AVOIDANCE LEARNING IN DOGS WITHOUT A WARNING STIMULUS[1]

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In previous research on avoidance learning in dogs (Solomon & Wynne, 1953; Solomon, Kamin, & Wynne, 1953; Solomon & Brush, 1956), the operant of jumping between compartments of a shuttle box was used with considerable success. However, this research was concerned with avoidance-learning situations involving a discriminative or "warning" stimulus. The present experiments were undertaken in order to determine whether this jumping operant could also be used effectively in studying avoidance behavior without a warning stimulus. This response is normally more effortful than either bar pressing or key pecking. Also, it requires a total change of position of the organism, thereby exposing it to an alternating set of stimulus conditions. It lies somewhere between clearly discrete responses such as key pecking and continuous responses such as maze running in terms of the movements involved. However, for purposes of measurement, it can easily be treated as a discrete response.

Conditions affecting acquisition of avoidance behavior were studied. Also, the effects of punishment and a drug on the maintenance of avoidance behavior were explored in order to determine the sensitivity of the jumping responses to experimental manipulation.

SUBJECTS AND APPARATUS

The *S*s were 15 naive adult mongrel dogs. The apparatus was a modified Miller-Mowrer shuttle box (Solomon & Wynne, 1953). The avoidance response was jumping between compartments of the shuttle box over a barrier approximately 16 inches high. Responses were recorded automatically by the operation of photocells beamed across each compartment of the shuttle box. Mirrors were used to reflect the beam of each photocell so that it covered a vertical plane with a height of about 20 inches and a width equal to that of the shuttle box. Each of these two planes was parallel and adjacent to the opening over the barrier through which the dog jumped. The jumping dog intercepted the first plane about 3 inches before reaching the barrier, and the second plane about 3 inches after going over the barrier. The recording circuit was arranged as follows. When the dog jumped from one side of the shuttle box to the other, a response was recorded only when the beam on the second side was broken and the beam on the first side was not. In other words, the dog had to be completely out of the first side before a response was said to have occurred. This prevented the recording of partial jumps and spurious movements as responses. A 4.5-milliampere A.C., 60-cycle electric shock was delivered to the dog through grid bars which formed the floor of the shuttle box.

ACQUISITION

Although considerable research on the maintenance of avoidance behavior has been reported, little work has been published on the effects of temporal parameters on acquisition. In this experiment the effects of different S-S intervals were explored.

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Method

All 15 dogs were used in this part of the experiment. Each animal was used in at least two experimental sessions. A session usually lasted for 2 hours. However, if the subject failed to avoid shock, the session was terminated after 1 hour. During the first 10 minutes of each session, no shocks were administered.

The procedure which was used has been described in detail by Sidman (1953). When no responses occurred, brief shocks were presented in a continuous series separated by a fixed interval of time (the S-S interval). When a response did occur, the next shock was delayed for a given period (the R-S interval). The R-S interval was always 30 seconds. Three dogs were run using a 15-second S-S interval; seven were run using a 4-second S-S interval; five were run using a 0-second S-S interval. (Shock in this group was continuous and was terminated only when the dog jumped.) In all but the 0-second interval group, the shock lasted for 0.25 second.

Results and Discussion

All twelve dogs in the 0- and 4-second S-S interval groups were rapidly conditioned to jump, but none of the dogs in the 15-second S-S interval group. Each of the dogs in this latter group made a few responses during the early stages of acquisition, and then stopped jumping altogether. Examples of cumulative records of dogs in each of these groups for the first two experimental sessions are shown in Fig. 1. An examination of the first session for each dog shows that two dogs in the 0- and 4-second S-S interval groups were avoiding regularly by the end of the first experimental session, while the dog in the 15-second S-S interval group made no avoidance responses after the first few minutes.

Table 1 shows some indices of acquisition of avoidance responding for dogs in the 0- and 4-second S-S intervals. A comparison between the groups on the indices of acquisition in Table 1 shows no significant differences between groups, although the medians for the 4-second S-S interval group are lower than those for the 0-second S-S interval group.

