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Effects of Motivation on the Performance of Difficult and Easy Motor Tasks

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The purpose of this study was to determine whether high motivational level facilitates performance on an easy motor task and impairs performance on a difficult one.

The problem is suggested by the theoretical formulations of Hull (4) and Spence (12) and the experiments done within this framework. The theory states that a response tendency is some multiplicative combination of associative and motivational factors. The most obvious consequence of this formulation is that as motivational level increases, performance will increase. But this applies only to the simplest situations, in which there is but one response tendency to be augmented by increased motivation. A situation in which it is possible for the experimenter to keep a single response tendency dominant is classical defense conditioning. The prediction that speed and final level of conditioning will increase with augmented drive has been supported in a number of studies of conditioned eyelid closure (13, 14, 15, 16, 17). In this series of studies drive or motivation was manipulated by varying the intensity of the unconditioned stimulus (the air puff) or by dividing subjects (Ss) into high and low drive groups on the basis of their scores on the Taylor Scale of Manifest Anxiety.

Investigations of the effects of increased motivation on the performance of verbal and motor learning tasks did not show this simple result. Increased motivation sometimes facilitated, sometimes impaired performance (2, 3, 10, 11, 18). These results were incorporated into the theory with the aid of the idea of competing response tendencies. Increased motivation is said to augment the performance of the response that is dominant at the time. Increased motivation will facilitate the performance of a task which is easy, one for which S can readily find the correct responses. But increased motivation will impair the performance of a difficult task, one for which S has difficulty finding the correct response or for which S has an established habit of making an incorrect response.

The present study is designed to develop specific response tendencies in S, then observe the effects of motivation on S's ability to overcome dominant incorrect response tendencies and utilize dominant correct response tendencies.

Experimental Method

The basic procedure was to provide each S with both correct and incorrect tendencies by a verbal learning technique, then test S on a motor task. A motor task for which such a procedure is possible is available on the Star Discrimeter.

Apparatus

As indicated in Figure 1 the response unit of the Star consists of six slots, spaced 60 degrees apart, which radiate from a central opening in a horizontal steel plate. Out of this opening protrudes a wobble stick, which can be moved into any one of the six slots. The

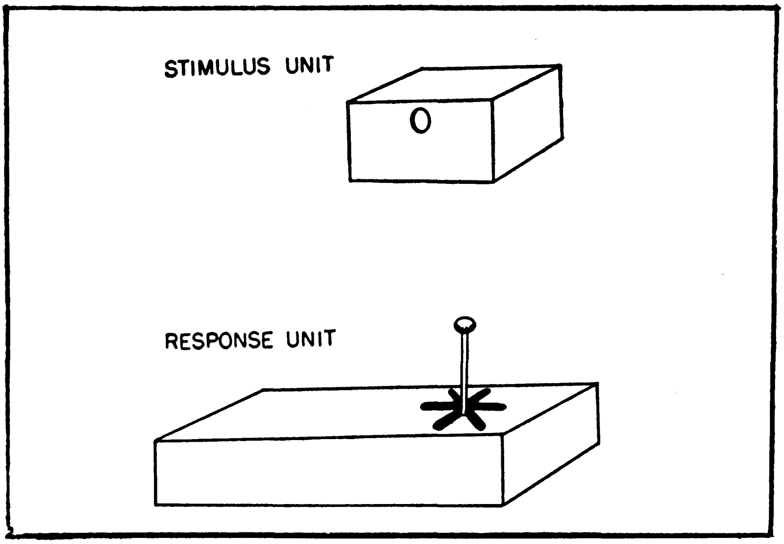

Figure 1. Schematic drawing of the Iowa Star Discrimeter.

stimulus panel contains a circular piece of opal glass onto which any one of six colors can be projected from inside the unit. The sequence of colors is controlled by a 50 point stepping relay. The colors used were a series from yellow to red, including two reddish, two yellowish, and two orangish hues. It is difficult but, for female Ss, still possible to discriminate the colors. The difficult colors were used to make the distribution of error scores a normal one. When quickly distinguishable colors are used, many Ss eventually make very few or no errors, so the distribution of scores is skewed. It was desirable to have a normally distributed criterion measure so that analysis of variance techniques could be directly applied to the data.

