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Performance on the Star Discrimeter has several interesting features, the most important of which have to do with retention and transfer. This paper summarizes recently obtained data and offers a tentative explanation.

A brief description of the apparatus and the task that is learned should first be given. The Iowa model of the Discrimeter is basically like the original unit developed at Northwestern University (1). The subject learns to move a vertical wobble-stick rapidly into one of six horizontal channels, depending on the color of the light that appears on a stimulus panel 30 inches away at eye level. The six channels, equally spaced 60 degrees apart, radiate out from a central opening through which the wobble-stick protrudes. When a correct channel is entered, a stepping switch is activated to bring up a new color. The number of channels correctly entered per trial period is recorded, as is the number of errors. Each channel has a length of 3¼ in., and each one has two microswitches placed ½ in. and 2¼ in. from its entrance. This provides for counting both shallow and deep errors. A large number of different tasks may be obtained on the Discrimeter by changing the interconnections between the six colored lights and the six channels.

In one of the first studies of transfer and retention in Discrimeter practice, Duncan and Underwood (2) gave four groups of male subjects either 10, 40, 80, or 160 trials on a particular task. There were 75 subjects per group. The work and rest periods had durations of 20 and 10 sec., respectively. All groups next received 60 trials on a second task. Twenty-four hours later, all subjects had 20 additional trials on the second task. These were the first retention trials—trials to determine the retention of the second task after a 24-hour break. Sixty-two percent of the subjects were available 14 months later (on the average) for a second relearning of the second task. Each subject received 20 trials at this time.

The means of number of correct responses for initial practice on the second task and also for the relearning trials (after 24 hours and after 14 months) are plotted against *pairs of trials* in Fig. 1. The means at the end of practice on the first task are represented by heavy dots at the left in the figure. Initial practice was least for Group I and greatest for Group IV.

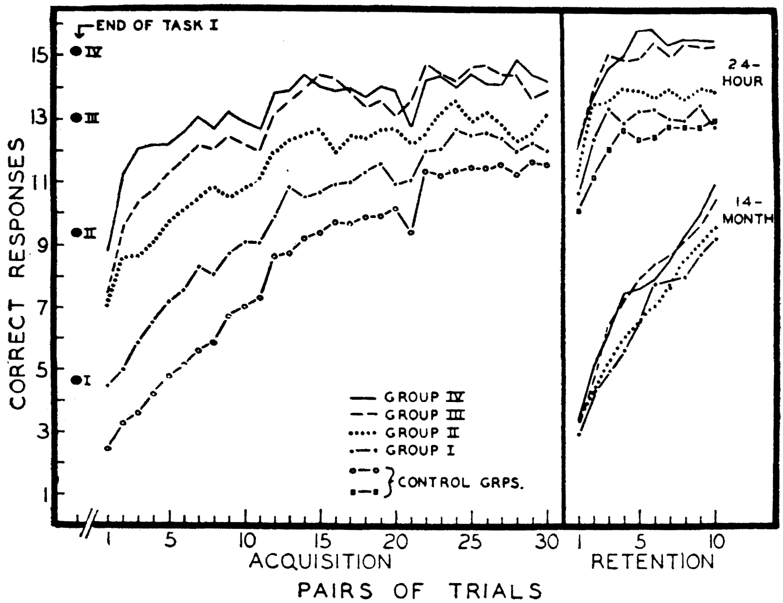

Figure 1. Borrowed from Duncan and Underwood (1). Performance curves for the acquisition and retention of proficiency on a second task on the Star Discrimeter following different amounts of practice on a first task.

The first point to be emphasized is that amount of proactive facilitation—amount of proactive transfer to the second task—was related to the amount of practice on the initial task. Also, level of performance after 24 hours was related to level before the break in practice and thus to level of learning on the first task.

Retention over 24 hours was fairly good, although there was a significant loss. (The average loss for all subjects was 2.68 correct responses—from 13.38 to 10.70.) It is not possible to say whether the loss was a warm-up decrement or was due to forgetting. Each group, after four or five trials, regained its previous proficiency and showed a slight upward trend.

A very large amount of forgetting occurred over the period of 14 months. The loss from the end of the first relearning trials to the beginning of the second was, on the average, 11.85 correct responses—from 14.49 to 2.65. The average performance of all subjects on the first pair of relearning trials was only slightly better than the average of the control groups on the first pair of acquisition trials. The rate of relearning was much faster than the rate of initial acquisition of skill, but at the end of trial 20, the subjects had still not regained their former level of proficiency on the task.

