1978

# The Effect of Anxiety on Direction of Attention and Short-Term Memory

Charles B. Kreitzberg
*The Graduate Center, City University of New York*

# THE EFFECT OF ANXIETY ON DIRECTION OF ATTENTION AND SHORT-TERM MEMORY

by

CHARLES BARRY KREITZBERG

A dissertation submitted to the Graduate Faculty in Educational Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1978

This manuscript has been read and accepted for the Graduate Faculty in Educational Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

July 19, 1978
date

[signature redacted]
Chairman of Examining Committee

July 21, 1978
date

[signature redacted]
Executive Officer

Dr. Sigmund Tobias

Dr. John Antrobus

Dr. Alan Gross

Supervisory Committee

The City University of New York

Abstract

THE EFFECT OF ANXIETY ON DIRECTION
OF ATTENTION AND SHORT-TERM MEMORY

by

Charles Barry Kreitzberg

Advisor: Dr. Sigmund Tobias

The purpose of this research was to examine the effect of anxiety on rehearsal in short-term memory. It was hypothesized that anxiety arousal would result in attentional alternation between task-relevant rehearsal and task-irrelevant personalized thinking. Because attentional focus becomes increasingly unitary at high levels of arousal, it was anticipated that the alternation resulting from anxiety would interfere with rehearsal of task-relevant information in short-term memory.

One hundred-fifty subjects were randomly assigned to a high-stress (testlike) or low-stress (neutral) condition. They were shown to-be-recalled strings consisting of seven consonants of low associability. Following a 1.5 second exposure to a given string, subjects were shown a series of addition problems which functioned as an interpolated task to control rehearsal. On two trials, the to-be-recalled string formed a meaningful seven-letter word. Anxiety arousal during the experiment was measured by the State Worry/Emotionality scale. Trait anxiety was measured by the Test Anxiety Scale one week prior to the experiment. The expected relationship between anxiety arousal and recall was found for the low-stress condition but was not significant for the high-stress condition. Individuals who reported high worry/emotionality arousal recalled fewer letters than those who reported low arousal. Subjects in the high-stress condition recalled fewer letters than those in the

low-stress condition. Trait anxiety did not predict letter recall but did predict performance on the interpolated task.
The results are seen as generally supportive of the attentional alternation hypothesis and are discussed in terms of their theoretical and practical relevance.

APPRECIATION

Many individuals have influenced this dissertation by their intellectual and emotional support. It was all deeply appreciated. In particular:

My parents - whose integrity, humanity and commitment to education produced an environment in which the concern for excellence was never made a condition of love.

My sister, Debby - who always preferred friendship to rivalry.

Dr. Sigmund Tobias - my advisor whose guidance was instrumental in shaping every aspect of the study.

Dr. John Antrobus - who helped me formulate appropriate questions and draw appropriate conclusions.

Dr. Alan Gross - who made me aware that issues of theory can not be separated from issues of measurement.

Dr. Harry O'Neil Jr. - who cheerfully traveled 500 miles to serve as an outside reader at my defense and whose thoughtful suggestions substantially improved the product.

Dr. Alden Wessman - who encouraged my interest in affect and served as an outside reader.

Dr. Alvin H. Polatin - whose insight and support has always been reassuring.

And, most of all, Valerie - my friend, my colleague, and my wife. To whom this work is dedicated because without her it would have been twice as difficult and half as joyful.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

# INTRODUCTION

Ours is an age of anxiety -- characterized by a psychological construct whose manifestations are apparent in our art, our music, our literature, and our habits. Americans spend over ten billion dollars each year on alcoholic beverages: hundreds of tons of tranquilizing medications are dispensed each year (Coleman, 1964). Schlesinger (1948) has called anxiety the "official emotion of our age."

Of course, anxiety is not unique to our age; the contemporary preoccupation with anxiety is a result of our recognition of its centrality in the dynamics of interpersonal interactions and its role in psychopathology. According to Levitt:

> Anxiety is timeless; but only in recent years...have we begun to realize its enormous impact on human life. The list of phenomena in which it has been claimed that anxiety plays a role is imposing.
>
> ...Almost every corner of human endeavor is thought to be affected somehow by anxiety...Anxiety is not only our official emotion; it is the primary focus of a concerted effort aimed at the improvement, and perhaps the perpetuation, of human life (1967, p.2).

Because it affects so much behavior, anxiety is an important construct in theories of personality. Since Freud (1923) recognized anxiety's central role in personality development, anxiety has been incorporated into most other theories of personality. Seymour Sarason and his colleagues in their book, Anxiety in Elementary School Children state that they "are not aware of any systematic conception of personality, particularly with regard to its development, which does not give the concept of anxiety a role of great, if not of central, significance" (S. Sarason, Davidson, Lighthall, Waite, and Ruebush, 1960, p. 5).

