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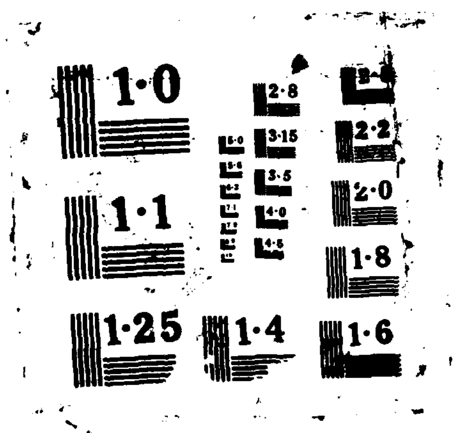
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THE EFFECT OF THE AMOUNT OF SINGLE-TASK PRACTICE ON DUAL-TASK TRACKING

(2)

Interim Technical Report

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By

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Prepared for

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This experiment had two primary purposes. First, it compared the relative efficiency of the fractionation method of part-task training to whole-task training for a combination consisting of two difficult tracking tasks. Second, it determined how the amount of single-task practice affected subsequent dual-task performance.

The experiment required two sessions, a training session and a retention session one week later. Four groups of 12 female subjects completed both sessions. During the training session, Groups 1 and 4 received one single-task trial on each task before performing their combination. Group 2 received three single-task trials on each task before performing their combination; Group 3 received six single-task trials. Groups 1, 2, and 3 received a total of 20 dual-task trials; Group 4 received 30 dual-task trials. During the retention session, all groups received a total of two single-task trials on (over)

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each task and ten dual-task trials.

The results of the experiment were inconclusive for two reasons. First, increasing the amount of single-task practice on each task did not result in better single-task performance as anticipated. That is, Groups 2 and 3 had approximately the same level of performance at the end of their single-task training even though Group 3 had twice as much practice as Group 2. Second, although subjects were assigned at random to the groups, Group 2 had better single-task tracking skills than the subjects in the other three groups. This made any between-group comparisons problematic.

THE EFFECT OF THE AMOUNT OF SINGLE-TASK PRACTICE ON DUAL-TASK TRACKING

Introduction

Historically, part-task training has played an important role in teaching individuals to perform complex tasks. The application of part-task techniques to real-world training problems has been aided by a large body of both theoretical and applied research. Nevertheless, Wightman and Lintern (1985) recently noted several gaps in the literature, particularly in the area concerned with training manual control skills. One such gap concerns the fractionation method of part-task training. This method first partitions the whole task into a number of concurrently performed subtasks. The subjects then practice each of these subtasks alone before attempting the whole task. To date, no studies have compared the fractionation method of part-task training to whole-task training for difficult tracking combinations with low intertask interaction. This omission is important because real-world tasks with these characteristics, such as flying a helicopter, usually require costly training and are often taught using the fractionation method. The experiment reported below addressed this omission by using the fractionation method to train subjects to perform two completely independent tasks concurrently. The tracking tasks were selected to be relatively difficult for the subject population.

This experiment also addresses another related problem: how much part-task practice should a subject receive before performing the whole task? The literature indicates that, for most tasks, as the amount of part-task practice increases to some point, performance on the whole-task improves (see Gagne and Foster, 1949 for an example). No such relation is known to exist when the whole task is actually a task combination; to date, only two experiments have addressed this issue (Folds, Gerth, and Engelman, in press; Rieck, Ogden, and Anderson, 1980). Until this relation is known, it will not be possible to examine the relative efficiency of the fractionation method of part-task training versus whole-task training. The experiment described in this report examined the relation between the amount of single-task practice and subsequent dual-task performance by adding two groups with differing amounts of single- and dual-task practice to the standard part- versus whole-task design.

Thus, the experiment reported below had two purposes. First, it compared the relative efficiency of part- versus whole-task practice for a difficult tracking combination when fractionation was used to construct the subtasks. Second, it examined how the amount of single-task practice affected subsequent dual-task tracking performance.

