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Introduction

The present study was concerned with the influence of different amounts of experimentally induced muscular tension on performance of a motor task. Following the pioneer investigations by Bills (1), a number of studies utilizing tasks under various techniques of inducing tension have attempted to test his general conclusion that tension facilitates performance. McGeoch (9) and Courts (5) present excellent summaries of the studies concerned and, in general, the evidence cited agrees with Stauffacher (11) who on the basis of his own work and early studies, stated the hypothesis that there is an amount of tension which is optimal for learning and that amounts of tension above and below this level are accompanied by slower rates of learning.

Another relationship, proposed by Bills and Stauffacher (2), is that tension facilitates performance of an easy task more than of a difficult one. However, the data necessary to refute or substantiate the hypothesis was not presented by the authors.

Stauffacher (11) demonstrated that there is an optimal level of tension for memorization of nonsense syllables. This finding was corroborated by Courts (4, 5) who also showed that tension higher than the optimum resulted in poorer performance. In a more recent study, Courts (3) employed the Koerth pursuit rotor and induced tension by having the subjects maintain weights through a pulley system. He found that the effects of tension on performance on the Koerth pursuit rotor during the early stages of learning are essentially the same as those on memorization.

The primary purpose of this study was to investigate further the effects of different amounts of experimentally induced tension on a motor task that differed from the Koerth pursuit rotor employed by Courts (3). It was assumed on the basis of Courts findings that evidence would be found to support Stauffacher's hypothesis—that is, that there would be an optimum amount of tension, at least initially, for performing the task and that amounts greater or less than the optimum would result in poorer performance.

A second purpose of the study was to obtain evidence on the relationship proposed by Bills and Stauffacher (2) that tension facilitates performance on an easy task more than on a difficult one.

Apparatus, Subjects, and Procedure

A modified version of the Discrimination Reaction Time Test (10) was used. The subject is seated in front of a horizontal response and vertical stimulus panel. The stimulus panel contains at eye-level five lights, two red and two green stimulus lights forming a square plus a white indicator light centered above the four stimulus lights. The horizontal response panel has four momentary toggle switches placed at 90 degree intervals.

The task involves pushing with the right hand one of four toggle switches to turn off the white indicator light when one of four possible red-green stimulus patterns is presented. The four red-green combinations are red above green, red below green, red right of green, and red left of green. Each of the stimulus patterns can be associated with any one of the four toggle switches.

This study employed two tasks that were basically similar but which differed in the connections between the stimulus patterns and the toggle switches. Task I, the task that on an apriori basis was judged to be the least difficult, had the following stimulus pattern response relations: red above green, push upper toggle switch; red below green, push lower toggle switch; red right of green, push right toggle switch; and red left of green, push left toggle switch. For Task II, the stimulus pattern response relations were as follows: Red above green, push left toggle switch; red below green, push right toggle switch; red left of green, push lower toggle switch; and red right of green, push upper toggle switch.

The performance measures yielded by the modified D.R.T. are latency of correct response in one hundreths of a second per trial and number of errors per trial. A correct response consists of pushing the toggle switch that turns out the white indicator light while an error consists of pushing any of the other toggle switches.

Physical tension was induced by having the subjects exert downward pressure with their left hand on a stirrup attached to a pulley system. Two and four pound weights were employed.

Six groups of female subjects, none of whom had had previous experience with the apparatus, were selected from volunteers enrolled in the elementary psychology class at the State University of Iowa. Each subject was assigned in a random manner to one of six groups. Of the fifty subjects volunteering, two were dropped because of failure to comprehend the nature of the task required.

Three of the six groups practiced on Task I and the other three groups performed Task II. On each task, one group had zero

weight, another had the two pound weight, and the third group performed while lifting the four pound weight.

Four groups of twenty stimulus patterns each were presented for a total of eighty test trials. The stimulus lights were on for three seconds per presentation with a 0.5, 1, or 1.5 second foreperiod between presentations. Also, after twenty trials, there was a forty second rest period followed by a warning buzzer, at which time the subject raised the weight and maintained it for the next twenty trials. Prior to the test series, detailed instructions were administered which included a demonstration of the four stimulus patterns and the correct response for each plus six presentations of sample settings. The total sequense of instructions, four demonstrations, six sample settings, and eighty test trials was administered in approximately fifteen minutes.

