation level, where the highest performance level was attained, suggests that the drive-level/performance relationship is not a simple one and was affected by the sequence of exposing Ss following prolonged training.

Clearly these results show rapid shifts in performance with shifts in drive levels; however, the extent of this effect appears to decline with extensive training. Estes (1958, p. 52) argued that the amount of training is an important parameter of studies that compare performance at different drive levels. He argued that one would expect to find maximum differences

in performance at intermediate degrees of training, and smaller differences, or in some instances no difference, after very small or very large amounts of training.

In summary, these results indicated that performance change in the direction of drive shifts occur immediately following a change in deprivation level, when Ss are exposed to extensive training at each of several drive levels. However, these results are indeterminate as far as Estes's drive-stimulus theory is concerned due to the relatively small number of drive shifts, the limited range of these shifts, and the small number of Ss used.

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NOTE

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Specific hungers in hyperphagic rats¹

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Preference-aversion functions for glucose, sucrose, and sodium chloride were

determined using the single-stimulus, brief-exposure procedure. The functions generated by hyperphagic rats were similar to those generated by controls.

Specific hungers in the rat are characterized by highly reliable intake