Transfer effects in adaptation to prismatic displacement¹

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Twenty Ss wore a 20 diopter displacement prism while they practiced tracking a moving target and when they performed a second task requiring location of a stationary target. Results showed significant transfer of adaptation effects to performance on the second task, and showed a limited aftereffect upon removal of the prism. Massed and distributed practice on the tracking task produced differences in tracking performance, but no differences in the amount of transfer or in the aftereffect. Ten control Ss showed no adaptation and no aftereffect.

Held & Freedman (1963) and others have shown the importance of active movement in adaptation to prism displacement. Although adaptation has been produced in a wide variety of experimental situations, there is inadequate information on the degree to which adaptation produced by movement on one task transfers to a different motor task. The question of transfer effects is part of the larger question of the generality of prism adaptation produced in experimental situations.

The present experiment was designed to shed light on these questions by having Ss wear a prism while tracking a moving target, and testing for transfer effects when Ss were required to mark the apparent location of a stationary target under conditions of restricted visual feedback. The magnitude of the negative aftereffect following removal of the prism was used as an additional measure of transfer effects. If transfer were observed under these conditions it would suggest that adaptation is not specific to the task and movements involved in producing the adaptation.

A secondary purpose of the experiment was to determine whether differences in accuracy of performance on the adapting task would affect the amount of transfer observed. Differences in accuracy were experimentally produced by manipulating distribution of practice.

METHOD

The Ss were 30 experimentally naive undergraduate volunteers, 18 males and 12 females.

The apparatus was a plywood, 36 in. sq platform with four 6 in. high legs. The platform was painted flat black. A 1½ in. finishing nail was the target; it was nailed upright into the center of the top surface of the platform. The legs of the platform were secured to the top of a table. A 18 by 24 in. pad of paper was placed on the tabletop beneath the platform so that the long edge was parallel to the front edge of the table. The pad was held in alignment by two metal runners anchored to the table on the right and left sides of the pad. The pad could be slid under a metal crossbar that was located parallel to the front of the table, and was positioned directly under the target.

Two pairs of plastic goggles, each with an opaque left eyepiece were used. The right eyepiece of one pair of goggles was an optical flat. A Bausch and Lomb wedge prism of 20 prism diopters base left was the right eyepiece of the other pair of goggles. The aperture of the right eyepiece was 3.1 cm sq for both goggles; all other parts of the goggles were opaque.

An illuminated-target pursuit apparatus (Marietta No. 5-100) was also used. An illuminated disc revolved beneath a translucent fiberglass surface at 60 rpm. A buzzer sounded when contact with the disc was made by a Lucite probe. A Springfield Electric Timer recorded time on target. A stop watch was used to time trial length and intertrial intervals.

The Ss were told only that their ability to locate targets when restricted to one-eyed vision would be tested. Four phases of the experiment consisted of 10 marking trials each, spaced at 5-sec intervals. Procedure for the marking trials was as follows: S moved his preferred hand under the platform up to the crossbar that was positioned beneath the target. He moved his hand along the bar to a point corresponding to the apparent location of the target above, and made a short vertical pencil mark on the paper. The bar permitted marks to vary in position on the horizontal axis, but restricted variation on the vertical axis. After making the mark, S lifted his hand from the paper, and E moved the paper to provide a clean surface for the next trial. The platform obscured the S's hand and his marks.

All Ss wore the goggles containing the optical flat during the marking trials of Phases I and IV, and wore the prism goggles during the marking trials of Phases II and III. The S was instructed to close his eyes each time he put on or removed a pair of goggles. A 30-min interval elapsed between Phases II and III. During the interval two subgroups of 10 Ss wore the prism goggles while they practiced on the pursuit apparatus. Both subgroups completed 15 50-sec trials. The intertrial rest interval was 70 sec for a distributed-practice subgroup and 10 sec for a massed-practice subgroup. The massed-practice Ss were required to sit quietly for 7.5 min before and after the pursuit trials. A control group of 10 Ss, wearing prism goggles, sat quietly for 30 min with their hands at rest in their laps or on the table under the platform. At the termination of the experiment Ss were encouraged to give a complete description of the apparent optical effects of the goggles.

RESULTS

Figure 1 shows that the marks made by both experimental groups were closer to the target in Phase III than they were in Phase II. The control group showed little change between the two phases. Similarly, a comparison of Phases I and IV shows a

Fig. 1. Mean displacement in centimeters of marking responses from the target during four phases: D = distributed-practice group, M = massed-practice group, and C = control group. (Each value represents the mean of 10 trials.)

shift in marking responses for the experimental groups, but not for the control group. There was no evident difference between the massed- and distributed-practice groups.

The results of an analysis of variance indicate that there was no significant main effect of Groups ($p > .05$). The main effect of Phases was significant ($F = 296.6$, $df = 3/81$, $p < .001$), and there was a significant interaction between Groups and Phases ($F = 3.50$, $df = 6/81$, $p < .01$). A planned orthogonal comparison between combined experimental groups and the control group for Phase III showed a significant transfer effect ($F = 7.26$, $df = 1/27$, $p < .01$). A Scheffé comparison for the two experimental groups combined showed a significant increase in accuracy in Phase III as contrasted to Phase II ($F = 4.84$, $df = 11/81$, $p < .01$). A second Scheffé comparison, between Phases I and IV for the two experimental groups combined, showed that the mean aftereffect was of borderline significance ($F = 1.79$, $df = 11/81$, $p < .10$).

The target-pursuit performance of the distributed-practice Ss was, on the average, approximately 2.5 times as accurate as that of the massed-practice Ss; the mean total time on target was significantly different for the two groups ($t = 3.61$, $df = 18$, $p < .01$).

DISCUSSION

The results show that adaptation achieved on one motor task can transfer to a different motor task. In addition, a limited aftereffect can be produced by this procedure. The indication is that adaptation is not specific to the task or the movements involved in producing the adaptation. Adaptation shown on the transfer task was not complete, but complete adaptation is not achieved in experimental situations where S receives only limited feedback (Coren, 1966; Lazar & van Laer, 1968).

The results reaffirm Held & Freedman's (1963) emphasis on the importance of active movement in adaptation in that the

Ss who did not perform a motor task showed little if any adaptation. Differences in accuracy of performance on the adapting task did not produce differences in performance on the transfer task. It might be concluded that simply performing a motor task is sufficient to produce adaptation; within limited ranges, accuracy of performance on the task is irrelevant.

Target-pursuit was chosen as the adapting task because it was thought that the task would be sufficiently difficult to prevent the S from discovering the principle of the optical displacement, and then deliberately applying the principle to the transfer task. When questioned all Ss stated that the prism goggles produced "distortion," not one S could verbalize the right-left displacement, and none admitted that they deliberately corrected for the displacement. The present experiment does not provide conclusive evidence on the questions concerning "awareness" and deliberate correction for displacement. However, the suggestion is that the S learned a new hand-eye coordination during the adapting task that transferred to the second task, and that this took place in the absence of deliberate correction on the part of S.

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