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A NEW LOOK AT THE EFFECTS OF ANXIETY AND STRESS ON THE PERFORMANCE OF COMPLEX INTELLECTUAL TASKS, STUDY II. SCHOOL ANXIETY AND COGNITIVE FUNCTIONING--EXPLORATORY STUDIES.

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THE EFFECTS OF TEST ANXIETY AND TEST STRESS ON THE PERFORMANCE OF TWO DIFFERENT INTELLECTUAL TASKS WERE STUDIED. IT WAS HYPOTHESIZED THAT THE DESCRIPTIVE EFFECTS OF ANXIETY WOULD BE GREATER FOR DIFFICULT BUT SIMPLE TASKS THAN FOR COMPLEX BUT EASY TASKS, AND THAT SITUATIONAL STRESS WOULD BE MORE DISRUPTIVE FOR COMPLEX TASKS THAN FOR SIMPLE TASKS. A MULTIVARIATE DESIGN WAS USED. ANXIETY AND STRESS WERE THE INDEPENDENT VARIABLES AND TWO WECHSLER ADULT INTELLIGENCE TEST SUBTEST SCORES SERVED AS DEPENDENT VARIABLES. ANXIETY WAS MEASURED BY A 15 ITEM, MULTIPLE CHOICE FORM OF SARASON'S TEST ANXIETY SCALE FOR CHILDREN. SUBJECTS WERE 176 COLLEGE JUNIORS. DATA WAS ANALYZED BY CORRELATION OF COMPARISON AND ANALYSIS OF VARIANCE. RESULTS ARE SUMMARIZED IN TWO TABLES. THERE WAS NO ANXIETY AND STRESS INTERACTION APPARENT AND THE CORRELATIONS BETWEEN THE WECHSLER SUB-TEST SCORES WERE LOW. THE AUTHOR SUGGESTS THAT NUMEROUS STUDIES WERE STRESS IS DEFINED AS PAIN, SHOCK, LOUD NOISE, ETC., MAY NOT BE STUDIES OF PSYCHOLOGICAL STRESS BUT RATHER STUDIES OF THE DISTRACTION POTENTIAL OF IRRELEVANT BACKGROUND STIMULI. THIS DOCUMENT APPEARED AS STUDY 2 IN SCHOOL ANXIETY AND COGNITIVE FUNCTIONING, EXPLORATORY STUDIES, REPORT 4, IRCOPPS MIDWEST RESEARCH CENTER FOR PUPIL PERSONNEL SERVICES, ANN ARBOR, MICHIGAN, PP. 102-121. (PS)

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Report 4

MCOPPS MIDWEST RESEARCH CENTER
FOR PUPIL PERSONNEL SERVICES

SCHOOL ANXIETY AND COGNITIVE FUNCTIONING: EXPLORATORY STUDIES

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PREFACE

This report is the fourth in a series of research monographs published by the IRCOPPS Midwest Research Center. A survey of Center activities plus a comprehensive synopsis of the Center's project reports may be found in the Center's 1967 Summary Status Report.

The present monograph reports the results of eight modular pilot studies conducted by various center staff. All research was supported by NIMH Grant #01428. Several of the studies have been presented, in abbreviated form, at various professional meetings and certain of the results have already appeared, or are due to appear, as short published articles.

Appreciation is expressed to the various staff associated with the production of these reports.

James A. Dunn
Director
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STUDY II

A NEW LOOK AT THE EFFECTS OF ANXIETY AND STRESS ON THE PERFORMANCE OF COMPLEX INTELLECTUAL TASKS

JAMES A. DUNN

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Since the work of Taylor (1956) and Spence (1958) treating anxiety as chronic, drive-related, affect state, anxiety has been generally assumed to facilitate simple intellectual task performance and debilitate complex task performance. Research has not always substantiated the Taylor-Spence hypothesis, however (see Wiener, 1959; Maltzman, Eisman, & Morrisett, 1961; Mangan, Quartermain, & Vaughan, 1960; and Pyke & Agnew, 1963, for example).

The present paper is based on the assumption that the apparent inconsistency of results across anxiety studies may have been due, in part, to a lack of conceptual distinction between task complexity, difficulty, and passability.

A complex task may be described as one which involves a large number of discrete, but interconnected, parts. Webster's 1966 Unabridged Dictionary gives "composite" as the primary synonym of "complex." Thus, complexity is a structural concept. Where behavior is involved, complexity is manifested as act sequentiality. An example of a complex task is the Stanford-Binet Three Commissions item in which the

subject is required to place a pencil on a chair, close the door, and then fetch a box. There are 3 distinct parts to this task, none of which are particularly difficult for a 4-year-old child to comprehend or to execute. What makes the Three Commissions item an effective screening item for 4-year-olds is the sequentiality (i.e., complexity) involved.

