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Test Anxiety: Cognitive Interference or Inadequate Preparation?

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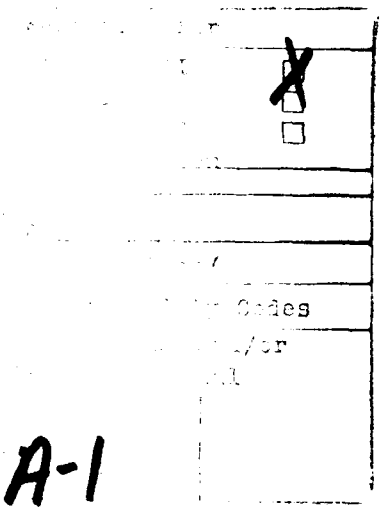

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This paper reviews the differences between two interpretations accounting for the poor test performance of highly anxious students: 1) that anxiety interferes with retrieval of prior learning, or 2) that, due to study skills deficits, the initial acquisition by an anxious student is less thorough than that of a less anxious student. Research results dealing with both hypothesis are reviewed. It was concluded that these were complementary rather than mutually exclusive formulations. A hypothesis was advanced predicting that test anxiety debilitates performance by reducing the cognitive capacity available for task solution, and that study skills facilitate learning by reducing the cognitive capacity demanded by different tasks.

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Test Anxiety: Cognitive Interference or Inadequate Preparation?

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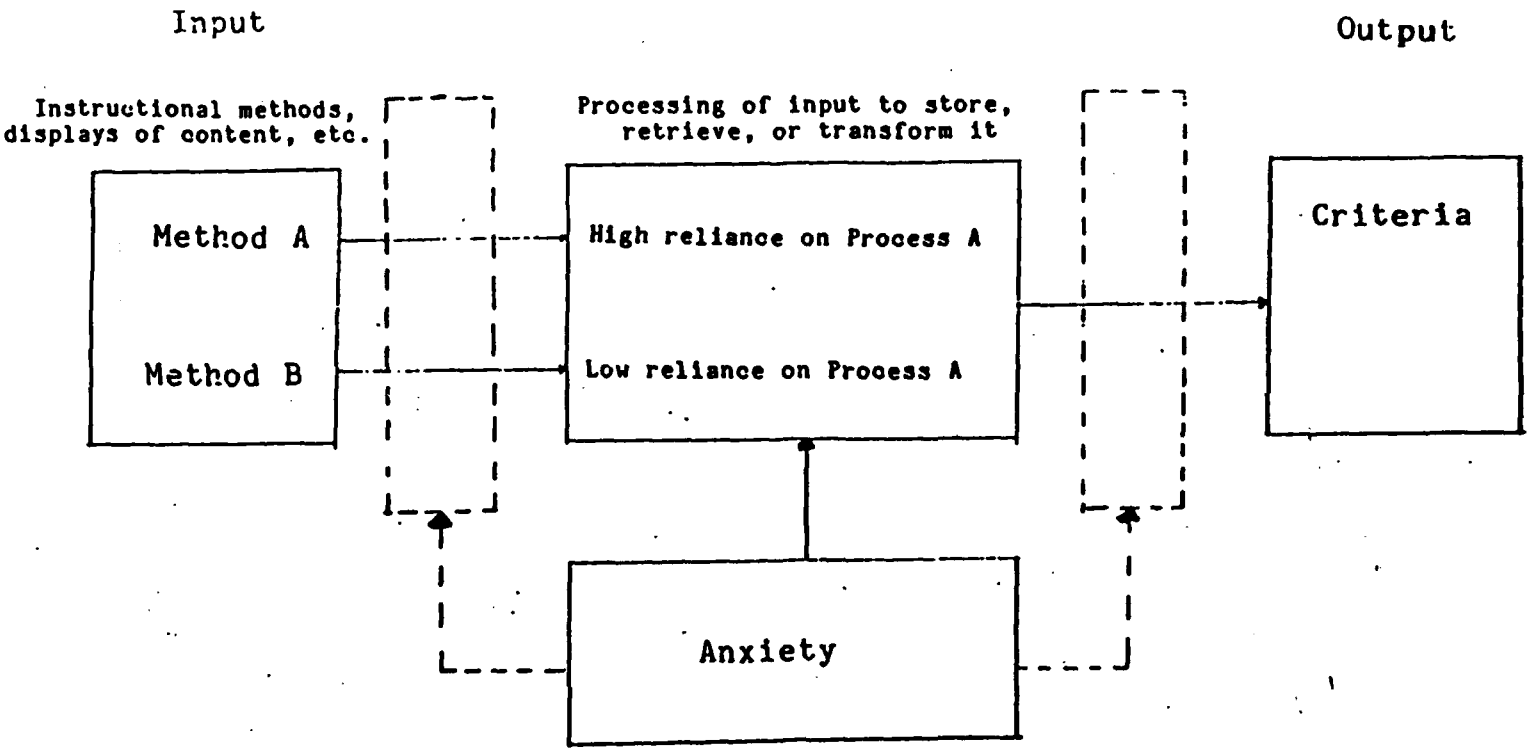
It has long been assumed that test anxiety interferes with students' recall of prior learning on examinations. This so called interference model has recently been challenged by an alternative deficit explanation advanced by a number of researchers. The deficit hypothesis assumes that the lower test scores obtained by test anxious students are attributable to inadequate study habits, or to deficient test taking skills rather than to interference by anxiety. The purpose of this paper is to review these alternative formulations, the research on which they are based, and to update a model to account for the effect of both interference and deficit phenomena.