Method

Tasks

The subject performed two identical one-dimensional compensatory tracking tasks. One task was controlled by the subject's right hand; the other, by her left. Each task required the subject to keep the cursor centered in a horizontal track by making appropriate left-right movements of a control stick. For each task, the disturbance input to the cursor was a random forcing function composed of the sum of nine sine waves with a breakpoint frequency of 0.35 Hz. The transfer function was $Y=K(0.65/s + 0.35/s^2)$. Under dual-task conditions, the task controlled by the subject's left hand was displayed slightly above and to the left of the task controlled by the subject's right hand. The tasks were completely independent of each other.

The average absolute error expressed as a percentage of displayed scale was calculated and presented to the subject at the end of each trial. A score of 0% represented perfect performance (the cursor centered at all times during the trial) and a score of 100% represented the worst possible performance (the cursor displaced as far as possible throughout the trial).

Apparatus

The tracking tasks were displayed on an AMDEK Model Video 300 CRT. A DEC 11/23 computer generated inputs for the tasks, recorded and processed the subject's responses, and timed all trials. All subjects were seated 117 cm from the display. The ambient illumination was 1.5 ftcndls. Two identical Measurement Systems Inc. Model 542 two-dimensional control sticks were used to respond to the tasks. The control sticks were mounted in adjustable arm rests attached to the subject's chair.

Subjects

Forty-eight right-handed females between the ages of 18 and 35 completed the experiment. All were students or staff at a large, private university, native English speakers, and had received no flight training. Subjects were recruited through advertisements placed in the student newspaper and in university buildings. All subjects were paid $5.50/hour for participating. Additionally, each subject could obtain a bonus of $0.20 for each trial in which she performed better on both tasks than on her own preceding best trial.

Design

A three-factor, mixed-model experimental design was used. Task was a within-subject factor with two levels corresponding to the left- and right-hand tracking task. Trial also was a within-subject factor. Group was a between-subjects factor with four levels. Groups 1, 2, and 3 differed on the number of single-task trials they received on each task before performing 20 dual-task trials. Group 1 received one single-task trial, Group 2 received three trials, and Group 3 received six single-task trials. Group 4, a control group, received one single-task trial on each hand followed by 30 dual-task trials. Subjects were assigned at random to the four groups.

Procedure

As soon as the subject arrived, she completed an informed consent form and performed the appropriate number of single-task trials for her group. Subjects in Groups 1, 2, and 3 then completed four blocks of five dual-task trials. Subjects in Group 4 completed six blocks of five trials. The experimenter checked on each subject after each block of trials, mentioned the number of bonuses she had won in the preceding block, and the scores on the subject's best trial. The experimental session concluded with two single-task trials for all groups.

The retention session occurred exactly one week later for all subjects but one. This subject received the retention session 5 days after the training session. Each subject began the retention session with two single-task trials followed by two blocks of five dual-task trials. The testing concluded with two single-task trials. The subject was then debriefed and paid.

All trials were 60 s long with a 45 s break between trials. All single-task trial blocks began with the left hand and alternated between hands. All instructions were taped and immediately preceded the appropriate condition. Bonus instructions were given to the subjects after the first dual-task block for Groups 1, 2, and 3 and after the third block for Group 4.

Results

The sphericity test available in BMDP2V (Dixon, 1985) was conducted on all repeated measure factors with more than one degree of freedom in the analyses of variance (ANOVAs) to test the assumption of homogeneity of covariance. Violations ($p<.025$) are noted in the appropriate place by giving the probabilities associated with the Huynh-Feldt test.

Only significant results ($p<.05$) are discussed.

Training

Single-task analyses. Although all subjects were assigned randomly to the four experimental groups, two one-way analyses of variance (ANOVAs) were conducted on the scores from the first trial performed on each task. Although neither of these analyses showed a significant effect of group, Group 2 had better performance than the other three groups on both analyses.

