

# Response strategies after overtraining in the jumping stand\*

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Rats were trained to criterion (CT) and overtrained (OT) on a horizontal against vertical stripes discrimination in the jumping stand. A change in response strategy, from inspecting both stimuli to inspecting just the S-, was observed during overtraining. Replacing the S- with a novel stimulus disrupted performance in the OT Ss, but replacing the S+ did not. Performance in the CT Ss was disrupted, but not very severely, both when the S+ was replaced and when the S- was replaced. These results suggest that OT Ss in the jumping stand come to rely especially upon the S-. The overtraining effects found here are compared with those found in other types of apparatus.

There has recently been an increase in interest in the "response strategies" that animals show when learning discrimination problems. Siegel (1967) reports that rats may learn a discrimination in the T-maze by using a "reorientation strategy." Animals with this strategy, even when they had mastered the problem, persisted in showing a sort of position habit: they consistently approached one of the goalboxes (left or right) on each trial but turned away from the preferred position when it contained the negative stimulus (S-). Siegel's apparatus was specially modified to demonstrate strategies of this kind, but similar effects have been found in a standard Y-maze. Mandler (1966) and Mandler and Hooper (1967) describe for this apparatus a similar strategy which they call a "detour strategy." They also report that this strategy disappears when the animals are given an extended period of training after they have learned the problem. It is replaced by a "choice point strategy" in which the animals pause at the choice point of the maze and scan the stimuli before approaching the S+.

Do similar strategies emerge when rats are trained (and overtrained) in the jumping stand? Hall (1973) found that the detour strategy developed when rats were overtrained on a discrimination of horizontal against vertical stripes. The present experiment attempts to elucidate the role of the detour strategy, to determine if animals with different strategies have learned their discrimination problems in different ways. In particular, it tries to assess the relative importance of the two stimuli (S+ and S-) which, according to Mandler and Hooper, may be related to the strategies that the animals show. They suggest that a detour strategy may "... train the animal to pay more attention to S- than to S+, since it is only in the presence of S- that it must execute the fairly complex response of slowing down and turning round [Mandler & Hooper, 1967, p. 148]."

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## METHOD

### Subjects

The Ss were 32 female hooded rats, 100 days old at the start of the experiment. They were maintained on a schedule of food deprivation, being allowed access to food for only 2 h each day following experimental treatment.

### Apparatus

A modified jumping stand was used, based on that described by Mackintosh (1962). It consisted of a goalbox with two adjacent doors and with landing platforms 14 cm wide and 4 cm deep fixed in front of each door. The Ss jumped from a stand shaped like a small elevated Y-maze, the stem 17 cm long, the arms 18 cm long and 6.5 cm wide, each arm facing one of the goalbox doors. Beneath each arm was a sensitive switch which was operated when a S moved onto the arm and which thus enabled a record to be made of the S's movements before the jump. Typically a S would move to and fro between the arms several times, facing each goalbox door successively, before making its jump. A movement from one arm to the other was scored as one "VTE." A timer recorded latency to jump to a landing platform. The goalbox doors, 14 cm square, were themselves the stimulus objects. In pretraining, the doors bore alternating black and white stripes 1.3 cm wide running diagonally. The training stimuli had similar stripes running horizontally (H) and vertically (V). In the test stage of the experiment, a door with a plain gray face (G) was used.

### Design and Procedure

In pretraining, the Ss learned to cross from the Y stand to the goalbox. The gap between stand and goalbox platform was gradually increased until the Ss could jump across a gap of 17 cm. A "forcing" procedure was used to ensure that the animals had equal experience of both paths to the goalbox. Discrimination training was given at 10 noncorrection<sup>1</sup> trials per day, the interval between trials being about 5 min. The reward for a correct response was four 45-mg sugar pellets; after an incorrect response, the animal was detained on the landing platform in front of the locked goalbox door for 15 sec. The positions of the stimuli were changed between trials according to a sequence which ensured that each appeared on the left and on the right five times each day. The criterion of learning was 18 correct responses over 2 days with the last 10 all correct.

