Proceedings of the Iowa Academy of Science

Volume 64 | Annual Issue

Article 55

1957

The Multipoint Two-Hand coordinator: Apparatus for Studying the Acquisition and Tran sf er of Skill in Performing Subject-Paced Tasks

Don Lewis
State University of Iowa

The Multipoint Two-Hand Coordinator: Apparatus for Studying the Acquisition and Transfer of Skill in Performing Subject-Paced Tasks

By Don Lewis

The Multipoint Two-Hand Coordinator[1] retains the control mechanism of the Two-Hand Coordinator described elsewhere by Shephard and Lewis (1). Both devices require the turning of two lathe-like cranks to effect changes in the position of a target follower. The essential difference between them is that the Multipoint utilizes a stationary hard-rubber plate bearing an irregular "pathway" of small circular brass buttons instead of a revolving disk and a single moving target. Consequently, the Multipoint provides subject-paced (unpaced) tasks while the more familiar Two-Hand Coordinator provides paced tasks.

The buttons of the Multipoint are ⅛″ in diameter and flush with the surface of the stationary plate. They may be seen in the photograph of the apparatus in Figure 1 and also in the close-up of the plate *at the left* in Figure 3. They extend from an identifiable starting button, through a complex circuitous pathway, back to the starting point. They constitute, in succession, a series of small targets to be contacted with the target follower.

Figure 1 shows the principal features of the apparatus—the two cranks, the worm gears, the stationary plate with imbedded buttons, and the target follower—as seen from the subject's standing position. The cranks are turned with the two hands in moving the target follower over the face of the plate, from one button to another.

Two forms of the task—the *standard* and the *reversed*—are readily obtained through a shifting of gears. The two forms, as their names signify, require opposite directions of turning the cranks. For the *standard* task, clockwise turning of the right crank moves the target follower to the subject's right while counter-clockwise turning moves it to his left. Clockwise turning of the left crank moves the follower toward the subject while counter-clockwise turning moves it away. For the *reversed* task, the cranks must be turned in opposite directions to effect the desired movements. It is possible, although an

[1]Modeled after apparatus designed by Dr. J. Bradley Reynolds and constructed in one of the laboratories of the U. S. Air Force Personnel and Training Research Center.

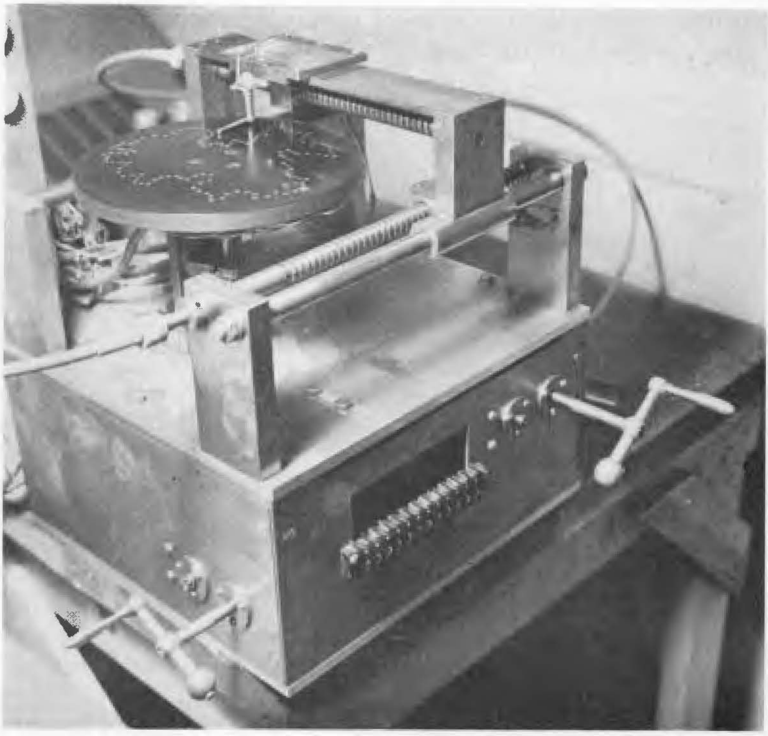

Figure 1. Photograph of the Multipoint Two-Hand Coordinator.

uncommon practice, to reverse one of the cranks without reversing the other; and it is also possible through the use of flexible drive cables to interchange the connections between the cranks and the two major axes of movement of the target follower.