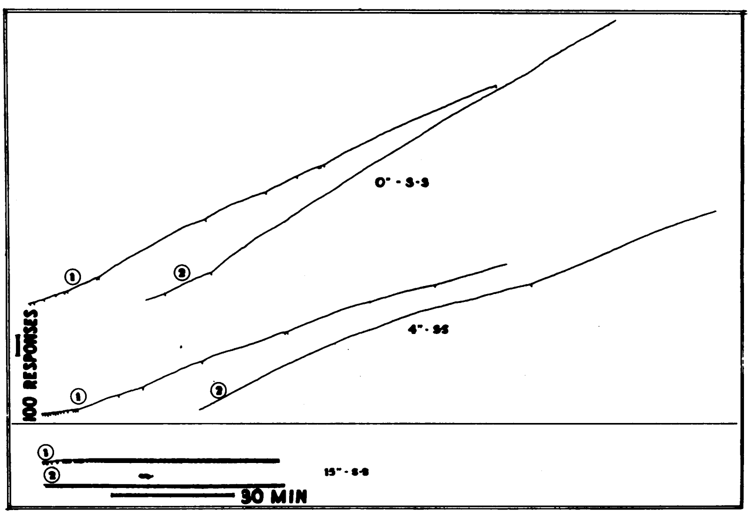

Figure 1. Cumulative records of three dogs showing the first two avoidance sessions. Each dog was conditioned at a different S-S interval as shown in the figure. The R-S interval was 30 seconds for all dogs. Shocks are shown by the vertical marks on each record.

Table 1
Indices of Acquisition of the Avoidance Response

S-S interval group	Time in minutes before a period without shock		Number of shocks on Day 2
0 second	10-minute period	30-minute period	
Median	34.6	77.2	3
Range	17.9–46.8	34.6–130.6	1–11
4 second			
Median	47.0	126.0	7
Range	8.8–107.4	60.2–244.0	0–198

The three dogs which had failed to avoid shock on the 15-second S-S interval were then run on a 4-second S-S interval. Two out of the three still failed to avoid shock, whereas all seven dogs that were run on the 4-second S-S interval were conditioned to jump from the very beginning. It would seem that prior exposure to the 15-second S-S interval had an adverse effect on later avoidance learning.

These results indicate that acquisition of the avoidance response proceeds more rapidly when shorter S-S intervals are used. Further, animals which fail to learn to avoid under a given schedule may be engaging in some other behavior which interferes with the required response when a more suitable schedule of reinforcement is instituted. Finally, the response is maintained with very few shocks, once it has been conditioned.

VARIABLES AFFECTING AVOIDANCE BEHAVIOR

Punishment

In the present experiment the effects of punishment on an avoidance response which was conditioned without a discriminative stimulus is described.

Method. The subjects were six of the dogs used in the previous experiment which had reached a stable rate of responding. A tone was sounded for approximately 5 minutes four times during each 2-hour experimental session. These 5-minute periods when the tone was on were called the punishment periods. While the tone was on, the previously used shock contingencies were ineffective, and every jump was immediately followed by a 0.25-second shock. When the tone was not on, the dog could avoid shock by jumping in the usual manner.

Results and Discussion. Figure 2 shows three examples of behavior during the first presentation of tone. The first effect of punishment is an increase in rate. All animals eventually stopped responding during the punishment period, however. The initial increase in rate of response produced by the punishment procedure is similar to the results reported by Sidman, Herrnstein, and Conrad (1957), who studied the effect of superimposing a stimulus followed by a free shock on avoidance behavior in monkeys. Solomon, Kamin, and Wynne (1953) also noted that punishment of the avoidance response decreased the latency of response in many dogs in situations using a discriminative or warning stimulus.

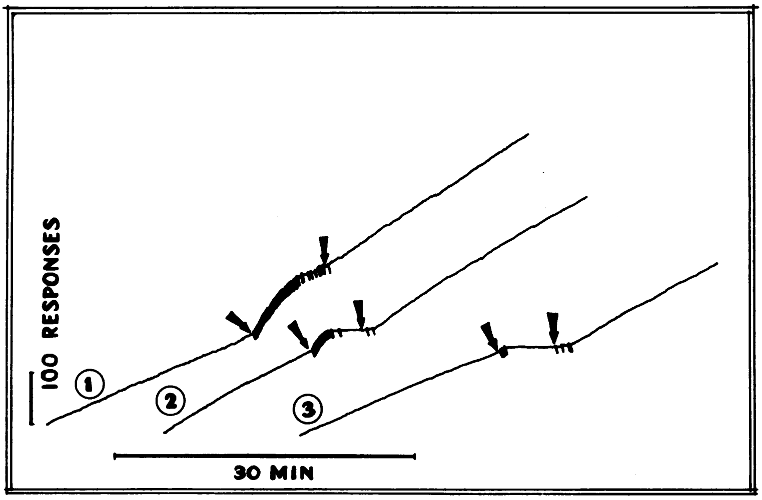

Figure 2. Sample cumulative records for three dogs showing the first punishment period for each. The arrows show the onset and termination of the punishment periods.

