Effects of overtraining on Intra- and extra-dimensional shifts

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Rats were trained in a jumping stand on a simultaneous orientation or brightness discrimination and were then switched to a different orientation problem involving either an intra- or extradimensional shift. Overtraining at the first stage facilitated extradimensional-shift learning. The two kinds of shift learning had equal retroactive effects on retention of the original discrimination.

According to Sutherland's (1964) theory of discrimination learning, the main effect of overtraining on a discrimination is to strengthen the analyzer for the dimension discriminated; the theory appears to predict that overtrained animals should learn an intradimensional shift (IDS) faster than nonovertrained, but that they should be retarded on an extradimensional shift (EDS). The latter result has been obtained several times where the cue relevant during original training was present as an irrelevant cue during EDS learning (e.g., Goodwin & Lawrence, 1955; Mackintosh, 1963; Schade & Bitterman, 1965). It has only once been obtained in rats when a constant or neutral value of the relevant first-stage cue was used during the shift training (Mackintosh, 1962). Other experiments employing this design have either found that overtraining increases the rate at which an EDS is learned (Komaki, 1961; Mandler, 1966; Mandler, 1968) or have found no effect of overtraining (Tighe, Brown, & Youngs, 1965). Mackintosh's result was obtained in a jumping stand; the other studies used different apparatuses. The present experiment investigates whether the difference between the results obtained by Mackintosh and by others is a function of the apparatus used. We repeated Mackintosh's experiment using the same apparatus but different stimuli.

Since overtraining should benefit an intradimensional nonreversal switch, additional groups were included to test this prediction. Finally we included a test at the end of the experiment to discover whether interpolated IDS and EDS learning have differential retroactive effects on the retention of the original discrimination.

METHOD

The Ss were 32 naive 100-day-old female Norwegian hooded rats. Ten days before the experiment began Ss were placed on a 24-h

feeding schedule with 1.5 h ad lib food per day. The apparatus was a modified Lashley jumping stand with landing platforms in front of the stimulus windows as described by Mackintosh (1962). The stimuli used were 5 x 5 cm squares and 10 x 2.5 cm rectangles; the rectangles were presented horizontally, vertically, or in opposite 45-deg diagonal orientations. The stimuli were cut from ¼-in. black and white Perspex and were mounted centrally on grey hard-board doors. All Ss were pretrained to jump to grey doors. During training 10 trials a day were given with an intertrial interval of about 5 min. Correct jumps were rewarded by 15-sec access to wet mash and a correction procedure was employed. The experiment was conducted in three stages and involved a 2 by 2 by 2 factorial design.

Stage 1

All Ss were trained on a simultaneous discrimination. Group ED were trained to discriminate a black and a white square, and Group ID were trained to discriminate between white horizontal and vertical rectangles. Half the Ss in each group were trained with one stimulus positive, the remainder with the other stimulus positive. Within each of the four subgroups, half the Ss (C groups) were trained to a criterion of 18 correct responses in 20 successive trials; the remainder (OT groups) were given 100 trials of overtraining after reaching criterion.

Stage 2

All Ss were trained to criterion to discriminate between two white diagonal rectangles at opposite 45-deg orientations to the horizontal.

Stage 3

All Ss were tested for 20 trials on the Stage 1 problem; at this stage they were rewarded whichever way they jumped.

RESULTS

The results are shown in Table 1. There was no difference in the relative ease of learning the Stage 1 brightness and orientation discriminations. However, a strong preference was shown for black over white and for horizontal over vertical. An analysis of variance revealed a significant difference in trials to criterion between Ss trained with preferred stimuli positive and those trained with nonpreferred stimuli positive ($p < .025$, $F = 5.79$, $df = 31$). In Stage 2 there was no difference between the performance of Group ED on the new orientation discrimination and that of Group ID but overtrained Ss learned the discrimination significantly faster than nonovertrained Ss ($p < .01$, $F = 8.63$, $df = 31$). The interaction term between level of training and type of discrimination learned at Stage 2 was not significant. Stage 3 results were affected neither by the type of discrimination nor by which shape was positive, but overtrained animals again performed significantly better than nonovertrained ones ($p < .01$, $F = 7.84$, $df = 31$).