When practicing on the Multipoint, a subject is obliged to move the target follower from one button to the next, usually in a counter-clockwise direction from the starting point. Each time the follower is correctly brought into contact with a button, a clicking sound is distinctly audible. If a button in the sequence is skipped, a buzzing sound is heard and the subject must return the follower to the preceding button before going ahead. The ordered sequence is controlled with a stepping switch. If desired, the sequence of buttons may be reversed requiring the subject to move along the pathway in a clockwise direction.

The usual measure of performance is the number of buttons contacted (hit) by the subject during a practice period. Errors (skips in the sequence) may also be counted, but these occur so infrequently after the first trial or two that they are usually disregarded. As a common thing, a subject is instructed to make as many hits as possible, without special reference to the occurrence of errors.

The apparatus is automatically adaptable to different degrees of massing of practice. For completely massed conditions, that is, for uninterrupted practice over extended periods of time, the subject is told to "keep on going along the pathway, on past the starting button when it is reached," so the entire pathway may be traversed several times before work is terminated. During 10 minutes of continuous work, for example, the average subject will complete two full excursions and be well into a third. When practice is distributed, each trial may begin with the target follower positioned on the starting button, or it may take off from the point in the pathway where the preceding trial ended. In studies of transfer, when distributed practice conditions are preferred, the target follower is returned to the starting button after each trial. As a consequence, the successive trials are more nearly uniform in overall difficulty although the subjects do acquire an increasing familiarity with the first part of the pathway.

Representative Performance Curves

Representative performance curves for the practice of male subjects on Tasks A and B (the standard and reversed tasks, respectively) under massed and distributed conditions, are shown in Figure 2, where means of number of hits are plotted against trials. The data are part of those obtained in a major investigation involving changes in conditions of practice as well as shifts in task.

Forty-five subjects practiced on Task A for 20 trials, each 30 seconds in length and separated by 30-second rest intervals. After a longer rest of 5 minutes, 15 of them continued on Task A under the same distributed regime. Similarly, 45 subjects practiced on Task B for 20 trials under distributed conditions, and after a 5-minute rest, 15 of them continued for 20 additional distributed trials. Two groups of 30 subjects each worked continuously for 10 minutes, one of them on Task A, the other on Task B; and then after a 5-minute rest, half of them in each group worked continuously again on the same task for 10 minutes. Scores were recorded for the massed groups at the end of each 30-second interval of work.

The curves in Figure 2 display the familiar depressive effects of massed practice; and they reveal that Task A is somewhat easier to master than is Task B. The relative difficulty of the two tasks became more evident as practice continued. As seen, the four large groups performed at essentially the same average level during the first 30 seconds of work; and the two curves for Task A tend to overlap for trials 1-10 while those for Task B do not begin to diverge until after 2½ minutes of work. Of incidental interest are the