Because Group 3 received more training trials than Group 2, it was assumed that Group 3 would perform better on both tasks than Group 2. The data, however, showed little difference between the two groups at the end of their respective training; Group 2 had an average of score of 30.5 on the last (third) left-hand trial; Group 3 had an average score of 30.4. Comparable scores for the final right-hand trial for Groups 2 and 3 were 28.3 and 29.5.

Additionally, two one-way ANOVAs were conducted on the last single-task trial of each task. The ANOVA performed on the left-hand task showed no significant effect of group. In contrast the analysis of the right-hand task did show a significant between-group difference [F (3,44)=4.40, p =.0086]. Scheffe's S test (see Kirk, 1968) revealed three significant contrasts: Group 1 versus Group 2, the average of Groups 1 and 4 versus Group 2, and the average of Groups 1 and 4 versus Groups 2 and 3. In all cases these contrasts indicate that the groups that received more single-task practice (Groups 2 and 3) performed better than those that only received minimal practice (Groups 1 and 4).

Dual-task analyses. Two identical, two-way (Group by Trial) ANOVAs were conducted on the right- and left-hand tasks (the first 20 trials were used for Group 4). Both analyses showed significant main effects of Trial [F (19,836)=31.17 , Huynh-Feldt p <.0001 and F (19,836)=34.07, Huynh-Feldt p <.0001 for the right- and left-hand tasks, respectively]. No other main effects or interactions were significant.

Retention

Single-task analyses. Two one-way ANOVAs were conducted on the first trial of each task. Neither analysis showed a significant effect of group.

Two similar ANOVAs were conducted on the last single-task trial of each task. The ANOVA performed on the left-hand task showed no significant effect of group. In contrast, the main effect of group was significant [F (3,44)=3.01, p=.0400] in the ANOVA performed on the right-hand task. Scheffe's S test revealed two significant contrasts: Group 1 versus Group 2 and the average of Groups 1 and 4 versus Group 2. These contrasts indicated that Group 2 had significantly better performance than Group 1 or the average of Groups 1 and 4.

Dual-task analyses. Two two-way (Group by Trial) ANOVAs were performed on the right- and left-hand tasks. The main effect of trial was significant in both analyses [F (9,396)= 11.61, Huynh-Feldt p <.0001 for the right-hand task and F (9,396) =13.40, Huynh-Feldt p <.001 for the left-hand task]. The only other significant effect was a main effect of group [F (3,44)=3.43, p=.0249] for the right-hand task. The source of this main effect could not be identified using Scheffe's S Test although Group 2 had better performance (33.4) than Groups 1, 3, or 4 (46.8, 43.8, and 39.1, respectively).

Discussion

The results of this experiment are inconclusive for two reasons. First, extended single-task practice did not affect the performance of Group 3 as anticipated; after the third trial on each task, there was little subsequent improvement in performance. As a result, Groups 2 and 3 reached approximately the same level of single-task performance. It is impossible, therefore, to examine the effect of the amount of single-task practice on dual-task performance.

The second problem, between-group differences in tracking skill, make interpreting even simple contrasts between the effects of minimal (Groups 1 and 4) and more extensive (Groups 2 and 3) single-task practice problematic. Although there was no significant between-group difference on the first single-task trial of either task, Group 2 had better performance on both tasks. This difference was maintained on all subsequent single-task trials during the training and retention sessions and resulted in statistically superior performance for this group on the last right-hand trial of both the training and the retention sessions. It is plausible to assume that the superior single-task performance of Group 2 resulted in the significant between-group difference on the right-hand task during retention.

Although no conclusions can be drawn from this experiment, one recommendation can be made for subsequent research: some type of incentive should be offered for good single-task performance during the initial training sessions. Data from this experiment and from Damos (1986) indicate that extended single-task practice on discrete tasks did not result in better performance than intermediate levels of practice. In both experiments performance incentives were offered only under dual-task conditions. Future experiments should, therefore, use incentives for good performance in the initial single-task training session as well as in the dual-task sessions to maintain the subjects' motivation during the initial phase of the experiment.

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