Task difficulty is related to the decision processes required by the task. Task difficulty can be defined operationally in terms of the fineness of the discrimination required (e.g., in terms of the number of j n d's between stimuli); or in terms of the number of nearly equally probable response alternatives acceptable for a given task. The more subtle the discrimination required, or the larger the number of probable, acceptable response alternatives to be considered, the more difficult the task may be assumed to be. Difficulty (D) then may be held to increase as discriminability (d) decreases and/or the number of probable, acceptable response alternatives (r) increases; $D = f(1/d,r)$.

In most instances, task difficulty typically increases with complexity; that need not be the case however.

The early work of Taylor and Spence dealt with classical conditioning where complexity was the salient variable. Many subsequent studies have gone beyond the classical condition-

ing paradigm, though, and have attempted to investigate the relationship between anxiety and task complexity in verbal learning, operant conditioning, IQ and achievement test performance, and the like. It is at this point that much anxiety research is weak. In attempting to extrapolate beyond the Taylor-Spence operations, it appears that attention was shifted from complexity to difficulty without explicit awareness on the part of many investigators.

Both task complexity and task difficulty presumably affect task performance but neither is an index of whether the task can actually be performed, i.e., passed. A complex task presumably has a lower probability of successful completion by a given individual than a less complex task. The same is presumably true for difficult tasks. But other factors may also affect whether a particular task can be successfully performed by a given individual (e.g., difficulty, complexity, personal susceptibility to situational cueing and the nature and extent of situational cueing). If one wishes to study the effects of anxiety and stress on complex versus difficult tasks, the tasks should differ in complexity and difficulty, but not passability.

PROBLEM

The present study was an analysis of the effects of test anxiety and test stress on the performance of two dif-

ferent types of intellectual tasks: one was easy, but complex; the other difficult but simple. Both were presumably equal in passability.

Hypothesis One

The first hypothesis held that the disruptive effects of anxiety would be greater for difficult but simple tasks than for complex but easy tasks.

This hypothesis was based on the belief that the depressant effects of anxiety on task performance would be better explained in terms of task difficulty (decision making) rather than task complexity (act sequentiality), as has generally been the case to date.

Hypothesis Two

The second hypothesis held that situational stress would be more disruptive for complex tasks than for simple tasks.

The rationale underlying this hypothesis held that since a complex task was, by definition, one that involved many discrete operational steps, each step presumably dependent on information from a preceding step, momentary distractions, resulting from the impingement of extraneous or stressor stimuli, would involve a proportionately greater loss of information, and hence result in greater performance disruption.

PROCEDURE

A multi-variate--treatment by levels--design was used. The independent variables were anxiety and stress. The dependent variables were scores on two subtests of the Wechsler Adult Intelligence Scale (WAIS).

The Independent Variables

Anxiety was measured by a 15-item, multiple choice form of Sarason's Test Anxiety Scale for Children (1958), developed for use with older subjects (Morse, Bloom, and Dunn, 1961).

The anxiety testing was conducted 6 weeks prior to dependent variable testing. Table 1 summarizes the means and standard deviations of the anxiety scores for subjects in the various cells of the study. (See Appendix.)

Stress was defined operationally in terms of the instructions given the subjects at the time they were tested on the dependent variables. To induce stress, subjects were told they were to be given a test; that it was a short form of an intelligence test; that the results would form part of their class record; and that they should try to do as well as they could. For the non-stress conditions, subjects were told the task was part of a research project and attention was called to the fact that there was no place on

the answer sheets for names. They were told that there were some questions the examiner would like to ask them; that no one was required to participate, but that if they elected to do so, they should take the work seriously and try to do as well as they could. The word "test" was never used with the low stress group.

The Dependent Variables

Two subtests of the WAIS were used to test the hypotheses. One was held to be operationally simple but psychologically easy. Both tasks had comparable passability. The two subtests were Information and Digit Span. The variables were subscale raw scores.

Aside from initial comprehension of the task, and final verbal reply, the Digit Span subtest may be considered to involve five molar operations: 1) a serial reception of information; 2) its temporary storage; 3) its immediate retrieval; 4) the evaluation of the retrieval data against the original serial list; and, 5) during the latter part of the subtest, data inversion, either at point of storage or retrieval. Thus, performance on the Digit Span subtest may be considered a complex operation. In spite of its complexity, however, the Digit Span test is basically an "easy" test insofar as performance on the subtest is a passive-respondent

activity, mechanical in nature, and involving little in the way of cognitive discrimination, decision making, problem solving, or the like.

