Overtraining and stimulus change in extra-dimensional shifts

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The hypothesis was tested that overtraining would differentially affect extradimensional shifts in which cues do or do not change over the shift transition. No evidence to support this hypothesis was obtained.

It has been established that overtraining facilitates discrimination-reversal learning in human Ss under a wide variety of conditions. (See Wolff, 1967, for a review of pertinent studies.) Whether the learning of an extradimensional shift (EDS) is similarly facilitated by this variable is open to question. Considering this matter in a recent article, Wolff (1967) tentatively concluded that the exact effect of overtraining on EDS may ultimately depend on both individual difference variables and procedural variations in the administration of the shift itself. More specifically, he hypothesized that the magnitude of overtraining facilitation is an inverse function of both subject age and the degree of stimulus change from original to transfer learning. Supporting this hypothesis are the following facts.

(1) Nearly all studies showing strong overtraining facilitation on EDS have been performed with college Ss and have employed an arrangement in which the shift stimuli were the same as were used in original learning; nearly all studies showing no significant effect of overtraining on EDS, on the other hand, have been performed with children and have used an arrangement in which the shift stimuli were different from those used in original learning.¹ Thus, either age, shift arrangement, or both variables, alone or in combination, act to modify the effect of overtraining on EDS.

(2) Consonant with the hypothesis that shift arrangement is an effective variable in the above studies, Walther (1962) and Sugimura (1960), in the only experiments which compared the effects of overtraining on different EDS arrangements, found that the magnitude of overtraining facilitation in adults was inversely related to the degree of stimulus change occurring between original learning and shift. This effect, however, was not statistically significant in either study.

(3) Also supporting the shift-arrangement interpretation is the fact that slight (but nonsignificant) overtraining "interference" has been obtained in nearly every study with children in which the stimuli were changed from original to shift learning.¹ This fact supports this interpretation because in the single study with children in which the stimuli remained unchanged over the shift transition, slight (but nonsignificant) overtraining "facilitation" was observed (Iwahara & Sugimura, 1958).

Although not conclusive, the above studies suggest that both age and shift arrangement may be important variables in overtraining-EDS phenomena. In the present study, an attempt was made to demonstrate more clearly the effect of the second of these factors. In line with Wolff's (1967) hypothesis and the trend of the above reported studies, it was predicted that overtraining would produce greater facilitation in an EDS in which the stimuli remained constant throughout the task than an EDS in which the stimuli changed over the shift transition.

EXPERIMENT 1

Subjects

The original sample consisted of 123 graduate education students, of which 27 were eventually eliminated—one for refusal to cooperate, one for procedural error, and 25 for failure to learn the original problem. This left 96 Ss in all, 12 per cell. Elimination of Ss was not related to experimental

conditions according to a chi-square test ($p > .10$). Half of the final sample was run in the summer and the remaining half was run in the fall.

Apparatus

The apparatus, which rested on a desk, consisted of a Masonite screen ($2\frac{1}{2} \times 4$ ft). Stimuli were presented in a window ($2\frac{1}{2} \times 5$ in.) located at its center. The stimuli, which were formed from eight binary stimulus dimensions, appeared in pairs on 3×5 in. cards. These cards, 256 in all, were assembled into two equal-numbered packs, which differed in terms of the particular values assigned to five of the eight stimulus dimensions. The eight dimensions and the values of these exhibited in Packs 1 and 2 were as follows: COLOR OF LINES—Pack 1 (green and yellow), Pack 2 (brown and purple); TYPE CASE—Packs 1 and 2 (small and large); POSITION OF ARC—Pack 1 (over and under), Pack 2 (left and right); NUMBER OF LINES—Pack 1 (two and four), Pack 2 (one and three); COLOR OF TYPE—Packs 1 and 2 (red and black); WORD—Pack 1 (Kansas and boy), Pack 2 (jump and throw); POSITION OF STIMULUS—Packs 1 and 2 (left and right). In both Packs 1 and 2 one of the stimuli on each card exhibited one value from all eight binary dimensions and the second stimulus exhibited the remaining eight values utilized in that pack. Since all combinations of values were present in the stimuli, there were thus 128 unique cards in each pack. Care was taken to order the stimulus cards of both packs so that the values of the relevant dimension did not covary with those of any other dimension for more than four cards in succession. This precaution was meant to reduce the likelihood of Ss' attaining criterion by means of an erroneous correlated hypothesis.

Design

A 2 by 2 by 2 factorial experiment was devised with overtraining vs no overtraining, cue change vs no cue change, and summer vs fall students as the three factors. Ss were assigned to the four experimental treatments in the order of their arrival.

Procedure

Subjects were informed that they were to learn a simultaneous two-choice discrimination and that the discrimination was to be based on a single "feature" of the stimuli. In reality each S was presented with two such discriminations—one during original learning (OL), a second during transfer learning (TL)—and in each period a different "feature" served as the basis for administering reinforcement. In OL the relevant "feature," i.e., dimension, was TYPE-CASE and the positive value was SMALL. In TL the relevant dimension was COLOR and the positive value was YELLOW.

In both OL and TL, the cards were presented one at a time in the windows of the screen and S indicated his choice of stimuli by saying "left" or "right." Following S's responses, E said "correct" or "incorrect." Ss were permitted to view the cards for about 2 sec following feedback. The intertrial interval was approximately 5 sec.

All Ss worked to a graduated criterion in OL: i.e., five consecutive correct responses in Trials 1-25, or six consecutive correct in Trials 26-50, or seven consecutive correct in Trials 51-75, or eight consecutive correct in Trials 76-128. Ss who failed to achieve one of these criteria were eliminated. Following attainment of criterion, Ss in the overtraining condition received 10 additional trials on the OL problem and were then shifted to the TL problem with no break in procedure. Ss in the no-overtraining condition were shifted immediately following attainment of the OL criterion. Criterion for the TL problem was 10 consecutive correct responses. Cutoff was 80 trials.

