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The Relation of Anxiety Level to the Performance of an Abstract Reasoning Task Under Stressful and Non-Stressful Conditions

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THE RELATION OF ANXIETY LEVEL TO THE PERFORMANCE OF AN ABSTRACT REASONING TASK UNDER STRESSFUL AND NON-STRESSFUL CONDITIONS

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THE RELATION OF ANXIETY LEVEL TO THE PERFORMANCE OF AN ABSTRACT REASONING TASK UNDER STRESSFUL AND NON-STRESSFUL CONDITIONS

This experiment is concerned with the relation of anxiety level to performance under stressful and non-stressful conditions.

Stress has been hypothesized to result in an increase in drive level. Furthermore, this drive level may result in an increase of task-irrelevant rather than problem-solving responses. This point is brought out by Spence and Taylor (1953) who deal with the effects of stress within a motivational framework derived from Hull. They regard reactions to stress as intensifying existing levels of motivation. In the case of simple conditioning the increment in drive intensifies the single "correct" response tendency and hence, facilitates conditioning. For more complex tasks, such as abstract reasoning, the "incorrect" as well as the "correct" response tendencies are strengthened, response competition is intensified, and the probability of a correct response is reduced.

Deese and Lazarus (1952), on the other hand, have conceptualized this relationship in the following statement:

> Another element in the concept of stress

> is a secondary affective state that occurs whenever a powerful motive remains ungratified. This state consists of responses commonly called emotional. They include such things as physiological changes, motor activity, and subjective reactions such as anxiety. In addition the affective state may serve as a new motive itself, and may produce responses that are directly aimed at the reduction or elimination of this condition rather than at the solution of the problem causing the state of deprivation.

In general, solution of a complex task requires a prescribed response pattern. If the effect of increased stress is an increase in the number of task-irrelevant responses, the likelihood that the prescribed response will appear is markedly reduced.

Experiments concerning the effects of stressful situations and subjects' anxiety level on performance have been reviewed by Lazarus, Deese and Osler (1952), Child (1954) and Taylor (1956). It has been generally found that subjects' anxiety and stress interact so that the performance of high-anxiety subjects is more impaired in stressful situations than that of low-anxiety subjects. Taylor (1956) has suggested that under conditions of psychological stress, responses of the type that Child (1954) has referred to as task-irrelevant are more easily or more intensely aroused in high-anxiety than in low-anxiety subjects.

These findings were suggested by the results of studies by Gordon and Berlyne (1954), and Lucas (1952). In both of these investigations, high-anxiety subjects

that were told that their performance on a verbal task was inadequate, were inferior in performance on a subsequent task to high-anxiety groups run under neutral conditions. The low-anxiety group, in contrast, showed no decrement in performance under stress when compared to their control groups. While the results of these studies seem to confirm the notion that high-anxiety subjects are more liable to make task-irrelevant responses under conditions of psychological stress, they could also be attributed simply to a greater emotional reaction to the stress instructions and hence a greater increase in anxiety on the part of high-anxiety groups. That is, the empirical predictions generated from anxiety theory state that increases in anxiety level facilitates performance in relatively simple tasks in which a single response tendency is evoked (e.g. classical conditioning). In more complex situations in which competing responses are evoked and the correct response tendency is relatively weak, high-anxiety subjects tend to lose their superiority and, as the number of incorrect responses becomes greater and/or more dominant, to become inferior. Both the Gordon and Berlyne (1954), and the Lucas (1952) studies employed learning tasks of the competitive type. Thus it could be argued that the high-anxiety subjects reacted with greater emotionality to the stressful conditions than the low-anxiety subjects, and the resultant

increase in anxiety was responsible for their performance decrement.