For a particular task, each color is connected with one of the response slots. S moves the stick into the appropriate slot for each color. Pushing the stick all the way into the correct slot closes a microswitch which simultaneously activates the stepping switch (changing the color in the stimulus panel) and the correct response counter. Entering any of the other five slots closes first a shallow and then a deep error microswitch. These microswitches activate their corresponding counters. An electric polygraph recorder automatically makes a detailed record of the stimulus colors as they appear and all the responses made to them. The Star situation is a free-responding one in that a color will remain on the stimulus panel until S goes all the way into the correct slot, turning off the stimulus color and bringing up a new one.

During verbal pretraining, the response unit is covered. A slide projector, mounted next to the unit, projects the response words (white on black) beneath the circle of opal glass on the stimulus panel. The stepping switch of the Star and the automatic slide projector (La Belle 33) are operated synchronously by five decade interval timers. For the two-second anticipation period a color appears in the circle of opal glass. Then the projector flashes a word beneath this color and the color and the word are together on the stimulus panel for two seconds. At the end of this period both the color and word disappear and a new color appears to begin the next four-second cycle.

The verbal learning technique utilized a clock analogue. The six slots of the response unit can be conceived of as pointing toward the even numbered hours on the face of a clock. From the point of view of an S standing before the response unit, 12 o'clock is straight ahead, 2 o'clock is to the right and forward and so forth. It has been found (7, 9) that when Ss learn to respond to the colors in the stimulus panel with the verbal responses 2 o'clock, 4 o'clock, etc. and when the clock-hours designate the correct motor response, motor task performance is facilitated. All S has to do in motor practice is substitute moving into the correct slot for the previously learned verbal response of the clock-hour.

For the present study S learned to respond to the colors by saying the even-numbered hours, but three of the color-hour pairs used were appropriate for the motor task, and three were not. An example of the former three is that one shade of orange was paired with "12 o'clock" in the verbal learning part of the experiment. In motor practice, the correct response to this color was moving the stick into the slot straight ahead. This pair was one for which the pretraining and motor task responses were *concordant*. An example of the latter three is that one shade of red was paired with "2 o'clock" in the verbal pretraining. In motor practice the correct response to this color was not moving the stick into the right-for-

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ward slot, but into the straight-backward slot or the "6 o'clock position." Thus three of the pairs were rearranged between the verbal and motor tasks. Such pairs are ones for which the verbal and motor responses were *discordant*.

The errors made to the two sets of three colors were recorded separately. For convenience the two classes of errors will be spoken of as C errors (errors made to colors with concordant responses in verbal and motor learning) and D errors (errors made to colors with discordant responses in verbal and motor learning). The stimuli for which C errors are recorded are the stimuli of the easy task, those for which D errors were recorded, the stimuli of the difficult task.

Experimental Design

The study consists of two parallel experiments for which motivational level was defined differently. For the first, motivation was defined in terms of the achievement imagery (AI scores) of the Iowa Picture Interpretation Test (IPIT) (5). This is a group TAT test in which each S ranks four statements about each picture (projected on a screen for one minute) in the order of their agreement with S's interpretation of the picture. In each set of four statements there is one judged by clinical psychologists to have achievement content. The assumption is that those who consistently assign a high rank to achievement items are high in achievement imagery, that they are interested in success. The AI score is the sum of the ranks assigned to the achievement content items. There are 24 pictures; the possible scores range from 24, for those with very high AI, to 96, for those with low AI. The two groups in the first experiment were selected from the ends of a distribution of scores of about 200 women on the AI scale of the IPIT. The high AI group consisted of 30 women with scores of 46 and below; the low AI group of 30 women with scores of 61 and above.

Sixty women were selected from the middle of the AI score distribution (scores 54 to 57) and randomly divided into two groups for the second of the two parallel experiments. One of these groups was given instructions intended to motivate them to do well, the other instructions intended to make them indifferent. These groups will be referred to as the Motivated and Non-motivated Groups respectively.

For both of the parallel experiments the expected results were that the Ss with a high level of motivation would do better than the others on the easy task (make fewer C errors) but worse on the difficult task (make more D errors).