A model summarizing the effects of anxiety on learning from instruction has been advanced (Tobias, 1977, 1979) which may clarify differences between the interference and deficit formulations. It was assumed in the model that anxiety as an affective state can have only an indirect effect on learning by impacting on the cognitive processes determining whether learning occurs. The model divided learning from instruction into the three classical information processing components: input, processing and output. Input stands for the presentation of instructional material to students. Processing denotes the operations performed by students to encode, organize, and store input. Output represents the performance of students on evaluative measures after instruction. The model, shown in Figure 1, suggested three possible points at which anxiety can affect learning from instruction: preprocessing, during processing and post processing.

Insert Figure 1 about here

The difference between the interference and deficit formulations can be seen most clearly in the post processing part of the model which assumes that learning has occurred but that the evaluative threat posed by the testing situation interferes with students' ability to retrieve what was learned. This effect was meant to represent students' anecdotal reports of "freezing up" during examinations and, therefore, being unable to recall prior learning. This is exactly the prediction made from the interference formulation. The skills deficit hypothesis, on the other hand,

Figure 1. Model outlining the effects of anxiety on learning from instruction (from Tobias, 1977, 1979).



assumes that inadequate initial preparation or poor test taking skills may account for the reduced performance, rather than interference in the retrieval of prior learning.

Deficit Model

Researchers invoke two types of deficits to account for the reduced performance by high test anxious students: study skills and test taking deficits. The study skills explanation assumes that students' reduced test performance is due to less thorough initial acquisition of the content because of deficient study skills. The test taking deficit formulation assumes that reduced performance is caused by deficiencies in students' test taking skills.

Study Skills Deficit. This hypothesis is based on findings relating both performance and anxiety indices to study skills measures. Desiderato and Koskinen (1969), Mitchell and Ng (1972), and Wittmaier (1972) found that anxious students had less effective study skills than those lower in anxiety. Kirkland and Hollandsworth (1979) found that study habits and achievement anxiety measures were the major predictors of grade point average, excluding scholastic ability. They "raise the question whether anxiety interferes with effective test-taking behavior or whether the lack of effective study skills results in anxiety" (p.435).

Culler and Hollahan (1980) also reported that "high test-anxious students who have developed and exercise better study skills did better academically than those with poor study habits . . . . . The findings . . . . . tend to contradict the common stereotype of the high anxious student who knows the subject matter but 'freezes up' at test time" (p.18). High anxious students reported spending more time studying than their low anxiety counterparts, and study time was significantly related to grade point average for high test anxious students but not for those with less anxiety, suggesting that anxious students may compensate for poor skills by studying longer.