Table 1
TL Trials to Criterion Scores for Eight Groups Transformed to $\sqrt{x + 5}$ (Experiment 1)

	Summer		Fall	
	Mean	Variance	Mean	Variance
Overtraining				
Cues Same	4.97	4.06	4.08	3.38
Cues Change	3.70	1.03	4.41	4.27
No Overtraining				
Cues Same	5.24	4.67	6.14	6.66
Cues Change	5.42	6.78	4.50	1.30

Table 2
TL Trials to Criterion Scores for Four Groups Transformed to $\sqrt{x+5}$ (Experiment 2)

	Mean	Variance
Overtraining		
Cues Same	4.50	4.00
Cues Change	3.46	1.05
No Overtraining		
Cues Same	4.91	4.81
Cues Change	4.37	1.82

In the cue change condition, Ss were presented Card Pack 2 in OL and Card Pack 1 in TL. In the no cue change condition, Ss used Card Pack 1 in both OL and TL.

RESULTS

An analysis of variance of the OL scores revealed no significant effects due to the three variables or their interactions. Since trials-to-criterion scores for TL were badly skewed and variances were heterogeneous they were transformed to $\sqrt{x+5}$ for purposes of analysis. The transformed data are summarized in Table 1. According to analysis of variance, there existed a main effect for Training [$F(1,88) = 6.38, p < .05$] and a significant Training by Change by Semester interaction [$F(1,88) = 4.34, p < .05$]. All other effects were nonsignificant ($p > .10$) including the three possible simple two-way interactions whose analysis was suggested by the significant Training by Change by Semester interaction. The significant second-order interaction found in the TL data was mirrored in the OL means. In OL, however, the interaction was not significant.

EXPERIMENT 2

The unexpected second-order interaction involving summer-fall students makes interpretation of Experiment 1 extremely difficult. In view of the similar second-order interactive trend found in the OL data, the best explanation of this interaction is that it resulted from a chance breakdown in the original method of subject assignment. Supporting this interpretation is the fact that no simple two-way interaction achieved significance ($p > .10$). To add further weight to this interpretation, however, Experiment 2 was performed. This experiment was essentially a replication of the four experimental conditions of Experiment 1 with several minor changes. These were as follows: (a) The semicircles of Pack 1 were filled in with black ink. This modification made the Packs 1 and 2 cards somewhat more distinct. (b) Overtraining was changed from 10 additional trials to 10 additional consecutive correct trials. (c) Undergraduate rather than graduate Ss were used. On the basis of the Experiment 1 results, no interaction between overtraining and stimulus change was predicted.

The original sample consisted of 94 Ss, but 14 of these were eliminated for failure to learn the original problem. Thus, the final sample consisted of 80 Ss (20 per condition). The Ss were assigned to conditions in the same manner as Experiment 1.

RESULTS

Analysis of variance of the OL trials-to-criterion scores showed no main effects due to the two experimental variables and no interaction ($p > .10$). The means of the TL trials-to-criterion scores (transformed to $\sqrt{x+5}$ to reduce heterogeneity of variance) were as follows: overtraining-cues same, 4.50; overtraining-cues changed, 3.46; no overtraining-cues same, 4.91; no overtraining-cues changed, 4.37. An analysis of variance of these scores showed main effects for both training [$F(1,76) = 3.02, p < .10$] and change [$F(1,76) = 4.29, p < .05$] but no interaction ($p > .10$).

DISCUSSION

The results of Experiment 2 confirm the interpretation that

the unexpected second-order interaction obtained in the TL data of Experiment 1 occurred by chance. Since the same curious trend was observed in the OL data of Experiment 1, it seems likely that the interaction resulted from a breakdown in the original method of subject assignment. On this assumption the results of the present two studies are in good agreement: both overtraining and stimulus change tend to facilitate EDS, and there is no first-order interaction between these two variables.

The lack of interaction between the change and training variables in the present two experiments would seem to contradict the results of the several studies discussed in the introduction which provided the basis for Wolff's (1967) hypothesis regarding the limiting effects of age and stimulus change on overtraining facilitation. No contradiction is involved, however, if it is concluded that age alone was critical in those studies in which the two variables were confounded, and that the nonsignificant (but suggestive) trends in the studies affording a direct assessment of stimulus change were due to chance. Such a conclusion, though not compelled by the present data (the specific stimuli and degrees of training employed preclude broad generalization) is at least strongly suggested by them, and, in the opinion of the present authors, awaits only a larger experiment in which both age and stimulus change are varied simultaneously to establish its correctness.

The results of the present study are also of interest in relation to the overtraining-facilitation hypothesis proposed by Grant & Cost (1954). According to this position, overtraining facilitates because it makes the transition from OL to TL more discriminable and hence better enables S to adjust his responding to the altered reinforcement contingencies involved in shift. On the basis of this hypothesis, two effects of changing the stimuli between OL and TL are predictable. First, it would be expected that changing the stimuli over the shift transition would facilitate performance. This expectation follows from the fact that stimulus change, as well as overtraining, should make the onset of TL more easy to discriminate. Second, it would be expected that the effectiveness of overtraining should be reduced in the changed-stimulus condition, because in this condition the passage from OL to TL should be obvious to criterion-trained and overtrained Ss alike. The present results confirmed the first but not the second of these expectations. Neither Experiment 1 nor Experiment 2, therefore, can be said to give unequivocal support to the Grant-Cost hypothesis, and it would appear that further research is required to determine its validity.

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NOTE

1. For a listing and discussion of these studies see Wolff (1967).