The main variable associated with speed of suppression of responding produced by punishment seems to be the amount of previous avoidance experience. Two dogs which had received over 14 hours of avoidance experience before the punishment procedure began showed a marked increase in rate when first punished, and took longer to suppress completely in the presence of tone. For the four dogs which received less than 6 hours under the avoidance condition before punishment began, the increase in rate at the beginning of the punishment condition was of shorter duration and total suppression was achieved more quickly.

Figure 3 presents data on the development of suppression for two animals. The inflection ratio (the responses for 5 minutes during the tone over the sum of the responses for 5 minutes before the tone and 5 minutes during the tone) on the first 12 punishment periods is presented.

The dog which had 17 hours of previous avoidance experience (A) showed a prolonged increase in rate before it stopped responding during the punishment period. The other dog (B) had only 4 hours of training before the punishment periods began, and rapidly ceased responding in the presence of tone.

Drug Effects

Method. When each animal was avoiding regularly during the periods when no tone was presented and also making no more than a few responses during the punishment periods, the drug procedures were initiated. Three dogs were run for daily sessions, 15 minutes after an injection of 1 milligram per kilogram of amphetamine, one dog after an injection of 5 milligrams per kilogram of amphetamine, and one dog after an injection of 10 milligrams per kilogram of amphetamine.

Results and Discussion. Amphetamine produced an increase in rate of avoidance responding. (See Fig. 4.) The magnitude of the drug effect seemed to be related to the level of avoidance responding in the normal state when the dose level was held constant. This effect has been noted in other experimental situations (Dews, 1958). At a dose level of

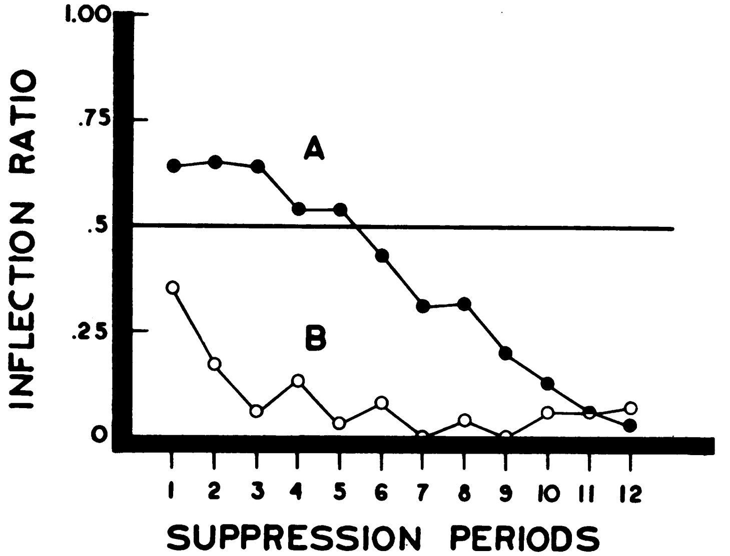

Figure 3. Inflection ratios for two dogs during the first 12 punishment periods. Dog A had received 17 hours of avoidance training before punishment; Dog B, 4 hours of avoidance training before punishment.