Results and Discussion

Two measures utilized in assessing the effects on performance of lifting the different weights and of the two tasks were reaction latency (correct responses) and number of errors (incorrect responses). Trials were grouped and mean differences were evaluated. Both decreases in reaction latency and errors were taken to indicate improved performance.

It was assumed that the groups were initially comparable in their ability to perform the tasks since the subjects were assigned randomly to the groups prior to their receiving any experimental treatment. Thus any real differences appearing later could be attributed to the treatment effects.

Table 1

Analysis of Variance of the Mean Reaction Latencies for Tasks, Weights, and Trials with the Trials Combined in Blocks of Four

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Between Subjects (S)	47	726.08	
Tasks (Tk)	1	0.0013	0.0013
Weights (W)	2	55.46	27.73
Tasks x Weights (Tk x W)	2	8.78	4.39
error (b)	42	661.84	15.76
Within Subjects (WS)	912	1394.33	
Trials (T)	19	493.6	25.98
Trials x Tasks (T x Tk)	19	35.27	1.86
Trials x Weights (T x W)	38	31.54	0.83
Trials x Tasks x Weights (T x Tk x W)	38	22.26	0.59
error (w)	798	811.66	1.02

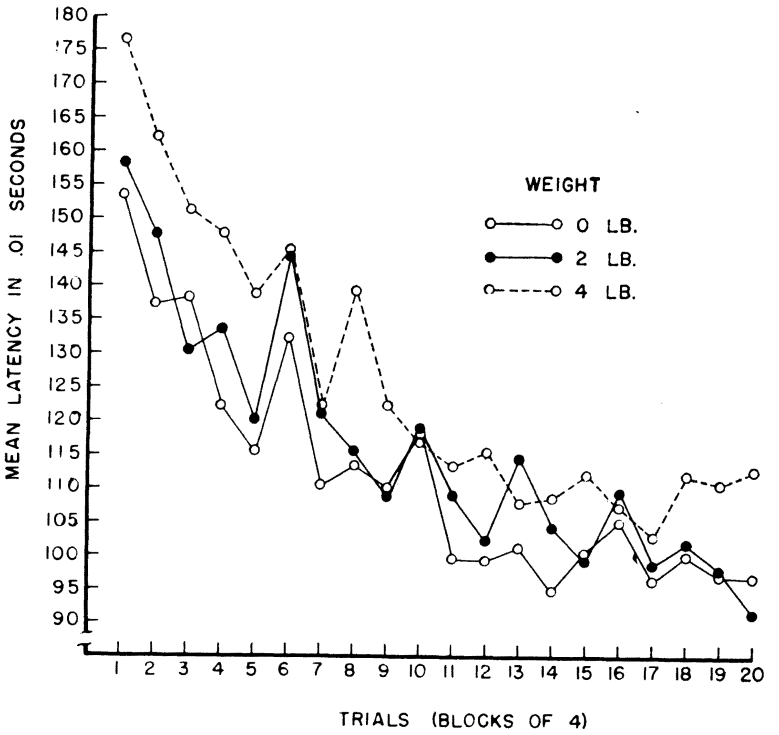

Figure 1:

The experimental design was regarded as a factorial experiment with three factors (weights, tasks, and trials). The analysis of the reaction latencies followed Lindquist's Type III design (7) especially formulated for trend data. The trials were grouped in fours. The results of the analysis are presented in Table I.

The first hypothesis tested was that the curves were parallel for the three different amounts of weight when tasks were disregarded. The curves are presented in Figure 1. The analysis yielded an F ratio of 0.81 with 38 and 798 df, providing no basis for rejecting this hypothesis. The second hypothesis under test was that the general means for the three amounts of weight were the same. The F ratio, in this case, was 1.76 with 2 and 42 df., and gave no basis for rejecting the hypothesis. Therefore, it was concluded that the observed differences in general means for the different amounts of physically induced tension could be attributed to random sampling. The general means for the 0, 2, and 4 pound weight groups were 112.3, 116.2 and 126.5, respectively. The interaction (Tk x W) between weights and tasks was not significant ($F = 0.05$ with 2 and 42