Procedure

For verbal pretraining, Ss were seated on a high chair facing the stimulus panel. The instructions were identical for all groups. S was presented with each of the six color-clock hour pairs 24 times, making a total of 144 presentations. A 90 second rest was given midway through verbal learning.

Upon completion of verbal pretraining, S was given a three minute rest, during which E set the apparatus for the motor task. The basic motor task instructions were the same for all groups. In addition to the basic instructions, Ss in one of the two middle AI groups were given instructions intended to motivate them and those in the other middle AI group instructions intended to make them indifferent.

All Ss were given 30 trials on the Star. The trials were 20 seconds in length and were separated by 10-second rests. A three-minute rest was given after 15 trials.

Results

Verbal Learning

The verbal learning performances of the four groups were practically identical. Table 1 shows the means and standard deviations of the number of correct anticipations made by each group out of the 144 possible. For the first experiment the difference in mean number of correct anticipations for the high and low AI groups is

Table 1

Means and Standard Deviations of the Number of Correct Responses Made by the Four Groups in Verbal Pretraining

Group	Mean	Standard Deviation
High AI	63.70	16.08
Low AI	64.17	16.78
Motivated	66.07	17.72
Non-motivated	67.60	16.56

0.47. For the second the difference between Ss randomly assigned to the Motivated and Non-motivated Groups is 1.53.

Comparison of C and D Errors for All Ss

The purpose of the verbal learning portion of the experiment was to establish certain response tendencies in S without giving any experience with the criterion task. That this technique did give Ss the response tendencies intended is demonstrated in Figure 2, where the means of number of C and D errors made by all 120 Ss are plotted against trials. On all but the first of the thirty trials, more D errors were made than C errors.[1] For this reason it can be said that S was practicing on two tasks, a difficult task and an easy one.

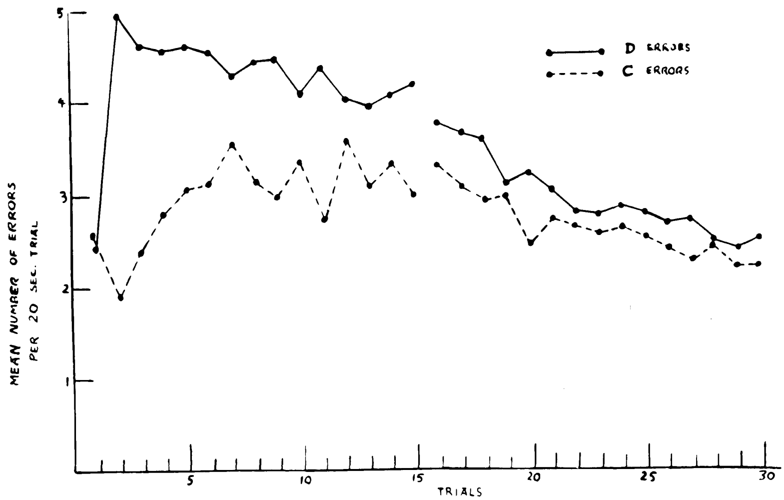

FIGURE 2: MEAN NUMBER OF C AND D ERRORS PER TRIAL FOR ALL OF THE 120 SUBJECTS

In general, after the first trial, the trend of the curve for D errors is downward and linear, with an apparent change of slope after the 3-minute rest between trials 15 and 16. The trend of the curve for C errors is not so simple. Here, the number of errors increases after Trial 2, then levels off to remain essentially uniform until the rest period. After the rest the line is virtually parallel with that for D errors, but a little lower.

Comparison of the High and Low-AI Groups

Before the results are considered, it should be recalled that the expected results are as follows: The high AI group will make fewer C errors and more D errors than the low AI group. The numbers of C and D errors made by the high and low AI groups are shown in Figure 3. In the first half of practice, before the rest period, both groups made more D errors (represented by the solid line curves) than C errors. For both groups, as for all Ss, the initial point on the D error curve is low. Afterwards the curve is horizontal for

[1]The atypical values of the means on the first trial may be explained by the fact that all Ss began at the same point in the sequence of colors and that most of the colors S would see on this trial (most Ss changed 3 colors and thus had an opportunity to make errors in response to 4 colors) were colors for which S had learned concordant verbal and motor responses. This limited the number of D errors that could be made on the first trial, while increasing the likelihood of C errors.

the low AI goup while that for the high AI lies both above and below it. In the second half of practice the D error curves for the two groups lie quite close together. The similarity of the D error curves for both groups is contrary to expectation.