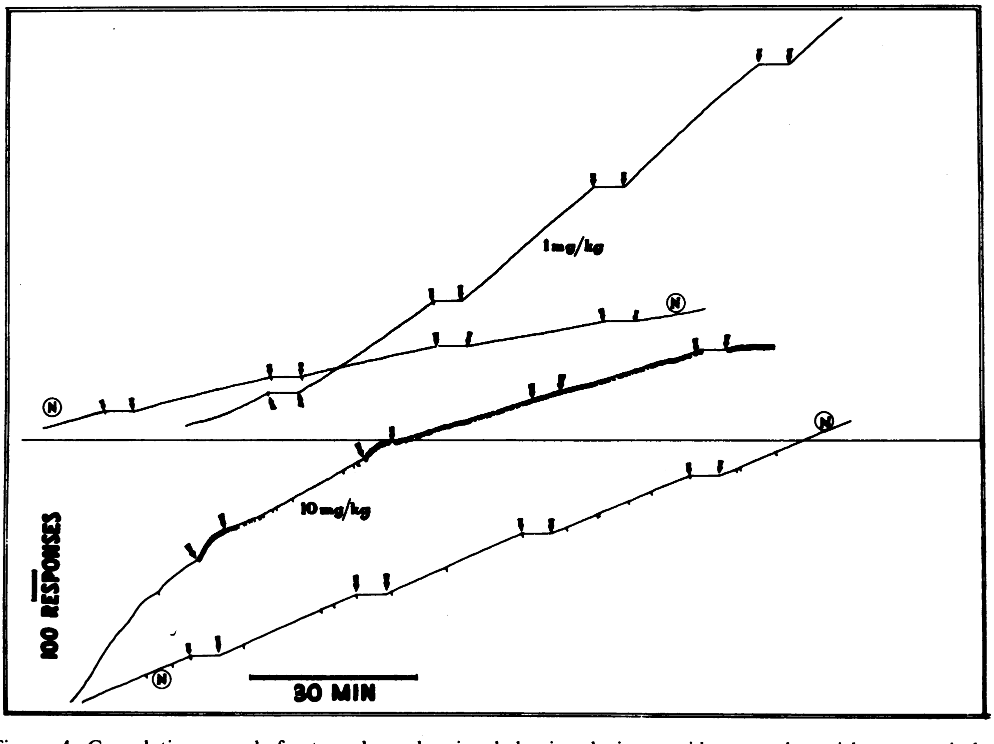

Figure 4. Cumulative records for two dogs showing behavior during avoidance and punishment periods on the day preceding drug administration (N) and on the day that amphetamine was administered.

1 milligram per kilogram, the higher the rate of avoidance responding on the day prior to injection the less the drug effect.

The drug had no noticeable effect during the punishment period at a dose of 1 milligram per kilogram. The animals continued to show almost complete suppression of avoidance behavior. However, higher dose levels produced an increase in rate of responding during punishment periods. Figure 4 shows records for two dogs, the first receiving a dose of 1 milligram per kilogram, the second a dose of 10 milligrams per kilogram. Although avoidance responding in both animals increases, the punishment period is affected only in the latter animal.

The dog which had received 10 milligrams per kilogram during the first two punishment periods behaved in a manner that was almost identical to that shown by animals on the first exposure to punishment. Discrimination between avoidance and punishment periods appeared to be poor. Following the second punishment period under the dose of 10 milligrams per kilogram, the avoidance behavior rapidly deteriorated, and the dog died shortly after the third punishment period. The dog injected with 5 milligrams per kilogram of amphetamine also died following exposure to the avoidance and punishment schedules. Both of these dogs had been tested with the same doses a few days before the experimental sessions described above, and left in their home cages. No ill effects were observed. The interaction of amphetamine with the other variables controlling behavior appeared to have a more drastic effect. Dosage levels which do not appear to have deleterious effects in the home cage do so when the dog is working under aversive schedules of reinforcement. Similar interactions between amphetamine and other variables controlling behavior have been reported (Lasagna & McCann, 1957; Weiss & Laties, 1959).

CONCLUSION

These results suggest that the jumping operant is an effective response for studying avoidance behavior without a warning stimulus in dogs. Under appropriate conditions, acquisition is rapid and the response is maintained at a stable rate by very few shocks. The rate of responding is sensitive to various experimental manipulations such as changes in parameter values and the effects of a drug. Also, the dog discriminates clearly among schedules of reinforcement, for example, between regular avoidance and punishment periods.

SUMMARY

Dogs were trained to avoid an intense shock by jumping across the barrier of a shuttle box. No warning stimulus was used. The effects of different S-S intervals, of punishment, and of a drug on the avoidance response were explored. Conditioning was rapid at short S-S intervals. Once the avoidance response had been acquired, it was maintained with relatively few shocks. Punishment produced an increase in avoidance rate followed by a decrease. The increase in rate was of longer duration for animals which had more avoidance experience. Amphetamine increased the rate of avoidance responding.

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