Benjamin, McKeachie, Lin and Hollinger (1981) found that high test anxious subjects had significantly poorer scores on both multiple choice and fill-in tests than those lower in anxiety. Anxious students also had lower scores on fill-in than on multiple choice tests suggesting to Benjamin et al that test anxiety created more interference for retrieval than storage. Highly test anxious students reported more problems than those lower in anxiety during both initial learning and reviewing. In an analysis of covariance, in which fill-in scores were the covariate and multiple choice scores the dependent variable, performance differences between anxiety groups disappeared. These results were interpreted to suggest that retrieval, at least as measured by fill-in tests, appeared to be more of a problem for test anxious students than storage and encoding. In a second study these investigators found that the higher the test anxiety the greater the difficulty reported by students while learning, reviewing, and remembering on

examinations.

Test Taking Skills Deficit. Kirkland and Hollandsworth (1980) compared the effects of anxiety reduction treatments and training in test taking skills. Their results indicated that a skills acquisition group reported less attentional interference during test taking, and had higher performance on an analogue test than anxiety reduction groups. Paulman and Kennelly (1984) studied the relative contributions of test anxiety and test taking skills to performance on two tasks. This study, to be described in greater detail below, found that both test anxiety and test taking skills influenced performance in evaluative settings.

Bruch (1981) found that high and low test anxiety groups differed in their knowledge of test taking strategies determined by students' free responses to a questionnaire. Test taking strategies were significantly related to differences in college achievement, even when scholastic ability was held constant in an analysis of covariance, while anxiety was unrelated to school achievement.

Bruch, Juster and Kaflowitz (1983) examined the relationships of anxiety and test taking strategies to performance on three simulated tests. Regression analysis indicated that test taking strategies significantly affected test performance on simulated essay and multiple choice tests, but had a less important effect on performance on a math test. Surprisingly, test performance was not related to students' anxiety reactions, nor to the type of self statements occurring to students during examinations. These findings are at variance with Sarason's (in press) reports of greater cognitive interference among test anxious students from negative self-thoughts. Perhaps differences in the evaluative stress experienced by subjects in these studies can account for the conflicting results.

Interference Model

Reviews of research on the effects of test anxiety (Sarason, 1980; Sieber, O'Neil & Tobias, 1977) have indicated that, in situations involving evaluative stress, students high in test anxiety perform at a lower level than their low anxiety counterparts. This effect disappears in less stressful situations. In field studies stress is generally defined by student performance on intelligence tests, course-related examinations and the like. In experimental contexts stress is induced by instructions, sometimes called ego involving instructions, suggesting that performance on the research task is related to students' ability or school performance.

Interference by test anxiety has generally been explained by variations in the way students deploy their attention (Wine, 1971; Sarason, 1972). Students high in anxiety are hypothesized to divide their attention between task demands and personal concerns composed principally of negative self-preoccupations; those lower in anxiety,

on the other hand, are presumed to devote a greater proportion of their attention to task demands.

It should be noted that interference by test anxiety is inferred from performance on examinations by high anxiety students. Lower scores of test anxious students could have occurred either by less thorough acquisition, as suggested by the study skills deficit hypothesis, or by interference in the retrieval of prior learning, or by some combination of these. A direct test of the interference model, then, demands evidence of students' state at acquisition and again at retrieval. Unfortunately, only a few studies have addressed the relationship between anxiety and the acquisition-retrieval distinction.

In a study by Wendell and Tobias (1983), students learned course-relevant material from six video modules. Pre and posttests were given after each module, and a summative posttest, using all the items from each of the six module posttests, was administered six weeks later. Two scores reflecting retrieval of previously acquired learning were calculated; one of these consisted of items which students passed on pretest and posttest immediately after the module, yet failed on the summative posttest administered later. This index, then, compared student learning after acquisition and again at retrieval and had a correlation of .22 ($p. < .05$) with Sarason's (1980) Test Anxiety Scale. A second retrieval index, composed of items failed on pretest, passed on immediate posttest and failed on the summative posttest, was not significantly related to test anxiety. Conceivably, the first index reflected more thorough mastery of the material since students had passed items on both pretest and module posttest, whereas the second index employed items failed only on pretest and passed on immediate posttest.