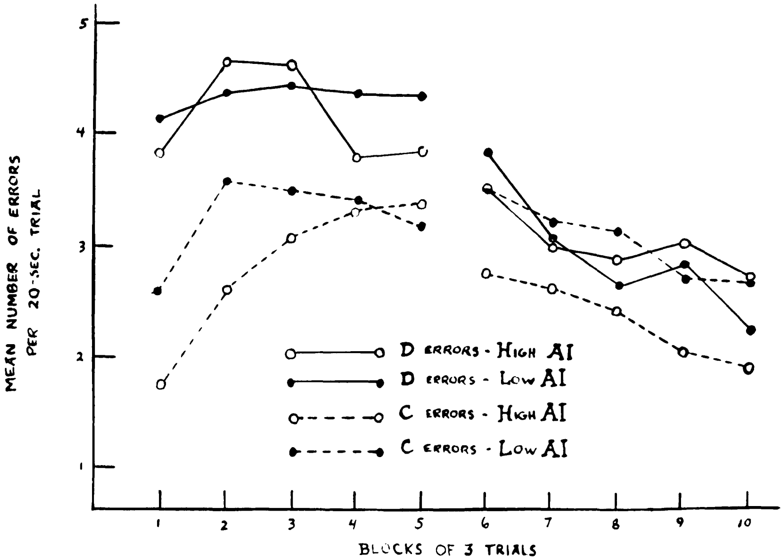

FIGURE 3: A PLOT OF MEANS OF NUMBER OF C AND D ERRORS AGAINST TRIALS FOR THE HIGH AND LOW AI GROUPS.

The C error curves seem to conform more closely to the prediction. As seen in Figure 3, the high AI group made fewer C errors on all but the fifth block of trials. It should be noted that for the high AI group the trend of C errors is a continuously rising one until the rest period. The explanation is probably that Ss became confused upon discovering that some of their previously learned responses helped them in turning off the colors while others did not.

The statistical reliability of the results depicted in Figure 3 was evaluated by analysis of variance (Lindquist's Type VI design). The analysis is summarized in Table 2. (Table 3 lists the hypotheses for which the Type VI design provides tests.) The chief results were that neither the difference between motivational levels nor the interaction of motivational level with task difficulty was significant.

Table 2

Summary Table of the Analysis of Variance of the Error Data for the High and Low AI Groups Over the Entire Practice Period.

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F	P
Between Subjects	59	91,959.130			
Between Groups	1	997.363	997.363	<1	
Error Between	58	90,961.767	1,568.306		
Within Subjects	1140	112,247.000			
Between Error Types (E)	1	6,111.053	6,111.053	15.068	.001
Between Trials (T)	9	11,022.897	1,224.766	23,475	.001
E x T Interaction	9	3,372.347	374.705	5.036	.001
E x G Interaction	11	755.254	755.254	1.862	.200
T x G Interaction	9	254.370	28.263	<1	
E x T x G Interaction	9	1,131.046	125.672	1.689	.100
Error Within	1102	89,600.003			
Error 1 Within	58	23,523.493	405.577		
Error 2 Within	522	27,233.733	52.172		
Error 3 Within	522	38,842.777	74.411		
Total	1199	204,206.130			

The records of specific errors made by each S yielded results in the expected direction. The high AI group made more intrusions or transfer errors than the low AI group (547 to 469). (An intrusion is an error that can be identified as resulting from the verbal responses S learned in pretraining. No C error can possibly be an intrusion.) The difference in intrusions between the two groups was not statistically significant.

None of the predictions made with respect to the C and D errors for the high and low AI groups was confirmed. No significant difference was found between these groups. The fact that most of the differences were in the expected direction is of little consequence.

Table 3

A List of the Hypotheses for which a Type VI Design Provides Tests. Stated in terms of the two experiments in the present study and listed in order to correspond with the order of F ratios in Tables 2 and 4.