The suggestion that psychological stress effects high and low-anxiety subjects in complex tasks bears some resemblance to the empirical predictions proposed by Sarason, Mandler and Craighill (1952) for the performance of groups selected by a different measuring instrument, a questionnaire of "test anxiety," designed to select individuals reacting with different degrees of anxiety to intelligence tests and course examinations. These investigators hypothesized that such high-anxious individuals react to an experimental situation represented as a test of intelligence or the like (thus, according to their conception, creating stress) with more anxiety or drive than low-anxious. As a result of past learning, their anxiety evokes irrelevant response tendencies which interfere with task performance. Under increasing stress (such as reports of failure) the performance of high-anxious subjects deteriorates because of the arousal of a greater number of these irrelevant tendencies, offsetting the facilitating effects of drive; the performance of low-anxious, however, improves with greater stress due to an increasing drive level, unaccompanied by irrelevant tendencies. The predictions of the investigators appear to have held up well. In the stressful condition, the high-anxiety subjects did poorer

than the low-anxiety; and in the non-stressful condition, the low-anxiety subjects did poorer than the high-anxiety.

The general problem area with which this study is concerned is behavioral changes in relation to stress. More specifically, it is limited to abstract reasoning performance under two conditions; stress and non-stress. An additional independent variable is included. It is the personality variable of "manifest anxiety."

This study is based on two assumptions: (1) Among high-anxiety subjects, stressful instructions will increase the strength of task-irrelevant responses; while non-stressful instructions will reduce the strength of these responses. (2) Among low-anxiety subjects, stressful instructions will strengthen task-relevant responses; while non-stressful instructions will reduce the strength of these responses.

It is hypothesized for purposes of this study that the high-anxiety group given stressful instructions will demonstrate poorer task performance than the low-anxiety group; and that the high-anxiety group given non-stressful instructions will demonstrate better task performance than the low-anxiety group.

METHOD

The subjects used for this experiment were 109 volunteers from Introductory Psychology classes at Western Michigan University. They were told that their participation in this study would consist of two separate sessions, during which they would take three paper and pencil tests.

All of the subjects participated in the first session, during which they performed two tasks. The first task was the Letter Series Test and the Number Series Test, which are two elements of the Abstract Reasoning Section of the Primary Mental Abilities Test (Adult Form), published by Science Research Associates. They were selected primarily because they require the same type of reasoning involved in the test used in the second session as a measure of the dependent variable, or performance under psychological stress. They are also very short tests which require only four minutes each to administer. In each of these tests, the subject was presented with a series of numbers or letters. He was to try to determine the pattern in which they were presented, and to select the number or letter which followed next in the series.

The second task performed during the first session

was the Taylor (1953) Manifest Anxiety Scale. Since its development in 1951, the "Scale" has been used in many research projects. In a majority of cases it has served as a selection device to obtain high and low-anxiety groups. In the present study it was once again used for this purpose. The "Scale" consists of 50 statements which have been selected from the Minnesota Multiphasic Personality Inventory. The administration is by self-reporting of the subject. The subject responds to each statement with a "T" for true and a "F" for false, depending on how he feels the statement applies to him. There is no time limit for the "Scale." The Taylor Manifest Anxiety Scale was introduced to the subjects under the title of "Biographical Index." Prior to the administration of the "Scale," the subjects were encouraged to respond to the statements as honestly as possible, and were assured that their performance would remain strictly confidential.

On the basis of their performance on the two pre-tests, 82 subjects were selected to participate in the second session of the experiment. The first step in this process involved the selection of high and low-anxiety subjects. Those who scored 20 or above on the Taylor Manifest Anxiety Scale were designated as "high-anxiety;" and subjects who scored 13 or below were designated as "low-anxiety." The second step in the selection process

involved the assignment of these two groups to the stressful and non-stressful testing conditions. High and low-anxiety subjects in both testing conditions were matched as closely as possible on the basis of scores on the Taylor Manifest Anxiety Scale, and the Abstract Reasoning Section of the Primary Mental Abilities Test. The number of subjects assigned to each group, and the mean and standard deviation obtained by each group on both of the pretests are represented in Table 1.

During the second session, the task used to evaluate the dependent variable or performance under psychological stress was the Abstract Reasoning Section of the Differential Aptitude Test, published by The Psychological Corporation. The test was selected because it is supposed to have a sufficient range of difficulty to distinguish the individual performances of college students, and also because of its length. The test has 50 problems, and the subject is allowed 25 minutes to complete them. Each item is presented in the form of four figures which have a definite relationship. The subject must select from five alternatives the fifth figure which follows next in the sequence.