The experiment had three stages. First, the Ss were trained to criterion on the H against V discrimination (half having H as S+ and half having V). Eight of the H+ and eight of the V+ Ss were then given 150 trials of overtraining (the OT group): the

**Table 1**  
Acquisition and Test Phase Scores\*

Score	CT		OT	
	S+	S-	S+	S-
Trials to Criterion in Acquisition	67.50	57.25	63.75	61.25
Errors on First Day of Test	1.12	2.00	0.37	2.87
Ss Making Errors on Test	3	4	1	7

\*The first two rows give group means (N = 8). The last row gives the number of Ss falling into the category described. S+ and S- refer to the stimulus replaced by G in the test phase.

remaining Ss (the CT group) went on immediately to the third stage. In the third (test) stage, all the Ss were given a new problem in which either the original S+ or the original S- was replaced by the G stimulus door. For half of each group (OT and CT) the S+ was replaced, and for the others S- was replaced. The test phase lasted for 30 trials. Correct jumps were rewarded as usual. e.g., if S+ was replaced, jumps to G were rewarded.

**RESULTS**

Table 1 gives the number of trials the Ss took in reaching criterion on the initial discrimination; these scores include the 20 trials over which the criterion was reached. It also presents the error scores of the four groups in the test phase. The changes in latency that occurred during acquisition, overtraining, and in the test phase are shown in Fig. 1. Figure 2 presents the group mean daily VTE scores. In both these figures, the acquisition scores are plotted backward from criterion, and in both the test data for the CT groups are displaced to the right to facilitate comparison with the performance of the OT groups.

**Acquisition**

The four main groups shown in Table 1 (which in this

phase had identical treatment) did not differ significantly in the number of trials they took to reach criterion (Kruskal-Wallis test,  $H = 0.236$ ,  $df = 3$ ). Most animals adopted position habits before they learned the problem; they had short latencies and showed little or no VTE. But as the criterion was reached, latencies lengthened and VTE increased. On the last day of acquisition, the Ss spent, on the average, 25 sec on each trial moving to and fro in front of the stimuli before they jumped. The mean number of VTEs made on that day was 11.5. The latencies of the four groups did not differ significantly ( $H = 1.013$ ,  $df = 3$ ), nor, despite the appearance of the means in Fig. 2, did the VTE scores ( $H = 2.749$ ,  $df = 3$ ).

**Overtraining**

The performance of the OT animals was nearly perfect during their overtraining. Only six Ss made errors, and only one made more than one error. During the last 60 trials of overtraining, no errors at all were made.

Latencies declined during overtraining so that, on the average, the OT animals came to respond within about 5 sec on each trial (see Fig. 1). This decline was statistically significant; comparing each OT animal's latency score on the last day of overtraining with its score on the day on which it reached criterion gives a difference significant at  $p < .01$  by the Wilcoxon test. (The two OT groups were combined for this analysis, since they were still receiving identical treatment in this phase of the experiment.) Overtraining also produced a decline in the VTE scores which was again statistically significant ( $p < .01$ , Wilcoxon test). Thus, at criterion, the Ss moved to and fro between the stimuli before jumping, but with overtraining they came to make their choice quite rapidly and with less VTE. VTE did not disappear completely, however; Fig. 2 shows that over the last 5 days of overtraining, Ss made an average of