On the other hand, again aside from task comprehension and verbal reply, the Information subtest also requires 1) information (question) reception, but sequentiality is not as crucial due to the redundancy inherent in grammatical structures; 2) temporary storage, but once again seriality is not critical; 3) information retrieval; and 4) subsequent data evaluation. The stored data pool from which information must be retrieved for successful completion of the Information subtest is much larger than that for Digit Span performance, however. Hence there is a presumably larger set of possibly correct alternatives for the Information questions. Thus, the Information subtest may be considered simpler than the Digit Span subtest, but more difficult.

In spite of the fact that Digit Span is generally accepted as the subtest most sensitive to anxiety (Schafer, 1948; Wechsler, 1958) Hypothesis One held that performance on the Digit Span subtest would be least affected by test anxiety. But, because Digit Span requires considerably more situational cueing, as compared to the Information subtest, Hypothesis Two held that Digit Span would be more seriously affected by situational stress.

Procedural Validation Measures

After the Wechsler subtests were completed, the subjects were asked to indicate, on a five-point scale, their answers to: "How much pressure did you feel you were under while you were taking this test?" and "How nervous did you feel while you were taking this test?" The purpose of obtaining these ratings was to cross-validate, in a simple way, the experimental procedures of the study.

Subjects

Subjects were 176 college juniors, approximately equally divided between males and females, enrolled in six sections of the same course in a large metropolitan university. Course sections were assigned randomly to one of two treatment groups. Table 1 summarizes the number of subjects in each cell of the data matrix (see Appendix).

Data Analysis

Two types of statistical procedures were used: correlation of comparison (Peatman, 1963) and analysis of variance (Hays, 1963). Pearson product-moment correlations were computed separately for the two treatment groups. N's were 92 and 84 for the stress and non-stress groups respectively. The significance of differences between correlations was determined by t-tests applied to Fisher's Z transformations.

For analysis of variance, high and low anxiety were defined as placement in the top or bottom 27.5% of the anxiety score distribution. The closest category approximating 27.5% was used. The N for the analysis of variance was 102.

RESULTS

Results for the study are summarized in Tables 2 and 3 (see Appendix).

Procedural Validation

The abbreviated Sarason scale used to establish the individual subject's general level of test anxiety appears to have been reasonably valid. The correlations between test anxiety and reported nervousness were .39 and .28 for the high and low stress groups, respectively. Both were significant at the .01 level of confidence.

In addition, analysis of variance (Table 3) indicates that while the nervousness experienced during the test was significantly affected by the stress conditions imposed (.05 level of confidence), even greater variation was due to the chronic test anxiety characteristic of the subject (.01 level of confidence).

The experimental method of inducing stress also appears to have been satisfactory. Under test conditions, there was

a highly significant (.01 level) correlation between anxiety and reported stress, .36, whereas under low stress conditions, the correlation was only .01 and non-significant. The difference between these two correlations is significant at the .01 level.

Analysis of variance also indicated that the most significant factor associated with felt stress was the type of condition imposed. Anxiety played a significant role, too, but a lesser one; and interaction between personal anxiety and situational conditions also resulted in significant differences in the degree to which persons perceived situations as stressful.

Hypothesis Evaluation

Information Subtest Performance. When the Information subtest was administered to subjects under stressful conditions the correlation between anxiety and Information scores was -.33, which was significant at the .01 level. When the subtest was administered under benign conditions, the correlation was .00. The difference was significant at the .02 level. Analysis of variance did not reflect this suggested interactive effect, however. The results in Table 3 indicate that the difference in Information scores was due to anxiety alone.

Digit Span Performance. As predicted, test anxiety did not affect Digit Span performance. Correlations between the two scores were low and non-significant, -.17 and -.16 for the high and low stress conditions, respectively. In addition, analysis of variance also showed no significant difference in Digit Span scores due to anxiety. Analysis of variance, however, did show significant differences (.05 level) due to stress.

Judging from analysis of variance, then, high test anxiety resulted in a significant decrement in Information scores but not in Digit Span score, whereas under high stress conditions the converse was true. Stress disrupted Digit Span performance but not Information performance.

DISCUSSION

Aside from the lack of resolution regarding the effects of test anxiety on Information performance, there are two rather obvious questions raised by the present findings. First, why was there no anxiety x stress interaction apparent in any of the experimental situations; and second, why were the correlations between the Information and Digit Span scores so low (Table 2) when such correlations are generally reported to be in the .50's (Wechsler, 1955, 1958).

Regarding the first question, it would seem that if test anxiety disrupts intellectual performance, that disruption should be greatest when situational cues reinforce that anxiety. Such was not the case, however, in either type of task. It may be that test anxiety, as measured by Sarason's scale, does not really reflect an individual's potential for a graded anxiety reaction, but rather his potential for a general "all or none" reaction that may be evoked by any test-like situation regardless of the reality or the extensiveness of the test cues actually generated in that situation.