The relearning curves for the four groups (after 14 months without practice) virtually overlap. This is a further indication that the amount of forgetting was very great.

These results, and especially those related to retention, are in sharp contrast to data obtained with the Mashburn apparatus. In performing on the Mashburn, a subject manipulates a wobble-stick and rudder bar (which are remindful of the controls of an old-fashioned airplane) to match green response lights to red stimulus lights. Three red lights appear in three rows spatially separated on the stimulus panel. The subject moves the controls until a green light is opposite each red light. When a match is accomplished, a stepping switch is activated to bring up a new array of three stimulus lights. The usual instruction to a subject is to make as many matches as possible during each trial period.

In research reported by Lewis and Shephard (3), three groups of male subjects received 50 two-minute trials on the standard Mashburn task, 10 trials per day on five successive days. One group then went without practice for five days, another group continued on the standard task during this period (10 trials per day), while the third group practiced the reversed task (directions of movement of all controls made opposite) for a total of fifty trials. On the 11th day, the three groups practiced on the standard task under the same conditions. There were clear evidences of increased proficiency for the group having additional standard task trials over the five days and of retroactive interference for the group having reversed practice. The present interest, however, is in retention.

There was a 24-hour period without practice for all groups between trials 40 and 41 of original learning. The over-night changes in means of number of matches and in means of number of errors were negligible. For the group going without practice for five days, a decrease in number matches and in increase in number errors occurred, but these changes were too small to have statistical significance. Retention over 24 hours and also over five days without practice was high.

Retention of proficiency on Mashburn tasks remains high over much longer periods without practice. A group of 30 male subjects had the equivalent of about 45 three-minute trials on the standard task during October of one year. They each received five relearning trials on the same task during June of the following year. The change over the 8-month period was from 44.6 to 38.7 matches per trial, a loss of 5.9 matches, on the average. It was significant beyond the 1% level of confidence. This was for RL trial 1. The means on trials 2 and 3 were 46.1 and 48.5, respectively. There was a gain on trial 3, as compared with the last trial in October, of 3.9 matches. This gain was significant at the 1% level.

The kinds and amounts of transfer and retention in the performance of perceptual-motor tasks are apparently not independent of their underlying characteristics. This notion will be elaborated upon after additional data have been presented.

In a recent study in the Iowa laboratory, 74 male subjects practiced successively on four different tasks (Tasks A, B, C, and D, in that order) on the Star Discrimeter, and then relearned the tasks without change in sequence. As in the Duncan-Underwood study, the trials were 20 seconds in length, with inter-trial rest pauses of 10 seconds. Twenty-four trials on Tasks A and B and 20 trials on C were given on Day 1. Four trials on C and 24 on D were followed by 24 relearning trials on A and 20 on B on Day 2. Practice on Day 3 consisted of four relearning trials on B and 24 on C and 24 and D.

Some of the data are summarized in Fig. 2. In the two graphs at the top, means of numbers of correct responses are plotted against trials; in the two at the bottom, means of numbers of errors against trials. The results for original learning (OL) are shown in the graphs at the left. Proactive facilitation is evident. In the upper left-hand graph, the curve for Task B lies consistently above that for A by a highly significant amount. In the curves for errors (at the lower left), the one for Task B, except on the first trial, lies conspicuously below that for A. In both graphs the curves for C lie very close to those for B, indicating either that there was little additional proactive facilitation accruing to Task C or that practice on A and B in succession generated some amount of proactive interference.

The alterations in performance after the 24-hour period without practice are unique. The loss in proficiency on Task C (shown by the decrease in mean number of correct responses and increase in mean number of errors on the 21st trial) is not particularly surprising; it may have arisen from loss of set (warm-up); but the lowered proficiency during the 24 trials of practice on Task

D is unusual, to say the least. As seen in the curves for this task (in the two left-hand graphs), the effects of the 24-hour break in practice persisted through the 24th trial. This failure of the subjects to attain the level of proficiency on Task D that was reached on Task B and C is difficult to rationalize on the grounds of altered set.