In both the stressful and the non-stressful conditions, the test consisted of three equal time periods. For purposes of distinguishing the performance of high and low-anxiety subjects under stressful and non-stressful

Table 1

Means and Standard Deviations of Pretest Scores Obtained by High and Low-Anxiety Groups Assigned to Stressful and Non-stressful Testing Conditions

	STRESS		NON-STRESS	
	N=20		N=19	
	Taylor M.A.S.	P.M.A.	Taylor M.A.S.	P.M.A.
High-Anxiety	Mean=24.65 S.D.= 4.45	Mean=21.75 S.D.= 6.70	Mean=24.47 S.D.= 3.92	Mean=22.10 S.D.= 4.63
	N=22		N=21	
	Taylor M.A.S.	P.M.A.	Taylor M.A.S.	P.M.A.
Low-Anxiety	Mean=9.31 S.D.=3.41	Mean=22.86 S.D.= 5.50	Mean=9.33 S.D.=3.25	Mean=22.61 S.D.= 4.40

conditions, the test was divided into three 6½ minute periods. The distinction between the two conditions was made evident by means of a supplement to the normal instructions.

In the stressful condition, the subjects were told the following:

> The test is composed of three periods. You will be allotted the same amount of time for each period. At the end of each period I will say "stop." When I do, you are to quit working and draw a line under the number on the answer sheet which corresponds to the question you are working on or have just completed. I will then tell you the number of questions you should have completed in the period, and this will have an important bearing on your score. The criteria for success in each section is based on the performance of high school graduates. Although you may find it difficult, each of you will be expected to complete the number of problems called for in each period. Before the start of a new period, I will say "begin," and you will resume working where you left off.

The number called at the end of the first two periods was beyond the possibility of completion in the amount of time allotted.

In the non-stressful condition, the subjects were told the following:

> During the course of the test, I will say "mark." When I do, you are to draw a line under the number on the answer sheet which corresponds to the question you are working on or have just completed. Work continuously and do not be alarmed by these signals. Your position at these intervals will have no bearing on your score.

At the end of the second session, all subjects were

thanked for their cooperation, and informed that the results and the purpose of the experiment would be made available to them as soon as all of the data had been collected and analyzed.

RESULTS

To evaluate the statistical significance of this study, an analysis of covariance was used. This procedure is intended to provide a weighting mechanism for pertinent variables, and compensate for potential sources of bias. This is accomplished by measuring an associated variate in addition to the variate of primary interest. The latter variate is called the criterion or simply the variate; and the associated variate is called the covariate. Measurements on the covariate are made for the purpose of adjusting the measurements on the variate. In the present study, experimental groups were matched on the covariate or pretest in order to control possible sources of variation. With this procedure, more precise information on the treatment effects may be obtained by adjusting the post test for the effect of the pretest or matching variable. If the pretest measures the effects of a source of variation that is increasing the experimental error, removal of the influence of the covariate is equivalent to statistical control on the experimental error. The change in experimental error due to this adjustment process depends upon the linear correlation between the post test and the pretest.

In this study, the purpose was to relate anxiety

level to performance under stressful and non-stressful conditions. In this case, scores on the pretest, or the combined scores of two elements from the Abstract Reasoning Section of the Primary Mental Abilities Test, was the covariate. Scores on the Abstract Reasoning Section of the Differential Aptitude Test, which was performed under stressful and non-stressful conditions, was the variate.

The means are summarized in Table 2, the analysis of variance in Table 3, and the analysis of covariance in Table 4. The analysis of variance disregards the presence of the covariate. In regard to the main effects, both tests indicated no statistically significant difference between the high and low-anxiety groups, or between the groups performing under stressful and non-stressful conditions. On both tests, the interaction effect, or the performance of high and low-anxiety groups under stressful and non-stressful conditions, approached, but did not reach significance at the .05 level.

