Strain differences in avoidance learning¹

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Abstract

Twenty-four Tryon rats, 14 S_1 and 10 S_3 , were given 100 trials in a wheel turn avoidance apparatus. In addition, 3 Ss of each strain were run for 9 more days. The S_1 strain showed significantly superior avoidance performance initially and maintained this superiority on subsequent sessions. No evidence of avoidance decrement was found for either strain. These results were interpreted as being consistent with both a CER and a neural perseveration-consolidation explanation.

Problem

Several studies have shown that behavioral differences exist between the descendants of the Tryon Maze Bright (S_1) and Maze Dull (S_3) strains (Madsen & McGaugh, 1961, McGaugh et al, 1962; Tapp, 1964) although these differences are not identical to those of the original selection produced by Tryon (Rowland & Woods, 1961). Tapp (1964), using a suppression technique, found that the S_1 strain acquired a conditioned emotional response (CER) faster than the S_3 strain. If the acquisition of a CER is necessary for the acquisition of a conditioned avoidance response, then the S_1 strain should show better avoidance performance than the S_3 strain. The present study compares the avoidance performance of the two Tryon strains in a wheel-turn avoidance situation.

Method

The Ss were 24 experimentally naive, female rats (14 of the S_1 and 10 of the S_3 strain) obtained from the colony maintained by the Psychology Department at Michigan State University. The age range for each strain was 150 to 260 days old but the S_1 strain tended to be somewhat older.

All Ss were run in two identical wheel-turn chambers. Responses were monitored and CS and US presented by electrical programming equipment and appropriate relay circuitry. The apparatus is described in detail elsewhere (Zerbolio et al, 1965).

All Ss received 100 trials in a single session. A 65 db electronic buzzer served as the CS and was paired with 1.0 ma shock. The shock was delivered to stainless steel grid floors by Grason-Stadler shocker scramblers, Model E1064GS. The CS-US interval was 5 sec. and both CS and US were response terminated when S made a 1/4 wheel turn. A variable intertrial interval with a mean of 80 sec. and ranging from 40-120 sec. was used. Background white noise at 40 db was present in the experimental chambers at all times.

In addition, six of the Ss (three from each strain) received 100 trials per day for the next nine days. Thus, these six Ss received a total of 1000 trials. The experimental conditions on each of the successive days were identical to those of day one.

TABLE I
TRANSFORMED DATA MEANS AND STANDARD DEVIATION
FOR THE NUMBER OF AVOIDANCES AND NUMBER OF 1/4
WHEEL TURNS FOR THE S_1 AND S_3 STRAINS. THE RAW
DATA MEANS APPEAR IN PARENTHESIS

	Bright (N = 14)	Dull (N = 10)	t
Mean Avoidances	8.14 (65.2)	6.51 (45.9)	2.65
S D	1.14	1.88	p < .02
Mean 1/4 Wheel turns	73.26 (5834)	62.14 (4147)	1.32
S D	69.7	56.2	p > .05

Results

The mean number of avoidance responses and 1/4 wheel turns for the two strains were compared. These results are summarized in Table I. A square-root transformation was performed on the data in order to reduce variance. After transformation, F-tests indicated homogeneity of variance for both avoidances and wheel turns ($F=2.76$; $df=9/13$; $p>.05$ and $F=1.53$; $df=9/13$; $p>.05$ respectively). The S_1 strain made significantly more avoidances than the S_3 strain ($t=2.65$; $df=22$; $p<.02$), but the strains did not differ significantly when number of wheel turns were compared ($t=1.32$; $df=22$; $p>.05$) although again the S_1 strain was superior.

In order to determine the effects of continued training for the six Ss which received daily sessions for 10 consecutive days, an analysis of variance was performed on both their avoidance scores and their wheel turn rates. As before, wheel turn rates were transformed to a square root scale before analysis. In general, both strains reached asymptotic avoidance levels and remained there without showing a consistent decrement in avoidance performance, which is indicated by a non-significant days of training effect ($F=1.19$; $df=9/36$; $p>.05$). But the S_1 strain reached and maintained a significantly higher asymptotic avoidance level than the S_3 strain ($F=9.857$; $df=1/4$; $p<.05$). A significant days x strain interaction ($F=4.302$; $df=4/36$; $p<.01$) was also obtained, indicating different effects of continued training on the two strains. Table 2 shows the mean avoidance levels for both strains over the 10 days of training.

The analysis of the wheel turn data found only a significant days x strain interaction ($F=3.346$; $df=9/36$; $p<.01$) which appears as a cross over in wheel turn rates after day one as indicated by the mean (untransformed) wheel turn rates for the two strains in Table 2. From the second day of training on, the S_3 strain made on the average, more wheel turns than the S_1 strain, but avoided significantly less often. It is possible that

TABLE 2
THE MEAN AVOIDANCE PERFORMANCE AND 1/4 WHEEL-TURN
RATES FOR Ss OF BOTH STRAINS FOR
10 CONSECUTIVE DAYS OF TRAINING

Strain	Days	1	2	3	4	5	6	7	8	9	10
S ₁	Mean Number of Avoidances	71.3	87.3	84.7	89.7	86.7	92.3	87.7	83.7	78.0	86.0
S ₁ (Bright) N = 3	Mean Number of 1/4 Wheel turns	4956	2136	1288	1189	1392	1814	2033	1490	1491	1296
S ₃	Mean Number of Avoidances	21.0	36.7	26.3	17.0	33.3	34.7	36.7	38.0	43.0	46.0
S ₃ (Dull) N = 3	Mean Number of 1/4 Wheel turns	1850	2758	3620	2352	3154	2470	2381	2426	1936	1872

the members of the bright and dull strain used in the continued training experiment might have been better and poor learners respectively, since their first day means do differ from the avoidance data for the initial avoidance learning experiment. However, these first day continued training performances are within the ranges of the one day training means.

Discussion

The superiority of the S₁ strain for an avoidance task is consistent with previous positive reinforcement studies. But the finding that the S₁ strain maintains this superiority over several avoidance training sessions has not been observed before.

The superior avoidance performance of the S₁ strain in the present study is consistent with the contention that CER is a necessary component in the acquisition of an avoidance response. An alternative explanation is that the S₁ strain neurally perseverates faster than the S₃ strain, and thereby produces more rapid consolidation of the habit to be learned. Presumably this latter explanation could account for both the rapid acquisition of CER (Tapp, 1964) and avoidance behavior in the S₁ strain.

The Ss given repeated acquisition sessions reached asymptote and remained there although Reynierse et al (1964) obtained the decrement effect in our apparatus

when albino rats were used. Yet this current failure to find a decrement in avoidance performance with continued training confirms the importance of the strain variable for obtaining the decrement effect (Nakamura & Anderson, 1962).

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Notes

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2. Now at Indiana University.