There were a number of difficulties in interpreting the Wendell and Tobias results. The scores employed were based on changes from one assessment to the other, and such change scores have well known reliability problems (Thorndike, 1963; Cronbach & Furby, 1970). Furthermore, there was some doubt as to whether the scores used actually tapped retrieval from long-term memory. Module posttests contained items covering content from all sections of the video modules. Since an average of about 35 minutes was required to view the modules before the test was administered even module posttests may have required retrieval from long term rather than working memory.

In a recently completed investigation (Tobias, 1984a) the acquisition-retrieval distinction was examined directly in a study using a list-learning paradigm. Students studied two lists of 18 meaningful words, each composed of three equal categories, for 30 seconds per trial. In order to assure that students mastered the material the first list was studied to a criterion of one perfect repetition. The second list consisted of similar, but not identical, categories so as to create interference for the recall of the first list, and was studied three times. Four scales from

Weinstein's (1983) Learning and Study Skills Inventory were then administered. Finally, students received instructions indicating that performance on this task was analogous to success in school, and were then asked to recall all the words from List 1 and List 2.

The list-learning (Tobias, 1984a) study was intended to form an analog to situations in which students studied materials for various courses one after the other, prior to being examined on them. Delayed recall of List 1 was, then, one clear-cut index of retrieval from long term memory. Stepwise regression analyses indicated that worry, a component of test anxiety measured by the Worry Scale (Morris, Davis, & Hutchings, 1981), contributed significantly to retrieval of List 1 words. Anxiety, as assessed by Sarason's (1972) Test Anxiety Scale and the Worry-Emotionality measures had a significant effect on the total number of List 2 words recalled, as did the set of study skills scales. A more precise test of retrieval for List 2 words, however, used a dependent variable composed of those words mastered on acquisition yet failed on recall. The latter index was significantly affected by worry and by the total group of anxiety scales; the set of study skills scales also had a marginally significant effect (p =.06) on this variable.

In general, neither anxiety nor study skills affected any of the acquisition indices in the list learning study. A clustering index, measuring the degree to which students recalled the stimulus list in clusters representing the categories to which they belonged, was not related to any of the anxiety or study skills scores. It was reasoned that the absence of anxiety effects on acquisition was attributable to the fact that stress was induced only when students were asked to retrieve previously learned words. Prior research (Sarason, 1980) has indicated that the debilitating effects of anxiety occured mainly in a stressful evaluative situation.

We attempted to test this interpretation in a succeeding experiment (Tobias & Sacks, 1984). Students were randomly assigned to three groups, in one of which stress was induced at acquisition, in a second at retrieval, and a third group did not receive any stress instructions. A list-learning paradigm was again employed, differing from the earlier study in three ways: 1) the words used had a lower frequency of appearance than those employed before, 2) subjects were required to master both lists, 3) the experiment was administered on microcomputers. Surprisingly, multivariate regression analysis revealed no significant overall effects for acquisition or retrieval on either list. Univariate tests revealed a significant difference among the groups on number of words correct on delayed recall of both lists. The retrieval stress group recalled the fewest words and had lower clustering scores on the delayed recall of List 1 compared to the other groups. None of the anxiety or study skills effects were significant, nor were any of the interactions.

The results of the second list learning study may well have

been an artifact of the experimental procedures. All students in this experiment had also participated in a preceding study (Tobias, 1984b) requiring two sessions, totaling about 31/2-4 hours. In the first session a variety of research instruments, including anxiety and study skills measures, were administered, and in the second session students learned some material on a microcomputer. When students reported for the list-learning experiment, also administered by computer, it seems unlikely that a great deal of credibility was given to the stress instructions since students were now both test- and experiment-wise. Evidence for this interpretation can be seen in the fact that the Worry and Emotionality scores for these students did not differ as a result of stress ($\underline{F}$ =<1). If the instructions had been effective in increasing evaluative concerns Worry-Emotionality scores should have increased prior to acquisition for the group receiving stress instructions at that point, and before retrieval for students stressed prior to delayed recall.