The hypothesis was not supported as stated. It is: The high-anxiety group given stressful instructions will have poorer scores on the Abstract Reasoning Section of the Differential Aptitude Test than the low-anxiety group; and the high-anxiety group given non-stressful instructions will have better scores on the Abstract Reasoning Section of the Differential Aptitude Test than the low-anxiety group. The stressful and non-stressful

Table 2

Mean Scores on the Abstract Reasoning Section of the Differential Aptitude Test for the Four Conditions

	Stressful Conditions	Non-stressful Conditions	Total
High-anxiety	38.150	39.789	77.939
Low-anxiety	39.636	37.571	77.207
	77.786	77.360	155.146

Table 3

Analysis of Variance Between High and Low-Anxiety Groups, and Stressful and Non-stressful Testing Conditions, and the Interaction Between These Factors

Source of Variance	SS	df	MS	"F" *
Anxiety level	2.105	1	2.105	.096
Test condition	1.888	1	1.888	.086
Interaction	70.114	1	70.114	3.202
Error	1707.942	78	21.897	
Total	1782.049			

*F.95(1,78)=3.96

Table 4

Analysis of Covariance Between High and Low-Anxiety Groups, and Stressful and Non-stressful Testing Conditions, and the Interaction Between These Factors

Source of Variation	SS	df	MS	"F" *
Anxiety level	9.729	1	9.729	.601
Test condition	2.129	1	2.129	.132
Interaction	60.174	1	60.174	3.718
Error	1246.317	77	16.186	

*F.95(1,77)=3.97

testing conditions were not significantly related to the performance of high and low-anxiety groups at the .05 level.

DISCUSSION

The results of this study are not in complete agreement with previous research. It was hypothesized that the high-anxiety group given stressful instructions would demonstrate poorer task performance than the low-anxiety group; and that the high-anxiety group given non-stressful instructions would demonstrate better task performance than the low-anxiety group. The results of the experiment did not uphold the hypothesis. Although the results were in the predicted direction, the interaction between anxiety level and testing condition was not statistically significant at the .05 level.

The results appear to contradict the studies of Gordon and Berlyne (1954), Lucas (1952) and Sarason, Mandler, and Craighill (1952), all of whom found a significantly poorer performance for high-anxiety groups under stressful conditions than under non-stressful conditions. One may have interpreted their results as due to a greater emotional responsiveness of high-anxiety subjects to the stress, or to a greater tendency to make irrelevant responses under stress. In any event, some type of differential reaction to stress by the high and low-anxiety groups was anticipated in the present study.

The results of the present study are in substantial

agreement with those of Taylor (1958), who failed to find a significant interaction between anxiety level and performance of a verbal learning task under stressful and non-stressful conditions. It is interesting to note that in both studies, it was predicted that the stressful condition would differentially effect the performance of high and low-anxiety groups; and in both studies the interaction approached, but did not reach significance. The direction of the findings in these studies seems to suggest that both drive level and extratask responses may have effected the performance of high-anxiety subjects in opposite directions; increased drive tending to facilitate and irrelevant responses to interfere. Thus the two may have counteracted each other.

There were two factors in the procedure of the present experiment which may have influenced the results. First, the performance of subjects on the pretest could have been more extreme in terms of high and low-anxiety test scores. One hundred and nine subjects volunteered to participate in the first session of the experiment, during which the Taylor Manifest Anxiety Scale and two elements from the Abstract Reasoning Section of the Primary Mental Abilities Test were administered. The desired criterion scores to distinguish high and low-anxiety subjects were based on a study by Taylor (1958). In her experiment, the raw test scores for the high-anxiety

group ranged from 24 to 50, and for the low-anxiety group from 1 to 9. After the pretest session of the present study, an insufficient number of subjects fell into these categories. As a result, it was necessary to raise the low-anxiety ceiling to 13, and to lower the high-anxiety ceiling to 20, in order to have enough subjects for the study. In short, the high-anxiety group was "less anxious," and the low-anxiety group "more anxious" than would have been desired. This factor is revealed in Table 1 in which the mean scores for high and low-anxiety groups are represented. For the 39 subjects who scored in the high-anxiety category, the mean score was 24.56; and for the 43 subjects who scored in the low-anxiety category, the mean score was 9.32.

In the present study, it is possible that the stress technique inadequately achieved its purpose. In all but a few cases, subjects did not approach completion of the number of problems called at the end of the first two periods. It is possible, however, that if the task had been divided into more periods, the realization of failure would have been more frequent and hence more stressful. The result might have been a greater arousal of task-irrelevant responses in high-anxiety subjects, and task-relevant responses in low-anxiety subjects. Consequently the performance of high and low-anxiety subjects under stressful testing conditions may have been more distinct.