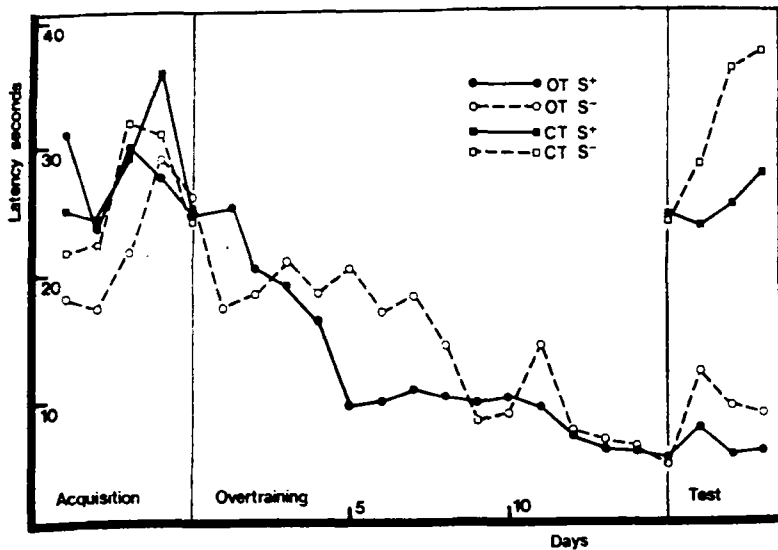
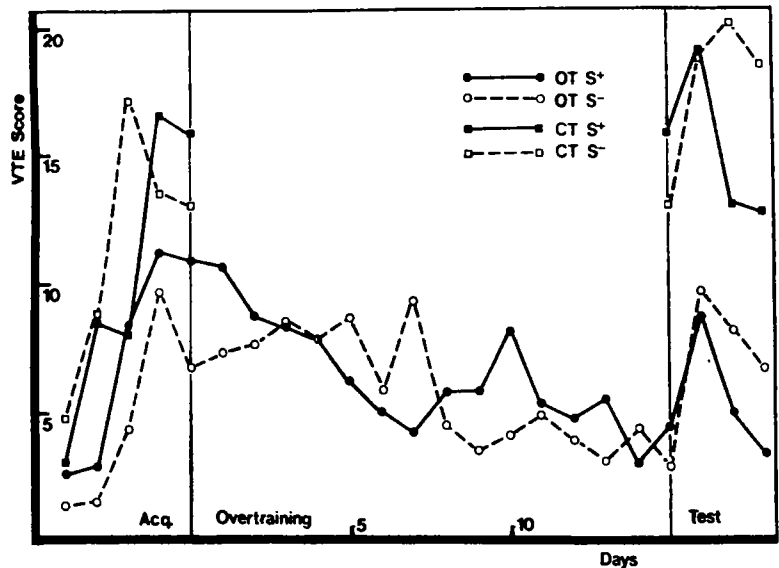


Fig. 1. Latencies: each animal's median daily latency per trial was scored. This figure gives group medians for the four main groups in acquisition, overtraining, and test. The scores given for acquisition are those made on the 5 days before the criterion was reached and are plotted backward from criterion. In each group, N = 8.

Fig. 2. VTE scores: on each day, the total number of VTEs made by each animal was scored. The figure gives group means. All other details are as in Fig. 1.



about five VTEs a day (per 10 trials). Tolman and Minuim (1942) have reported a similar decline in VTE for rats overtrained on a black against white discrimination in the jumping stand.

During acquisition, most of the Ss took up position habits before they solved the problem. Vestigial position habits remained during overtraining. The animals tended to approach a preferred position in the apparatus (a preferred arm of the Y stand) at the start of each trial before they began to exhibit VTE. For each animal, the number of trials on which it showed a preference for one position was determined for each day of overtraining, and these daily scores were then totalled. By expressing this total as a percentage of the total number of overtraining trials, we can derive a "preference score" with a score of 100% meaning a firm preference for making an initial movement to one position. The mean preference score for the OT Ss was 79.8%.

### Test Stage

The test, in effect, presents the Ss with a new discrimination which they must learn. But, of course, there was considerable positive transfer from their previous training; 17 Ss made no errors at all and only 2 animals made errors after the first day of the test. Both were CT animals faced with the discrimination G vs H and both reverted to position habits. One animal was in the S+ replacement group, the other in the S- replacement group.

The four main groups differed in the number of errors they made on the first day of the test phase (Kruskal-Wallis test,  $p = .05$ ). Testing the groups individually showed that the OT S- group made more errors than the OT S+ group (Mann-Whitney U test,  $p = .01$ ), but the difference between the CT groups was not significant (U test). The mean scores in Table 1 suggest that overtraining might have its effect both by improving the performance of the OT S+ group and by retarding

that of the OT S- group (with respect to the performance of the CT groups). But this effect was not borne out statistically; U tests comparing the error scores of the OT S+ and CT S+ and the OT S- and CT S- groups showed no significant differences. However, the other results given in the table support this interpretation. The distribution of animals making errors in the OT S+ group and in the OT S- group is as we would expect (i.e., few in the first group and many in the second) and is statistically significant (in both cases,  $p = .035$ , one-tailed binomial test). But in neither of the CT groups does the distribution differ from chance expectation (binomial tests).

