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Instrumental escape behavior with extended training*

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Four groups of nine Ss were run in a straight alley shock situation for 240 trials, 30 per day. Ss received either 180- or 300-V shock and intertrial intervals (ITI) of 30 or 120 sec. On Day 1 of training, the 300-V groups first started faster than the 180-V groups, but then showed considerable adaptation, resulting in approximately equal performance at the end of Day 1. Over all 8 days, the 180-V group started significantly faster than the 300-V group when a 30-sec ITI was used, but the converse when a 120-sec ITI was used. Over all 8 days, the 300-V groups continued to increase in performance, while the 180-V groups showed a decline after Day 4.

The present research was intended to gather data on the instrumental escape response to different levels of shock extended over several days of training, preliminary to a study of the effects of changes in shock level after asymptotic responding was achieved. This work was intended to parallel the appetitive conditioning work of McDonald, Porter, and Madison (1970). However, preliminary investigation indicated that any effects resulting from shifts in shock level were complicated by a pronounced decline in response speeds (adaptation) with prolonged training at a single shock level. Although there have been occasional reports of such adaptation in escape studies (Amsel, 1950; Dinsmoor & Campbell, 1956a, b), other studies (Campbell & Kraeling, 1953; Trapold & Fowler, 1960; Fowler & Trapold, 1962), using straight alleys similar to that used here, did not report significant adaptation. The most obvious difference between these alley studies and our preliminary work was their use of a 20-/30-sec intertrial interval (ITI) in contrast to our 120-sec ITI. The primary difference resulting from this longer ITI was that Ss were returned to their carrying cages to await their next trial rather than being placed immediately back in the startbox.

The effect of 30- vs 120-sec ITIs for adaptation to shock in escape training was examined in the present study. Eight days of training were given, using two shock levels (180 and 300 V). Preliminary investigation indicated that these shock levels yielded a considerable difference in running speed. It was hoped that a factorial design of this sort, conducted over several days of training, would

establish the viability of the shock adaptation observed in our preliminary research and indicate some of the factors governing the effect.

METHOD

Subjects

Four groups of nine male albino rats, 95 to 100 days old, were used. The Ss were supplied by Badger Research, Madison, Wisconsin.

Apparatus

The Ss were run in a straight alley, 60 in. long, 3/4 in. wide, and 3 in. high, with floor and wall construction similar to that used by Campbell and Kraeling, consisting of two L-shaped pieces of galvanized sheet metal for the floor, separated by a 1-in. space. Hunter electric doors divided the alley into a 12-in. start area, a 36-in. runway, and a 12-in. goal area. Shock level was controlled by a variable transformer and was delivered through a 27-megohm resistor in series with S.

The reciprocals of the times required for S to run from the start door to a point 11 in. down the alley and from that point to 2 in. inside the goalbox defined start and alley speeds, respectively. The times were measured by Hunter photocell relays and recorded by Standard Electric 1/100-sec clocks.

Procedure

On each trial, E turned the shock on and opened the start door after S had oriented toward the door. In order to escape the shock, S had to run more than 2 in. into the goalbox, whereupon E closed the goalbox door. Ss were detained in the goalbox for 25 sec. For two groups of Ss, the next trial began immediately after this 25-sec goalbox delay; for the other two groups, Ss were returned to their holding cages for approximately 100 sec before the next trial.

The experiment consisted of a

2 by 2 factorial design using shock intensities of 300 V (1.1 mA) or 180 V (0.7 mA) and ITIs of 30 or 120 sec. The experiment was continued for 8 days, with 30 trials per day. It was originally intended to include two 140-V (0.5 mA) groups, but Ss would not run reliably at this voltage.

RESULTS AND DISCUSSION

Two aspects of these results were examined. The first involved behavior over the initial 30 trials of Day 1, the data directly comparable to that of Fowler and Trapold (1962), Trapold and Fowler (1960), and Campbell and Kraeling (1953). These data were analyzed in a 2 by 2 analysis of variance conducted over the six blocks of five trials on Day 1. The second aspect of the data involved the course of behavior over all 8 days of training. In the latter case, the long-term effects of shock intensity and trial massing were particularly relevant to possible studies of changes in drive level following asymptotic performance. Similarly, these data were analyzed in a 2 by 2 analysis of variance conducted over the 8 days of training.

Figure 1 shows the start speeds on Day 1 in blocks of five trials. It was apparent that start speeds for both of the 300-V groups declined late in Day 1, while the speeds of the 180-V groups remained relatively constant. These effects were reflected in a

Fig. 1. Mean start speed on Day 1 in blocks of five trials.

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Fig. 2. Mean daily start speed over all 8 days of training. Group identification is the same as in Fig. 1.

significant Trials by Voltage interaction [$F(5,160) = 3.31$, $p < .01$]. The performance of the 300-V groups was superior to that of the 180-V groups through Block 3, while over Blocks 4-6 the mean performance of the 180-V groups was approximately equal to that of the 300-V groups. Simple effects tests confirmed that the 300-V groups were superior at Block 3 [$F(1,34) = 4.19$, $p < .05$] but that there was no significant voltage effect at Block 6 [$F(1,34) < 1.0$]. The fact that, on the average, there was little effect of ITI at 300 V but a large ITI effect at 180 V was confirmed by the significant overall V by ITI interaction [$F(1,32) = 6.10$, $p < .05$].

