Facilitation of shuttle avoidance by handling

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Three groups of albino rats received shuttle, shuttle-plus-handling, or one-way shock avoidance training with a tone CS. Results showed that the two-way handled group reached a performance level significantly superior to that of the nonhandled shuttle group. These results, as well as those of other studies cited, suggest that the use of a warning stimulus, prior to and distinct from the CS, might serve to enhance performance in the standard shuttle-avoidance task.

Considerable work has recently been reported in the literature regarding differences in one-way as opposed to shuttle avoidance conditioning, with the results invariably indicating the superiority of the one-way task (Kenyon & Krieckhaus, 1965; Olton & Isaacson, 1968; Theios & Dunway, 1964). In addition, several modified procedures, incorporating features of both the dual and the one-way tasks, have been devised that yield performance more comparable to the one-way than to the shuttle task (Baum, 1965; Baum & Bobrow, 1966; Olton & Isaacson, 1968; Wedeking, 1967). Furthermore, use of some US other than electric shock (e.g., Ray, 1966, pressurized air), and spatial reorientation of the apparatus between trials (Baum & Bobrow, 1966; Olton & Isaacson, 1968) have also tended to yield performance superior to the typical shock-motivated shuttle task. However, none of the shuttlebox studies reviewed by the present investigator assessed the effects of handling Ss between trials, which appears to be a major difference between the two-way and one-way procedures, other than the spatial or directional one. One study that did assess the effects of handling (Wahlsten et al, 1968) used a modified operant chamber that permitted one group of rats to escape from the shock chamber after each barpress, in addition to terminating the shock and CS. As a control for the handling required to replace those Ss into the shock chamber, a second group was simply lifted off the shock grid and replaced after each response. Results showed no differences between these two groups, whereas both handled groups performed significantly better than a group that received training on a standard discriminated operant-avoidance task.

The present study was designed to assess the effects of handling between trials for rats trained on an otherwise standard shuttle-avoidance task.

SUBJECTS

Eighteen male Holtzman-derived albino rats, approximately 100 days old at the time of testing, were maintained on an ad lib food and water schedule and a reversed day-night cycle in individual cages of a rat colony. The Ss were handled daily for 3 days prior to training, for approximately 3 min per S each day.

APPARATUS

The shuttlebox consisted of two compartments, each 12 in. long, 9 in. wide, with an 8-in. ceiling, and separated by a clear Plexiglas partition, the lower half of which dropped below grid level to permit S to shuttle. The box was constructed of plywood painted light gray inside, with Plexiglas windows in the front wall and a grid made of ¼-in. stainless steel bars.

Electric shock was delivered by a fixed-impedence 60-cycle ac circuit with a series resistance of 10K ohms. The intensity was controlled by a variable transformer that was set to deliver 60 V across the grid. The shock was scrambled by a silent electronic scrambler that provided effectively continuous shock (Flax & Hahn, 1967). The CS was produced by a Mallory Sonalert (Model 1168B), which provided a steady, high-pitched tone.

PROCEDURE

For training, the Ss were assigned randomly to one of the three following groups: Group 2-WN received standard shuttle-avoidance training; Group 1-WH received one-way avoidance training, being replaced into the "start" compartment 5 sec prior to CS onset; Group 2-WH received shuttle training like that of Group 2-WN, with the exception that they were picked up and immediately replaced in the same compartment 5 sec prior to CS onset, similar to Group 1-WH. This event was signaled by a relay-click, built into the apparatus, that was audible to S and that was present for all Ss, including the nonhandled ones. Placement of the 1-WH Ss on each trial was against the "start" compartment end wall, oriented towards the center door; on the other hand, when the 2-WH Ss were replaced in the compartments, the orientation they exhibited just before handling was preserved as much as possible. This was done in order to permit Ss to resume a freezing posture, since one possible effect of handling is to disrupt freezing behavior.

A trial started with the simultaneous onset of the CS and dropping of the door between the compartments. If S interrupted an infrared photobeam 6 in. inside the potentially safe compartment within the 5-sec CS-US interval, the CS terminated, shock was delayed for the 30-sec intertrial interval, and an avoidance response was recorded for that trial. If S failed to interrupt the beam within the designated 5 sec, the entire grid was electrified and remained so until S interrupted the safe-compartment photobeam, at which time both the tone and the shock were terminated for 30 sec, and an escape response was recorded. Each S received his entire 160 training trials in a single session, which lasted approximately 90 min.

RESULTS

Percent avoidance responses as a function of blocks of 20 training trials are presented in Fig. 1 for each of the three training groups. Because of the orderly progression of the functions depicted in Fig. 1, a one-way analysis of variance was applied to group percent avoidance responses for the entire course of training. Results of the analysis indicated a highly significant treatment effect [$F(2,15) = 66.80$, $p < .01$], the means of the 2-WN, 2-WH, and 1-WH groups being 15.17, 47.50, and 93.50, respectively. In order to determine the significance of specific differences, Scheffé's test for multiple comparisons among means was applied. Scheffé's test was used because recent evidence indicates that this test is the most appropriate test for such post hoc comparisons (Petrinovich & Hardyck, 1969). Results of this test showed significant differences between all three groups ($p < .01$).