Interference, Deficit, and Cognitive Capacity

The conflicting results of some recent investigations, together with the less than definitive data from previous experiments supporting either the deficit or interference formulations suggests that there is much to be learned about these phenomena. The deficit and interference models have been conceptualized by some as being mutually exclusive. For example, Kirkland and Hollandsworth (1980) suggested that the deficit formulation should be invoked as an alternative to the interference model. Analysis of the research in this area indicates that it is probably premature to view deficit or interference as alternative explanations; instead, perhaps both test anxiety and study skills contribute to decreased performance.

It has been suggested (Tobias, in press) that a limited cognitive capacity formulation provides a useful hypothesis to account for the effects of both anxiety and study skills. The cognitive representation of test anxiety must absorb some of students' information processing capacity, leaving a reduced portion for task solution. In turn, lower capacity leads to less effective processing of input and, in terms of the anxiety model (Tobias, 1977, 1979) shown in Figure 1, ultimately reduced output or test performance. High anxiety makes further demands on processing capacity by dividing the attention of test anxious students between task relevant and task irrelevant concerns (Sarason, in press; Zatz & Chassin, 1983). As M. Eysenck (1982) suggested, the performance of high anxious people on one task can be compared to that of less anxious students working in a divided task paradigm where processing capacity is absorbed by demands of the main and subsidiary task. Perhaps the threat posed by the evaluative situation is cognitively analogous to the demands of a subsidiary task for students with high anxiety, since debilitating anxiety effects tend to disappear on tasks in which such stress is absent. In evaluative situations both the cognitive representation of anxiety and high anxious students' division of attention absorbs a larger proportion of cognitive

capacity than is the case for those lower in anxiety, leading to performance decrements.

It was also hypothesized (Tobias, in press) that effective study skills may enable students to organize tasks so that they require less cognitive capacity than needed by those with poorer study skills. It seems reasonable to expect that the availability of various strategies ought to enable students with good study skills to reduce the cognitive demands of tasks, thus improving performance. Similarly, effective test taking strategies may also reduce the cognitive capacity required by tests.

The cognitive capacity formulation, then, suggests that test anxiety and both study and test taking skills have inverse, though complementary effects. That is, high test anxiety is expected to increase the demands made on cognitive capacity, whereas effective study or test taking skills are predicted to reduce the capacity demanded by tasks. Therefore, optimal performance can be expected of students with good study or test taking skills and low test anxiety since such students have the greatest proportion of their cognitive capacity available to cope with task demands. Students with high test anxiety and low skills, on the other hand, are in a situation where both the task and test anxiety make maximum demands on available cognitive capacity, leaving less capacity for dealing with the task. Students who are high on one of these variables and low on the other, of course, would be expected to be in an intermediate position.

A study by Paulman and Kennelly (1984), referred to earlier, provides support for the cognitive capacity model. These investigators assigned students to work on two tasks, Raven's matrices and backward digit span either sequentially or concurrently. Results indicated that for the Raven's, only test anxiety exerted an effect on outcome. On backward digit span there were significant main effects for both test anxiety and examination skills. "High-test-anxious subjects remembered significantly fewer total digits on concurrent versus separate (consecutive) trials....No differences emerged for low-test-anxious subjects across the two presentations methods....Thus increased processing load may have had a particularly negative effect on individuals with high levels of test anxiety." (p. 282-283). The results are interpreted as indicating that "test anxiety is associated with an impairment in information-processing capacity that is apparently independent of both ability and exam taking skill....Anxiety by itself seems to signal lower cognitive effectiveness when task demands are high" (p.285).

There are a number of advantages to interpreting deficit and interference effects in terms of cognitive capacity. First, as indicated above, the effects of both types of variables are seen as complementary rather than as mutually exclusive, an interpretation in accord with much of the evidence at hand. Second, as indicated previously (Tobias,1979) it continues to suggest a fruitful area of

investigation using the aptitude treatment interaction paradigm (Cronbach & Snow, 1977) to investigate study and test taking skills and test anxiety phenomena. That is, students high in test anxiety with sound study or test taking skills could profit from treatment focusing only on test anxiety reduction. On the other hand, students with defective study or test taking skills and high test anxiety will probably require an intervention program intended to improve their skills as well as reduce test anxiety. Denney (1980) has suggested that such treatment programs are likely to be more effective in both reducing self-reports of anxiety and increasing cognitive performance than programs aimed merely at the reduction of test anxiety.