As for the second question, a decrease in variance of Digit Span scores due to the paper and pencil group administration method used in the study is the most probable answer for the attenuated Information - Digit Span correlation. Digit Span scores suggest this to be the case. For all groups, the variability in Digit Span scores is much less than the variability in Information scores.

A third question, dealing with the theoretical question of the importance of relevancy between the various operational definitions used within a single experiment, should also be entertained. Recently, Pyke and Agnew (1963), for example, as have others before them, found a significant relationship

between stress and Digit Span. Stress, however, was defined in the Pyke and Agnew study as a 30-millisecond 100 volt shock to the fingers of the non-preferred hand. Under such conditions disruption of almost any task could be expected. Indeed, it would seem that such a noxious stimulus should have a distraction potential much greater than the simple instruction "this is a test." Such was not the case, however. Apparently the simple definition of a situation as a test is much more disruptive than even electric shock. Stress effects were observed by Pyke and Agnew in only one type of Digit Span performance and that in only one of the experimental conditions. One of the notable aspects of the present study is the degree to which performance is disrupted by the relatively simple and even gentle definition of a situation as a testing session. As suggested earlier, it is probable that the disruptive potential of situational cueing is, in large measure, a function of the relevancy of that cueing to the specific nature of the task at hand. If this should be the case, then the numerous studies where stress is defined as pain, shock, loud noise, etc., may be, in fact, not psychological stress studies at all, but rather stimulus prepotency studies, i.e., studies of the distraction potential of irrelevant background stimuli.

While the findings of the present study are of considerable theoretical interest, their practical utility, vis-a-vis prediction, at present, is somewhat less. Knowing the anxiety or stress status of an individual reduces the "uncertainty" about Information and Digit Span performance only some 3% or 4% (see omega squared column, Table 3).

While 3% to 4% of the variance is only a small proportion, taken in perspective, it is not an insignificant amount of variance with which to be concerned. This is especially obvious when one considers that, under optimum conditions, knowing an individual's Full Scale IQ, for example, reduces uncertainty regarding academic achievement only some 25%, and the IQ-achievement prediction is one of the best predictions possible in general psychological assessment.

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APPENDIX

TABLES

TABLE 1

Sample Sizes and Means and Standard Deviations of Test Anxiety Scores, by Treatment and Levels Groups

	High Anxiety	Medium Anxiety	Low Anxiety
High Stress	N = 24 M = 22.2 SD = 2.5	N = 37 M = 15.6 SD = 1.8	N = 31 M = 9.3 SD = 2.5
Low Stress	N = 27 M = 22.2 SD = 2.2	N = 37 M = 15.8 SD = 1.8	N = 20 M = 9.3 SD = 2.5

TABLE 2

Independent Variable Inter-Correlations;
by Treatment Groups

		Information	Digit Span	Reported Stress	Reported Nervousness
HIGH STRESS[1]	Test Anxiety	-.33**	-.17	.36**	.39**
	Information		.19	-.18	-.29**
	Digit Span			-.13	-.14
	Felt Stress				.75**
LOW STRESS[2]	Test Anxiety	.00	-.16	.10	.28**
	Information		.21	-.12	-.03
	Digit Span			-.08	-.10
	Felt Stress				.62**

1. df = 90
2. df = 82

** Significant at the .01 level.

TABLE 3

2 x 2 Analyses of Variance on the Various Dependent Variables

	Source	SS	df	MS	F	ω^2
WAIS Information	Anxiety	45.41	1	45.41	4.74*	.03
	Stress	17.27	1	17.27	1.80	.01
	Interaction	18.51	1	18.51	1.93	.01
	Error	938.84	98	9.58		
	Total	1,020.03				
WAIS Digit Span	Anxiety	14.45	1	14.45	3.14	.02
	Stress	22.55	1	22.55	4.90*	.04
	Interaction	6.72	1	6.72	1.46	.00
	Error	451.13	98	4.60		
	Total	494.85				
Reported Nervousness	Anxiety	12.53	1	12.53	11.31**	.09
	Stress	5.37	1	5.37	4.84*	.03
	Interaction	3.81	1	3.81	3.44	.02
	Error	109.25	98	1.11		
	Total	130.96				
Reported Stress	Anxiety	6.95	1	6.95	4.63*	.03
	Stress	16.64	1	16.64	11.09**	.08
	Interaction	6.76	1	6.76	4.51	.03
	Error	147.48	98	1.50		
	Total	177.83				

* Significant at the .05 level.
** Significant at the .01 level.