1. There is no difference between the numbers of errors made by the groups with high and low levels of motivation.
2. The number of C errors made by both groups is equal to the number of D errors.
3. The number of errors for one block of trials is equal to that for any other.
4. There is no error type by trials interaction. Or the difference between numbers of C and D errors for one block of trials is equal to that for any other.
5. There is no error type by groups interaction. Or the difference between numbers of C and D errors for one group is equal to that for the other.
6. There is no trials by groups interaction. Or the difference between the two groups for one trial is equal to that for any other.
7. There is no error type by trials by groups interaction. Or the error type by trials interaction for one group is equal to that for the other.

Comparison of the Motivated and Non-motivated Groups

The expectation for these two groups was of the same kind as for the high and low AI groups. The Motivated Group would make more D errors and fewer C errors than the Non-motivated Group. As seen in Figure 4 this was not the case. In the first half of practice there are no group differences. Both groups show a slow downward trend in D errors and a general upward trend in C errors.

In the second half of practice, the Non-motivated Group made about an equal number of C errors and D errors. The Motivated Group made more of both kinds of errors in this half of practice. Although the trends in Figure 4 do not support the prediction it was decided to determine whether the observed differences were statistically significant. The significance of the differences was evaluated by a type VI design over the second half of practice. The analysis is summarized in Table 4. There are no significant group differences or interactions.

Table 4

Summary Table of the Analysis of Variance of the Error Data for the Motivated and Non-motivated Groups Over the Second Half of the Practice Period

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F	P
Between Subjects	59	52,343.0983			
Between Groups	1	2,667.0416	2,667.0416	3.114	.10
Error Between	58	49,676.0567	856.4837		
Within Subjects	540	38,425.3000			
Between Error Types (E)	1	741.4816	741.4816	2.576	.20
Between Trials (T)	4	3,182.4400	795.6100	30.943	.001
E x T Interaction	4	297.1267	74.2817	1.601	.20
E x G Interaction	1	408.3751	408.3751	1.419	
T x G Interaction	4	173.0334	43.2583	1.682	.20
E x T x G Interaction	4	204.3999	51.1000	1.102	
Error Within	522	33,418.4433			
Error 1 Within	58	16,691.4917	287.7843		
Error 2 Within	232	5,965.2266	25.7122		
Error 3 Within	232	10,761.7250	46.3867		
Total	599	90,768.3983			

The detailed record of errors showed that the Motivated Group made a few more intrusion errors than the Non-motivated (540-516), but the difference was not statistically significant.

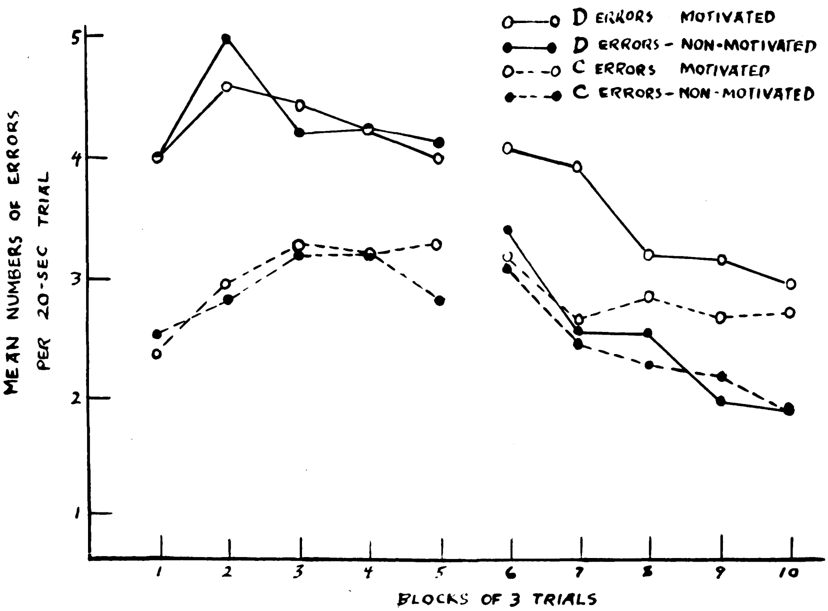

FIGURE 4: A PLOT OF MEANS OF NUMBER OF C AND D ERRORS AGAINST TRIALS FOR THE MOTIVATED AND NONMOTIVATED GROUPS.