It is also possible that another stress technique could have more successfully achieved the anticipated results. Electric shock, auditory distraction, or ego-involving instructions all could have been employed in the present study.

Another factor which may have affected the results of the present experiment is the rather low correlation between the Abstract Reasoning Section of the Primary Mental Abilities Test and the Abstract Reasoning Section of the Differential Aptitude Test. In the present study, a correlation of .52 was calculated by the experimenter (see appendix). In the Manual for the Differential Aptitude Tests, Bennett, Seashore, and Wesman (1959) reported correlations of .60 for males, and .47 for females. In the present experiment, an attempt was made to match subjects on the basis of abstract reasoning ability. Because correlation between the two was only .52, this attempt was not as complete as it might have been. It is possible that if the matching had been more successful, the treatment effects would have been more easily discernible.

If another experiment were to be attempted, four critical factors should receive special attention. First, if subjects are to be matched for ability, tasks which are highly correlated should be selected. Second, only subjects falling into extreme anxiety categories should

be used. Third, the experimenter should make certain that the number of subjects in each group is sufficient. Finally, a stressful situation should represent a real threat to the subjects. If these four requirements could be met, an interaction between anxiety level and the performance of a task under stressful and non-stressful conditions would seem likely.

In the present experiment, it seems likely that time as the stress-eliciting condition did not enter as a variable until the beginning of the second period. This suggests that a comparison of subjects' performance in the last two periods might have shown a greater degree of difference providing the comparison could have been made on comparable items. However, probable differences in speed of various subjects makes it quite likely that after the first time period, different subjects would have been working on quite different problems, thus invalidating any such comparisons.

It is suggested that future investigators examine a variety of techniques for measuring anxiety. Because there are so many individual differences as to its manifestations, anxiety has proved difficult to assess. Up until the present time, most of the research in the area has made use of the Taylor Manifest Anxiety Scale. This device appears to measure a more chronic type of anxiety than that measured by the Sarason Test Anxiety Scale.

Other techniques for measuring a more acute type of anxiety might focus on physiological responses, such as heart rate or galvanic skin reflex; or perhaps a self-report scale such as the Subjective Stress Scale. It is further suggested that the performance of tasks requiring different [illegible] to determine how [illegible] differ in their susceptibility to stress. When anxiety can be accurately measured, its relation to the performance of various tasks under stressful and non-stressful conditions may have implications which can help improve individual performance in the areas of education, industry, and the military, to mention a few.

SUMMARY

This study was designed to relate anxiety level to the performance of an abstract task given under stressful and non-stressful conditions.

All subjects were pretested for abstract reasoning ability and anxiety level. Subjects from high and low-anxiety categories were assigned to stressful and non-stressful testing conditions. High and low-anxiety groups in both testing conditions were then matched for pretested abstract reasoning ability. During the stressful testing condition, subjects performed under the influence of time stress, in which the norms for the post test were falsely reported as to time necessary for completion of the task. During the non-stressful testing condition, subjects were not exposed to any intentional form of stress.

This study was based on two assumptions: (1) Among high-anxiety subjects, stressful instructions will increase the strength of task-irrelevant responses; while non-stressful instructions will reduce the strength of these responses. (2) Among low-anxiety subjects, stressful instructions will strengthen task-relevant responses; while non-stressful instructions will reduce the strength of these responses. The hypothesis growing out of these

assumptions was that the high-anxiety group given stressful instructions would demonstrate poorer task performance than the low-anxiety group; and that the high-anxiety group given non-stressful instructions would demonstrate better task performance than the low-anxiety group. This hypothesis was not substantiated as stated.

The results of the experiment were analyzed by an analysis of covariance. Although the results were in the predicted direction, the interaction between anxiety level and testing condition was not statistically significant at the .05 level.

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APPENDIX

Correlation between the Abstract Reasoning Section of the Primary Mental Abilities Test, and the Abstract Reasoning Section of the Differential Aptitude Test

$$r = \sqrt{\frac{E^2xy \;/\; E\ xx}{E\ yy}} = \sqrt{\frac{461.627}{1707.940}} = \sqrt{.270} = .520$$