For alley speeds, the large amount of between-Ss variability in the data restricted statistical significance to the effect of trial blocks [$F(5,160) = 18.2$, $p < .01$].

Figure 2 presents start speed over all 8 days of training. Most striking was the increasing speed of the 300-V groups over days, which contrasted with the marked decrease in performance of the 180-V groups after Day 4. An analysis of variance over the 8 days of training indicated a strong Days by Voltage interaction [$F(7,224) = 5.10$, $p < .01$], reflecting the different trend of the 180- and 300-V groups after Day 4. Further examination of Fig. 2 indicated that, with a 120-sec ITI, the 300-V groups were superior to the 180-V groups, but that the converse was true with a 30-sec ITI. However, the interaction between voltage and ITI did not reach an acceptable level of significance [$F(1,32) = 3.84$, $p < .10$; $F(.05) = 4.15$]. This was probably due to the rapidly changing performance over days. It was felt that an analysis

of terminal start speed, e.g., Day 8, was inappropriate because of the rapidly changing performance levels at the end of training.

Turning to alley speeds over days, shown in Fig. 3, these speeds were also analyzed over Days 1-8. For all groups, it was clear that running speed declined radically after Day 1. The effect of days was significant [$F(7,224) = 39.7$, $p < .01$]. Newman-Keuls tests indicated that performance on Day 1 was significantly faster than on the remaining days of training ($p < .05$), while performance over Days 2-8 did not differ significantly. Though not as apparent as the trends in start speed evidenced in Fig. 2, there was a significant Days by Voltage interaction [$F(7,224) = 2.83$, $p < .01$], indicative of an increasing trend in the speed of the 300-V groups after Day 2, in contrast to the steady decline in the performance of the 180-V groups during the same period.

On Day 1 it was clear that the effects of ITI were dependent upon the voltage level employed during training. Thus, 300-V groups were not significantly influenced by differences in ITI. However, the 180-V 30-sec group was consistently faster than the 180-V 120-sec group. In fact, conclusions about the effects of shock intensity on performance would be reversed with a change from 30- to 120-sec ITI. It appears that conclusions from past escape studies need to be treated with caution, pending further research on the effect of longer ITIs.

Over days, performance seemed largely determined by voltage level. For both the start and alley measures, performance curves over days with a given voltage level were nearly parallel, though the trends at the 300- and 180-V levels differed markedly. As on Day 1, conclusions about the effects of voltage would have been opposite, depending upon the ITI used. Unfortunately, this pattern of performance was not reflected in a significant interaction between these variables.

The different trends observed under 300 and 180 V over days seemed to reflect qualitatively different behaviors under different shock levels. The 300-V groups showed much more agitated behavior in the alley than did the 180-V groups. This behavior seemed to interfere with running over the first few days, but tended to drop out later in training. Such behavior was not observed in the 180-V groups, which ran quite consistently. It is possible that at least for start speed, the most commonly used measure of shock effects, we observed the motivational or learning effects of

Fig. 3. Mean daily alley speed over all 8 days of training. Group identification is the same as in Fig. 1.

shock on the 300-V Ss only after the habituation of interfering behavior resulting from unconditioned shock responses took place. On the other hand, the performance of the 180-V groups was probably not influenced by unconditioned responses to shock, but these groups did exhibit strong adaptation effects to the shock. Possibly such adaptation would cause a downturn to occur in the 300-V groups with more extended training. Some hint that the correct interpretation of the present results involves factors other than unconditioned responses to shock, or adaptation to shock, is found in the fact that both of the 30-sec ITI groups displayed an increasing tendency to avoid entering the goalbox later in training, despite the fact that this prolonged their shock periods. One way of understanding this phenomenon is to assume that with a short ITI the temporal contingency between running and further shock is conditioned. Thus, in this sense, Ss are punished for more rapid running.

Further research attempting to separate the unconditioned effects of aversive stimulation from instrumental contingencies is needed. Perhaps the use of stimulation other than shock would help to separate the factors.

REFERENCES

- AMSEL, A. The combination of a primary appetitional need with primary and secondary emotionally derived needs. *Journal of Experimental Psychology*, 1950, 40, 1-14.
- CAMPBELL, B. A., & KRAELING, D. Response strength as a function of drive level and amount of drive reduction. *Journal of Experimental Psychology*, 1953, 45, 97-101.
- DINSMOOR, J. A., & CAMPBELL, S. L. Escape from shock training following

function of shifts in drive. *Psychonomic Science*, 1970, 19, 33-34.

TRAPOLD, M. A., & FOWLER, H. Instrumental escape performance as a function of the intensity of noxious stimulation. *Journal of Experimental Psychology*, 1960, 60, 323-326.