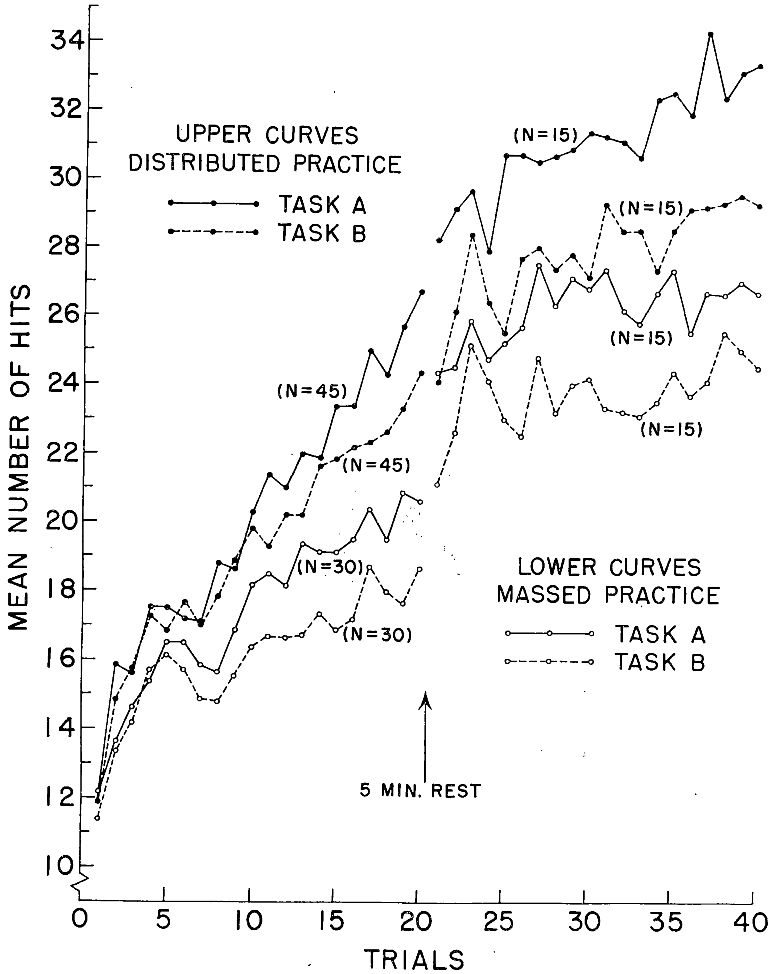

Figure 2. Performance curves for practice on Multipoint Tasks A and B under massed and distributed conditions.

marked gains of the two massed groups on trial 21, the first trial after the 5-minute rest interval. These gains were probably due to the dissipation of work inhibition and thus reflect the occurrence of reminiscence.

All of the subjects for whom data are summarized in Figure 2 began at the starting button and continued on through the pathway until the end of trial 20 (or the end of 10 minutes of uninterrupted practice). The target follower was returned to the starting button for the beginning of work after the 5-minute rest period. Attention is called to the noticeable dips in the curves between trials 5 and 10 and also between trials 23 and 27. These drops in average performance level reflect differences in the difficulty of the task over different parts of the pathway. A photograph of the Multipoint plate is shown at the left in Figure 3. The starting button, larger than the others, is seen near the bottom. The drops in performance level started when the subjects were about ⅔ of the distance through the pathway, at or near the 75th button. The 75th button is at the upper left, where the downward trend in the pathway begins. This is a point where the left hand must be used far more than the right and where the turning of the left-hand crank is, for the first time, predominantly in the clockwise direction, toward the subject's body. It is supposed that the relatively greater demand now placed on the use of the left hand was the important factor in reducing proficiency in performance.