On the first day of the test, VTE increased in both OT groups to 9.7 VTEs per day in the OT S- group and to 8.5 per day in the OT S+ group (group means). These increases were significant ( $p < .05$ , Wilcoxon test). In all groups, VTE scores were very variable, and there were no significant differences among them on the first test day (Kruskal-Wallis test). However, by the last day of the test phase, the mean VTE scores of the OT Ss had declined to 3.7 in the OT S+ group and to 6.2 in the OT S- group, the scores of the CT groups remaining high at 12.8 in the CT S+ group and 18.5 in the CT S- group. There were significant differences among the groups ( $p < .02$ , Kruskal-Wallis test). The CT S+ and OT S+ groups differed in the VTE they showed on this day ( $p = .01$ ), as did the S- groups ( $p = .05$ , U tests). Thus, there is some evidence that the reduction in VTE produced by overtraining reappeared after the initial disruption produced by the changed conditions of the test.

### DISCUSSION

The pattern of errors that the Ss showed in the test stage was influenced by overtraining. While CT Ss made some errors both when the S+ was replaced and when the S- was replaced, the performance of the OT Ss was disrupted by the replacement of the S-, but not by the

replacement of the S+. A reliance on the S- after overtraining has not been found in previous experiments (Stevens & Schofield, 1968; Mandler, 1968, 1970, 1971), and it may be an effect that depends critically upon the techniques of training. Mandler and Hooper (1967) suggest that the S- will be the important stimulus when the Ss must "execute the fairly complex response of slowing down and turning round" in front of it, i.e., when the Ss have a detour strategy. Since Mandler has shown that the detour strategy in the Y-maze disappears with overtraining, we should not expect to find the S- to be especially important after overtraining in this apparatus. However, the response strategies shown in the jumping stand are rather different.

At criterion, the Ss have high latencies and VTE scores: they spend much time moving back and forth between the arms of the Y stand before they jump. But with overtraining, they develop a detour strategy. Upon being put into the apparatus, the OT rat produces a smooth and rapid movement which brings him opposite one stimulus (the one on the left, say). If this stimulus is the S+, the rat jumps. But if this stimulus is the S-, the rat swings quickly over to the right and then jumps—hence, the short latencies at the end of overtraining and the low VTE scores; one VTE is required on each of the trials in which the rat is confronted with the S- on his preferred side, i.e., only five trials each day. These are strategies that are compatible with the stimulus replacement results. It is not surprising that the CT animal that is exposed to both stimuli on each trial is not especially dependent upon just one of the stimuli. But the OT animal has developed a pattern of behavior that is best described by the rule: "upon being put into the apparatus move to the preferred side and jump unless the S- is there." With this rule, the S- is the only external stimulus that is needed for correct performance to be maintained once the response has been initiated. All the S needs to do is to determine whether the stimulus on his preferred side is or is not the S-. A stimulus that is not the S-, be it the S+ or a novel gray card, will be jumped to.

This pattern of behavior has been observed before in an experiment by Hunter (1952). Rats were trained to swim down a water-filled alley and to escape from it by one of two doors at its end. These doors bore the objects to be discriminated—white squares of different sizes. Two of the rats learned the problem by using a detour strategy, swimming close to the door on their preferred side and turning away if its stimulus was the S-. When given a transposition test, these animals failed completely since they always attempted to open the door on their preferred side unless it bore the original S-, a result that parallels exactly the above finding for OT rats in the jumping stand.

These findings suggest that the effect of giving an animal overtraining on a discrimination is not simply to continue the strengthening of processes that were being strengthened in acquisition. Rather, the changes that are

observed to take place as a result of overtraining in the jumping stand can be seen as qualitative changes—from one mode of solving the problem to another. This conclusion makes it unsurprising that CT and OT animals should differ in the rate at which they learn a reversal; the two groups have learned different things initially.

A further point concerns the difference between the strategies found in the jumping stand and those that Mandler reports for the Y-maze. An influential theory that concerns overtraining and discrimination learning (Sutherland & Mackintosh, 1971) has been largely derived from experiments that use the jumping stand. But since the response strategies that are developed in the jumping stand at various stages of training differ from those found in the maze, care should be taken in extending the theory to experimental findings from other types of apparatus.

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## NOTE

1. "Noncorrection" here means that an incorrect response terminated the trial. However, it is not unlike the correction procedure sometimes used in the maze in that the S was able to move down one arm of the Y stand, close to a stimulus, and then turn away without making the final response (a jump in this case).