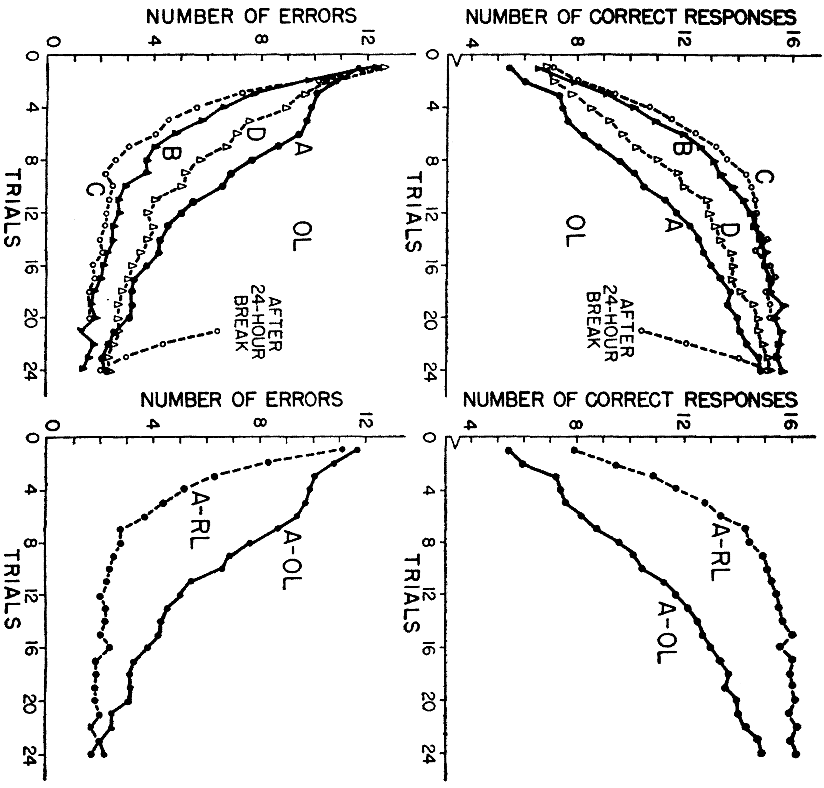

Figure 2. Mean number of correct responses and of number of errors during 24 trials of practice on four different tasks on the Star Discrimeter, along with curves for the relearning of Task A.

Curves depicting the course of learning (OL) and relearning (RL) Task A appear at the right in Fig. 2. The number of correct responses on the first trial of RL is far below that on the last trial of OL but higher than on the first trial of OL. But the number of errors on the first RL trial is only slightly less than on OL trial 1. A comparison of the RL curves for Task A and the OL curves for C is revealing. Although not drawn on the same graph, the OL error curve for C may be seen to be virtually the same as that for A. In the case of the correct responses curves, the RL curve for A falls, on the average, about one response above that for C. The obvious interference is that the forgetting of Task A during practice on Tasks B, C, and D was very great. There was little retention of Task A, as such.

The acquisition of proficiency on Task A during the relearning trials was facilitated as compared with acquisition during OL, but the amount of facilitation was seemingly little greater than it was during the original learning of Tasks B and C.

These findings on transfer are characteristically different from those obtained on the Mashburn apparatus. In successive phases of practice on different Mashburn tasks, significant losses occur at the shifts in task, but the general trend is toward higher levels of proficiency.

An old adage is that motor skills are retained indefinitely while other memories are soon forgotten. The data now available indicate that the retention of proficiency on a "motor" task depends upon its underlying characteristics.

It is helpful to think of perceptual-motor tasks as falling along a continuum ranging from those that are predominantly perceptual to those that are predominantly motor. The proficient performance of tasks on the Star Discrimeter demands some amount of manipulative skill but depends principally upon the learning of relationships between colored lights and response channels. The task is largely preceptual and minimally motor. Skillful performance on the Mashburn apparatus requires a high level of manipulative proficiency. The learner almost immediately perceives the fundamental nature of the task: the matching of green lights to red lights is readily understood; but movements of the stick and rudder bar must come to be quick and precise. Manipulative proficiency is acquired only as a consequence of experience in manipulation.

Tasks on the Discrimeter and on the Mashburn lie far apart on the perceptual-motor continuum. The differences in their retention and in the kinds and amounts of transfer displayed may be ascribed to differences in the demands placed upon perceptual and motor responses.

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