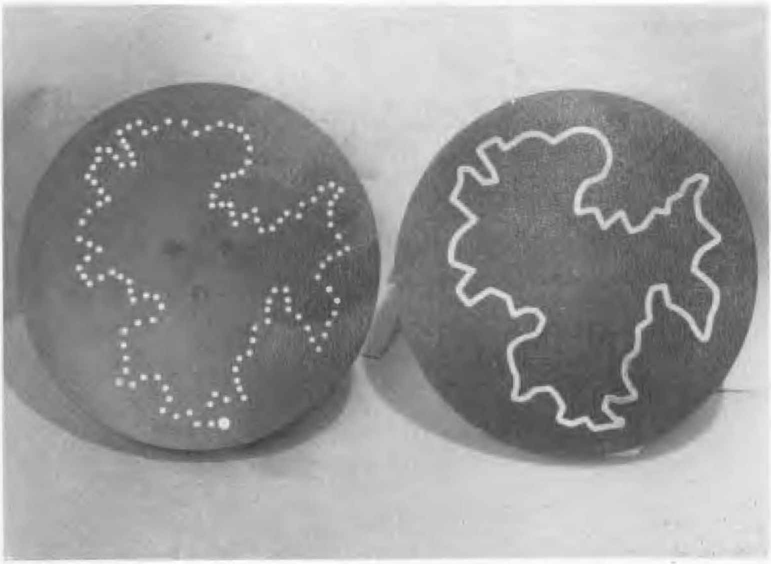

Figure 3. Close-up views of the Multipoint Plate (on the left) and the Multisegment Plate (on the right).

Investigations are needed to determine the relative difficulties of different major portions of the total pathway. As already stated, the regular procedure when massing and distribution of practice are not being investigated, is to begin each trial with the target follower positioned on the starting button. This procedure has the disadvantage of giving the subjects increasing familiarity with the pathway itself, but it serves to maintain greater uniformity in task difficulty. Difficulty of task can never, of course, be kept constant in performance on the Multipoint because the task itself (the number of buttons contacted) changes with increases in proficiency.

NEGATIVE TRANSFER ON THE MULTIPOINT

A rather surprising finding during preliminary investigations with the Multipoint was that negative transfer is a salient feature of performance when practice begins on either Task A or B and then is shifted to the other task. The negative effects are not only large but they persist over many transfer trials.

Representative data are summarized in Figure 4. Two groups of male subjects, 15 per group, were employed. Group 2 received 20 trials on Task B under distributed practice conditions. The