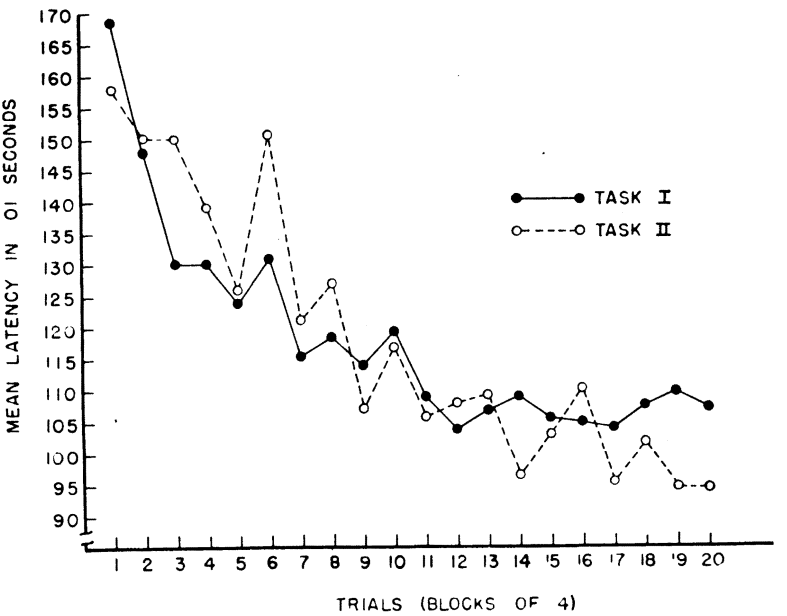

Figure 2.

df.) so it was assumed that the effects of the weights was the same for the two tasks.

The generalized curves for the two tasks are presented in Figure 2. The overall means for the two tasks were almost identical with a mean for Task I of 118.3 and a mean for Task II of 118.4 indicating that overall performance on the two tasks was almost identical—that is, the tasks did not differ in difficulty. The tasks by trials (T x Tk) interaction yielded an F ratio of 1.81 which with 19 and 798 df. is significant between the 5% and 1% level of confidence suggesting that the generalized curves for the task groups were not parallel. The curves in Figure 2 display much overlapping but, in general, the curve for Task II lies above the one for Task I during the early part of learning with the Task II curve crossing-over the curve for Task I and remaining below it for the last four trials. Whether the observed interaction between tasks and trials is real cannot be determined from this experiment. However, a replication of the experiment would yield evidence that would enable a decision on the significance of the observed interaction. There is no apparent reason for expecting the curves for the tasks to be other than parallel.

Since the groups showed significant differences over trials, it was concluded that the trends were genuine. For all groups the increase

in performance from the first to the last trial was pronounced, indicating that learning took place.

The error data indicated that in all cases the errors decreased with trials and that the group with the zero weight had the fewest total errors. The total number of errors for the zero, two and four pound weight groups was 109, 139, and 152 respectively.

The error data were skewed toward zero so the Mann-Whitney U-Test (8) which makes no assumption regarding the distribution of the scores, was used to compare the difference between the zero and four pound groups, the groups exhibiting the greatest differences. A z score of 1.13 was obtained which yielded a P of .13, so the hypothesis of no difference in the frequency distributions was not rejected. The errors indicated, as did the latency measures, that the groups performed in essentially the same way and that learning took place.

Contrary to expectations, no evidence was found in this study to support Stauffacher's (11) general hypothesis that there is an amount of tension which is optimal for learning and that amounts of tension above and below this level are accompanied by slower rates of learning. That the empirical results obtained are in disagreement with the general hypothesis serves only to limit the hypothesis and in no way discounts it. The zero weight group's performance gave some indication of being superior to the two and four pound weight groups which might indicate that the maintaining of the weights tended to interfere with performance on the D.R.T. test, but the results are not clear-cut.

By employing two similar tasks that, on an apriori basis, were judged to differ in difficulty it was hoped to obtain evidence on Bills and Stauffacher's (2) conclusion that tension facilitates performance on an easy task more than on a difficult one. However, the evidence obtained indicated that there was no overall difference in performance on the two tasks. Possibly no differences were obtained as the tasks were quite simple and the presentation of detailed instructions, four demonstration trials, and six sample settings prior to the experiment proper may have served to discount any original differences.

Summary

Six groups of female subjects were run on two motor tasks under three degrees of physically induced tension. All groups demonstrated learning but no substantial differences were obtained. Contrary to expectations, no evidence was found to substantiate Stauf-

facher's (11) proposal that there is an optimum amount of tension for performing a task.

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