From an examination of Fig. 1, it

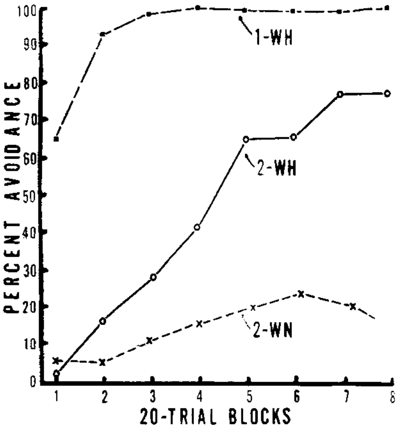

Fig. 1. Percent avoidance responses for the 1-WH, 2-WH, and 2-WN groups as a function of blocks of 20 training trials.

appears that the 2-WH group is comparable to the 2-WN group early in training, whereas the performance of the former group has improved considerably by the end of training, to a point more similar to the 1-WH group. In order to assess this effect, analysis of variance and Scheffé's test were applied to both early (Trial Blocks 1-3) and late (Trial Blocks 6-8) portions of training. Results of the analysis of percent avoidance responses early in training showed a significant effect [$F(2,15) = 177.42$, $p < .01$], with group means of 6.67 (2-WN), 6.00 (2-WH), and 75.00 (1-WH). Analysis of data from the late portion of training also showed a significant effect [$F(2,15) = 94.63$, $p < .01$], with group means of 17.17 (2-WN), 81.00 (2-WH), and 99.00 (1-WH). Scheffé's test revealed significant differences between the 2-WN and 2-WH groups ($p < .01$), and also between the two-way and one-way handled groups, although in this case only at the .05 level. These effects are reflected in Fig. 1 by shift of the 2-WH function from the 2-WN level in early training to a level much closer to that of the 1-WH group at the end of training.

DISCUSSION

The performance of the 2-WN and 1-WN groups is in accord with results of other investigators making the same comparison (Theois & Dunaway, 1964; Olton & Isaacson, 1968). By the end of training, the performance of the 2-WH group is what would be anticipated on the basis of the results presented by Wahlsten et al (1968)–in fact, both the 1-WH and the 2-WH groups of the present study appear to be superior to the handled and handled-escape groups of the Wahlsten study at comparable points in training. The relatively poor performance of the 2-WN group requires a note of explanation, although it is typical of standard shuttle groups run in this particular apparatus. The low percentage of avoidance responses appears to be the result of the 2-WN animals withdrawing or cringing from the noise of the door dropping. The Ss in this group then tend to remain crouched until shock onset causes them to run to the other compartment.

It is particularly important to consider the performance of the 2-WH group over the entire course of training. This group, which starts at a level identical with that of the 2-WN group, improves rapidly during the middle phase of training, so that by the end of training the 2-WH group is more similar to the 1-WH than to the 2-WN group. This change is indicative of a conditioning effect and suggests that handling acquired some significance as an additional cue during training. That handling did not merely serve to disrupt freezing behavior is suggested by the number of trials required for the two-way handled Ss to show an improvement in performance. In other words, the effects of such disruption should be evident earlier in training than these data show.

The results of two other studies also seem to be related to the effects of additional cues in shuttle avoidance. Olton & Isaacson (1968) found a decrement in performance when a light in the safe compartment, which originally served as a discriminative stimulus (but not as a CS), was left on continuously. On the other hand, Freedman & Callahan (1968), using either light or tone as a CS on different trials, reported no differences between a group that always received a particular CS on a particular side and a group that received these same CSs on a random schedule. Those authors concluded (p. 342) that rats do not attend to the CS as a differential cue. Collectively, the data from the present study and these latter two suggest that shuttle-avoidance responding might be facilitated by use of an additional cue prior to CS onset, which can serve a function analogous to a "ready signal" in signal-detection studies. Similarly, the spatial reorientation of the apparatus in the Baum & Bobrow (1966) and the Olton & Isaacson (1968) studies, since it occurred shortly before CS onset, could also have served as a warning stimulus.

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Scopolamine's effect on passive avoidance*

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Comparison in performance on active and passive retention tests was made for mice that had received scopolamine prior to a single passive-avoidance training trial. Control animals performed well with either retention test procedure, while the scopolamine group performed well for the active test but poorly for the passive test.

In an earlier paper (Calhoun & Murphy, 1969), we showed that mice could be trained under conditions of passive-avoidance but tested for retention with either active- or passive-avoidance procedures. This technique is superior to one where only a single measure of retention is obtained; an animal should perform appropriately with either test method if the initial training had been effective. From results in separate experiments, it appears that scopolamine disrupts passive-avoidance performance (Bohdanecky & Jarvik, 1967; Calhoun & Smith, 1968) but facilitates active-avoidance performance (Oliverio, 1967). To test the drug effect more thoroughly, we conducted the experiment reported here in which passive-avoidance training was used, but retention was tested with active- and passive-avoidance

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