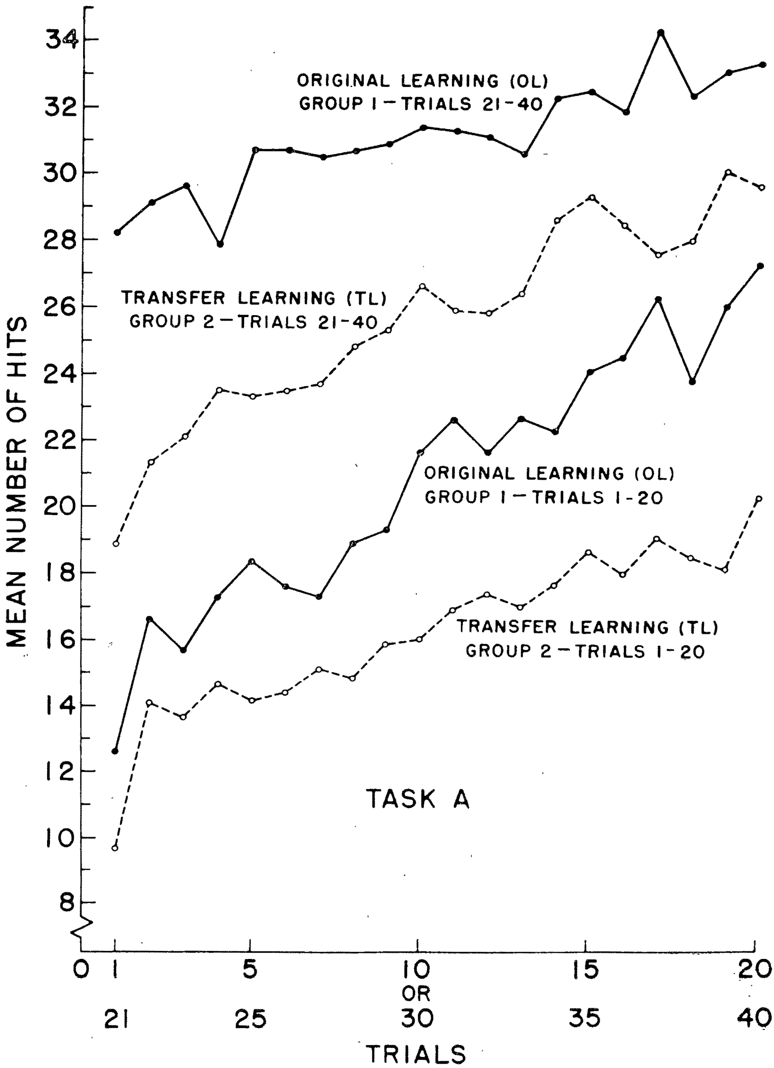

Figure 4. Performance curves showing the negative effects on the learning of Multipoint Task A of prior practice on Task B.

trials were 30 seconds in length and were separated by 30-second rest intervals. Group 1, during this initial "practice" session, was given the D.A.T. Space Relations Test. Both groups then had 40 trials of practice on Task A under distributed conditions with a rest of 5 minutes between trials 20 and 21. This practice constituted original learning (OL) for Group 1 and transfer learning (TL) for Group 2.

The means of number of hits are plotted against trials, in Figure 4. Note that the abscissa has double representation—trials 1-20 *or* trials 21-40. The four curves (two for each group) are clearly identified. Group 2 performed at levels substantially below those attained by Group 1, on all 40 trials. The differences are highly significant. Similar results have been obtained for transfer groups beginning practice on Task A and then shifting to Task B.

The persistence of proactive interference (negative transfer) in Multipoint performance is quite unique; facilitation (positive transfer) is commonly predominant under comparable conditions of practice on other complex perceptual-motor tasks. In fact, proactive effects in Multipoint performance appear to be significantly different, at least in magnitude, from those occurring during practice on the more familiar Two-Hand Coordinator. Unpublished findings in the Iowa Laboratory indicate that while practice on the standard Two-Hand task may have an initial retardative effect on the performance of the reversed task, some amount of proactive facilitation occurs when the shift is from the reversed to the standard task, especially if the amount of original learning on the reversed task is fairly large. The available evidence strongly suggests that proactive interference is much greater in magnitude and also much more persistent in the case of unpaced (subject-paced) Multipoint tasks than in the case of paced Two-Hand tasks.

Explanations for the apparent differences are being sought. Two-Hand tasks are paced, Multipoint tasks unpaced; but this difference is thought not to be crucial, in view of known transfer effects in the performance of other paced and unpaced tasks. Perhaps the important thing is that the pursuit of the single target in Two-Hand performance is continuous while the pursuit of the separate targets in Multipoint performance is discontinuous. The discontinuity is actually magnified by the requirement, through a time-delay circuit, that the target follower remain *on* each button for about $2/10$ of a second. This is to insure certainty of contact. Perhaps the discontinuities in responding on the Multipoint provide opportunities for interferring responses to occur and to impede the subject's forward progress.

The foregoing hypothesis is being tested in several ways. One way is to alter the task by minimizing, if not entirely removing, the dis-

Proceedings of the Iowa Academy of Science, Vol. 64 [1957], No. 1, Art. 55

continuities. The plate with its multi-*points* is replaced by a plate with multi-*segments,* as shown at the right in Figure 3. The basic pathway is unchanged. The subject still moves the target follower from one segment to the next, in ordered sequence; still hears a clicking sound for each correctly contacted segment and a buzzing sound if a segment is skipped. The conjecture is that the change in the appearance of the pathway with the accompanying reduction in obvious discontinuities will reduce the opportunity for interfering responses to occur and will thus lead to a decrease in the amount and persistence of proactive interference.

Reference

1. Shephard, A. H., and Lewis, D. Devices for studying associative interference in psychomotor performance: II. The Modified Two-Hand Coordinator. *J. Psychol.*, 1950, 29, 53-66.

DEPARTMENT OF PSYCHOLOGY
STATE UNIVERSITY OF IOWA
IOWA CITY, IOWA