Cognitive Capacity and Drive Theory

It can be maintained (Heinrich & Spielberger, 1982; Spielberger, 1984) that the test anxiety results summarized above can easily be accounted for by the Spence and Spence (1966) drive theory formulation. In summary, the Spences suggest that drive properties of anxiety can facilitate learning in a situation in which the habit strength of the correct response is markedly higher than that of competing incorrect responses. Researchers have assumed that such situations are "easy" despite Spence's caution not to extrapolate from laboratory to more complex settings. In such "easy" situations, the drive properties of anxiety are presumed to strengthen correct responses sufficiently to occur and leave the weaker responses below threshold, giving rise to a facilitative effect. "Difficult" tasks are assumed to be situatons in which the correct and incorrect responses are approximately equal in strength; anxiety may then indiscriminately strengthen all responses, leading to increased error and interference in learning.

Drive theory, then, predicts a facilitative effect of anxiety on learning in "easy" situations and a debilitative effect in "difficult" ones. The cognitive capacity formulation, on the other hand, predicts interference when the capacity required by the task and by the representation of anxiety are greater than that immediately available, or no effect when there is sufficient capacity for both requirements. Facilitation of performance would not, however, be predicted by the capacity formulation in any situation.

Heinrich and Spielberger (1982) and M. Eysenck (1982) reviewed the evidence of interaction between anxiety and task difficulty. Eysenck (1982) reports "a total of 54 relevant experiments; in 30 cases, the interaction was non-significant but, in 22 the predicted interaction between anxiety and task difficulty was obtained. In the two remaining experiments . . . . the reverse interaction was obtained. . . . . Of the 22 experiments reporting the predicted interaction, high anxiety significantly facilitated performance on the 'easy' task in eight experiments and significantly impaired it in three experiments. On the 'hard' task, high anxiety improved performance in two experiments and worsened it in six." (p. 103)

There are relatively few studies then, showing a facilitative effect of anxiety on any type of task. Following a review of the effects of anxiety in instructionally relevant situations Sieber, O'Neil and Tobias (1977) concluded that anxiety had either a negative effect, or made no difference in meaningful learning situations. There is some ambiguity regarding the results of this research since some of the same evidence cited by Heinrich and Spielberger (1982), in support of a drive theory hypothesis, is cited by O'Neil, Judd, and Hedl (1977) in concluding that "for meaningful computer-assisted instruction tasks of varying level of difficulty, drive theory seems to have limited utility in predicting the relationships between state anxiety and performance" (p. 208).

Obviously, these differences to some degree reflect stylistic preferences among different investigators. The cognitive capacity formulation appears to be more directly applicable to instructionally relevant situations than drive theory. The Spences' (1966) position demands analysis of the learning situation in terms of the habit strength of competing responses. Such an analysis is, of course, generally impossible to conduct in meaningful instructional situations, rendering the Spences' analysis of limited utility for such tasks. As suggested by Heinrich and Spielberger (1982), a relative ordering of difficulty is of course possible, in which differences in acquisition errors, time or other data are used to identify the "easy" and "difficult" content. Such an analysis is somewhat far afield from competing response hierarchies. For instructionally relevant tasks it appears more fruitful to conceptualize the problem in terms of the cognitive demands of affective states and tasks. Ultimately, of course, the utility of each approach in stimulating research in instructionally relevant situations will be decisive in determining the usefulness of these approaches.

Conclusion

The research reviewed above attempts to clarify the types of cognitive processes affected either by test anxiety or by study and test taking skills. Progress in this research can have several important effects. First, it can clarify the types of cognitive processes impacted by anxiety, and thus build a bridge between cognitive process research, and work on anxiety. Such clarification may also be important in gaining a better understanding of the relationship of affect and cognition in general. Second, progress in this type of work holds the eventual promise of prescribing student treatment programs aimed at specific cognitive processes with which the students need help. It is hoped that such an aim will be much more effective than the buckshot approach of assigning students to global test anxiety reduction programs, or attempts to improve their study or test taking skills.

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