SUMMARY

The purpose of the study was to determine whether high motivational level facilitates performance on an easy motor task and impairs performance on a difficult one.

Motivational level was defined in two ways: by extreme scores on the Achievement Imagery (AI) Scale of the Iowa Picture Interpretation Test, and by special instructions. There were 4 groups of 30 female Ss each: one high AI; one low AI; and two middle AI, specially instructed in one case to induce "eagerness", the other to induce "indifference". Aside from the motivating instructions, all Ss received the same treatment.

Motor performance was on the Star Discrimeter, a device requiring S to learn to associate six directional movements of a wobble stick with six different colors of light. As previously shown, overall performance on the Star can be facilitated or impaired by verbal pretraining procedures. To obtain "easy" and "difficult" tasks, all Ss were given verbal pretraining aimed at facilitating their performance on 3 of the 6 color-response pairings and impairing their performance on the other three. The numbers of errors made on the two sets of color-response pairs, on each trial, were separately re-

corded. An electric polygraph recorded specific errors as they were made so intrusions could be considered.

Although many differences were in the expected direction, none of those between performances of the various motivational groups was statistically significant. The interaction of motivation and task difficulty was non-significant. No dependable group differences were found in numbers of intrusions.

Literature Cited

1. Cantor, Joan. Amount of pretraining as a factor in stimulus predifferentation. *J. Exp. Psych.* 1955. 50, 180-184.
2. Castaneda, Alfred, and Palermo, D. S. Psychomotor performance as a function of amount of training and stress. *J. Exp. Psych.* 1955. 50, 175-179.
3. Farber, I. E., and Spence, K. W. Complex learning and conditioning as a function of anxiety. *J. Exp. Psych.* 1953. 45, 120-125.
4. Hull, C. L. *Principles of Behavior.* New York. Appleton-Century. 1943.
5. Hurley, J. R. Verbal learning as a function of instructions and achievement motivation. Unpublished doctor's dissertation, State University of Iowa. 1953.
6. Lindquist, E. F. *Design and Analysis of Experiments in Psychology and Education.* New York. Houghton Mifflin. 1953.
7. McAllister, D. E. The effects of various kinds of relevant verbal pretraining on subsequent motor performance. *J. Exp. Psych.* 1953. 46, 61-64.
8. McCormack, Peter D. Negative transfer in motor performance following a critical amount of verbal pretraining. Perceptual and Motor Skills. 1958. 8, 27-31.
9. Macek, A. J. Transfer from verbal to motor responses of different degrees of concordance. *Proc. Iowa Acad. Sci.* 1957.
10. Montague, E. K. The role of anxiety in serial rote learning. *J. Exp. Psych.* 1953. 45, 91-96.
11. Palermo, D. S. Proactive interference and facilities as a function of amount of training and motivational level. Unpublished doctor's dissertation. State University of Iowa. 1955.
12. Spence, K. W. *Behavior Theory and Conditioning.* New Haven. Yale University Press. 1956.
13. Spence, K. W. Learning and performance in eyelid conditioning as a function of the intensity of the UCS. *J. Exp. Psych.* 1953. 45, 57-63.
14. Spence, K. W., and Farber, I. E. Conditioning and extinction as a function of anxiety. *J. Exp. Psych.* 1953. 45, 116-119.
15. Spence, K. W., and Farber, I. E. The relation of anxiety to differential eyelid conditioning. *J. Exp. Psych.* 1954. 47, 127-134.
16. Spence, K. W., and Taylor, J. A. Anxiety and strength of UCS as determiners of the amount of eyelid conditioning. *J. Exp. Psych.* 1951. 42, 183-188.
17. Taylor, J. A. The relation of anxiety to the conditioned eyelid response. *J. Exp. Psych.* 1951. 41, 91-92.
18. Taylor, J. A., and Spence, K. W. The relationship of anxiety level to performance in serial learning. *J. Exp. Psych.* 1952. 44, 61-64.

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