DISCUSSION

The results show that even in a jumping stand overtraining may benefit EDS learning. Some recent experiments by Wagner and his associates (Wagner, 1969) indicate how this result can be explained on a theory of selective attention; their findings strongly suggest that one of the main attentional effects of training with a given cue relevant is to depress attention to the irrelevant cues present. If this is correct, then in the present experiment the effect of overtraining at the first stage on the brightness discrimination should be to depress attention to position and other irrelevant cues; hence, during shift learning with the brightness cue removed, overtrained Ss should attend predominantly to the new cue (orientation) and learn the discrimination faster than Ss whose attention to irrelevant cues has not been reduced by overtraining. As Wagner points out, the

Table 1

	Group	Stage 1 Trials to Criterion	Stage 2 Trials to Criterion	Stage 3 Per cent Correct
ED	B+ C	87.0	292	67.5
	OT	101.8	159.8	91.75
	W+ C	161	283.3	70.0
	OT	139.3	210.5	72.5
ID	H+ C	121.3	254.5	71.5
	OT	134.3	214.5	86.5
	V+ C	145.3	264.5	64.0
	OT	159.5	216.3	79.0

assumption that when animals learn to respond differentially to a given cue, the strength of analyzers for other cues is reduced, will also explain why generalization gradients obtained after single stimulus training are steeper if animals are first given differential training, even when the differential training involves a different dimension to that employed in the generalization tests (Honig, 1969).

It would appear, then, that a theory of selective attention can explain why overtraining should sometimes benefit EDS learning. The present findings confirm previous reports of this phenomenon, but unfortunately throw little light on why Mackintosh obtained the opposite result. Mackintosh used much larger stimuli than those employed in the present experiment and it may be that during overtraining his animals learned an external orienting response that was inappropriate to the stimuli used on the EDS.

The finding that overtraining on a discrimination results in better retention of that discrimination when tested after shift learning is scarcely surprising. It is, however, interesting that retention is not affected by whether the interpolated learning involves an EDS or an IDS.

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NOTE

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Saline appetite in rats as a function of dry food ingestion

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Thirty-nine albino rats were deprived of food and water for 24 h. Group 1 was given water for 1 h, followed by 1 h of water and dry food; Group 2 was given 1 h of 0.9% saline followed by 1 h of 0.9% saline and food; Group 3 was given 1 h of both water and 0.9% saline followed by the addition of food to the two liquids for 1 h. First-hour and second-hour intakes of water and saline were measured. Results show that rats drank more 0.9% saline than water with a single bottle, with or without food; with double bottles rats drank more saline when no food was given; rats switched to water when food was given. Since rats eat less food when given 0.9% saline than when given water (Hsiao,

1967) the rats may have chosen water in order to eat more food.

Rats drink more isotonic and hypotonic saline solutions than water in single-bottle tests (Hsiao, 1967; O'Kelly, 1954; Stellar, Hyman, & Samet, 1954; Weiner & Stellar, 1951), and in double-bottle tests (Bare, 1949; Richter, 1956; Stricker & Wolf, 1967). However, Deutsch & Jones (1960) reported that after 20-h water deprivation water was preferred to 0.8% saline in a T-maze choice test, though rats drank more saline than water in the double-bottle test. They reported that, after water satiation, rats showed no preference for either liquid in a T maze. Using a double-bottle brief-exposure technique, Falk & Titlebaum

(1963) observed that water-deprived rats revealed no preference for either water or 0.8% saline, but nondeprived rats preferred saline to water. Thus, "saline appetite" seems to depend upon the state of water need, though different testing situations may produce opposite results.

Using a single-bottle technique, Hsiao (1967) reported that food-water deprived rats drank more 0.9% or 1.8% saline solutions than water when no food was given. When given food, rats drank more water than 1.8% saline and less than 0.9% saline, but the increase in water intake from no-food condition to food condition was greater than the comparable increase in 0.9% saline intake. This decrease in saline appetite may be due to dehydration induced by dry food ingestion as shown by Lepkovsky, Lyman, Fleming, Nagumo, & Dimick (1957).

Rats eat less food when given 0.9% or 1.8% saline solutions than when given water (Hsiao, 1967). Thus, when saline and water are given simultaneously with dry food, deprived rats may choose water in order to eat more food.

Saline appetite was studied in this experiment with both single- and double-bottle tests and with either food or no food available to food-water deprived rats.

SUBJECTS AND APPARATUS

Thirty-nine albino rats (18 males and 21 females), about 120 days old, raised in the University of Arizona Psychology Laboratory, were individually housed in a room with constant illumination, with temperature of 72 deg C and humidity about 45%. Each S was trained to drink water from a 100-cc graduated tube with metal tip and to eat powdered food from a 250-cc glass beaker fastened at the corner of the home cage for over a week before the experiment started. The experiment was conducted in Ss' home cages with the drinking tubes and food beakers. Ss had previous experience of food and water deprivation schedules.

PROCEDURE

Subjects were divided into three groups, each containing six males and seven females. After 24 h of food and water deprivation the following procedures were administered to each group: Group 1, 1 h water only followed by 1 h of water and powdered food; Group 2, 1 h 0.9% saline only followed by 1 h of 0.9% saline and powdered food; Group 3, 1 h water and 0.9% saline simultaneously presented followed by 1 h of water, 0.9% saline, and powdered food. The saline bottle was placed to the left of the water bottle by 1.5 in. The saline was prepared by adding 0.9-g NaCl to 100 cc tap water. Data for this experiment consisted of first- and second-hour water and saline intake.