Faced with the immense theoretical and practical importance of the anxiety construct, psychologists have responded with a voluminous body

of literature on anxiety. Spielberger (1966b) noted that between 1928-1931, anxiety constituted about 0.2% of the entries in Psychological Abstracts but by 1960-1963 the percentage of literature categorized as anxiety-related had grown to 1.6%--an eightfold increase.

One specific type of anxiety which has received considerable study is test anxiety. Test anxiety is a construct whose manifestations are familiar to many students. Faced with the prospect of an examination, test-anxious persons become emotionally upset and self-deprecatory (Wine, 1973). As a result, evaluative experiences are extremely unpleasant for the highly test-anxious person who may go to extreme lengths to avoid anxiety-provoking situations. To some extent this fear of examinations is justified because under stress, test anxious people do not perform as well as their less anxious peers, although it has repeatedly been shown that anxious people are as intelligent as those less anxious (S. Sarason, Mandler & Craighill, 1952; Spielberger, 1966a). Highly test-anxious people are trapped in a vicious circle. Because of anxiety, they tend to perform sub-optimally in an evaluative situation. Their disappointing performance merely confirms their fears and reinforces the anxiety-provoking aspects of the test situation. Thus, test anxiety may be quite debilitating. Because of its ubiquity, test anxiety is an important concern in our achievement-oriented society.

## The Practical Importance of Test Anxiety

The significance of test anxiety as a debilitating force in academic achievement-oriented situations has been reviewed by Spielberger (1966a). In a study at Duke University, Spielberger found that more than 20% of a group of high-anxious students dropped out of school because of academic failure while only 6% of a low-anxious group, drawn from the same population, dropped out of school for this reason. The detrimental effects of anxiety on academic performance were more pronounced among the

lowest ability students where the failure rate of high-anxious students, as compared to low-anxious students, was nearly two to one. The relationship between anxiety and grade point average was found to parallel the relationship between anxiety and academic failure (Spielberger, 1962; Spielberger and Katzenmeyer, 1959). High-anxious students had lower grade point averages than low-anxious students except for students of very low aptitude (where a "floor" effect on grade point average was presumed to be operating) and for students of very high aptitude (where a "ceiling" effect on task difficulty was presumed).

Among elementary school children, Lunneborg (1964) found that high anxiety was associated with poor achievement in reading and mathematics. Gaudry and Spielberger (1971) reviewed a number of studies relating anxiety to academic achievement and concluded that the most consistent findings were that high anxiety was associated with low academic achievement at all levels of academic experience.

Because high anxiety has consistently been related to poor academic performance, anxiety is a construct of considerable educational importance and considerable effort has been devoted to investigating its characteristics.

## Test Anxiety as a Theoretical Construct

Not only is test anxiety a construct of practical educational importance, but it is theoretically important as well. One of the major problems faced by investigators studying anxiety is the highly idiosyncratic nature of anxiety reactions. The stimuli which elicit anxiety vary considerably among individuals. Consequently, exposing a random group of individuals to a presumed stressful situation does not assure the effectiveness of the anxiety-induction procedure. This problem is minimized if the anxiety-proneness of individual subjects in the experimental situation can be assessed. For example, only some individuals asked to perform an experimental task in the presence of a (presumably anxiety-arousing) snake would experience anxiety.

Because of the control gained by considering anxiety with respect to a specific stimulus situation, a number of investigators have chosen to focus their research on test anxiety. Test anxiety has proven to be a useful focus for anxiety research because it is easily aroused, it is a ubiquitous phenomenon in our achievement-oriented culture, and it is of practical, as well as theoretical, significance. According to S. Sarason et. al., there are two major reasons for a research study to focus on test anxiety. "First, the test situation frequently evokes the anxious response at a strength which should allow..[one]...to evaluate...[one's]...theoretical conceptions about the significance of anxiety in the organization and development of personality. Second, if test anxiety is an important and frequent response to the test situation, then the development of a valid methodology for its assessment would have relevance for the general problem of the nature and effects of test-taking attitudes and reactions" (1960, p. 10).

To the extent that the pattern of test-anxiety arousal is typical of anxiety-arousal in other situations, research findings based on test-like situations may be generalized to other anxiety-arousing situations. Although patterns of anxiety-arousal may vary across different situations and certainly varies across individuals in the same situation, test anxiety appears to have much in common with other forms of anxiety. A number of theorists (Fenichel, 1945; Wine, 1973) have noted that test anxiety is closely related to, or identical with, the more general construct known as <u>evaluation anxiety</u> which includes such phenomena as stage fright, fear of speeches, fear of blushing, and certain social fears. Wine (1973) suggested that the central element in evaluation anxiety is the possession, on the part of the anxious individual, of negative self-cognitions which are activated by conditions of evaluative psychological stress. The class of anxiety reactions which Wine categorized as evaluation anxiety are those situations in which the major threat is to the individual's self-esteem. Most anxiety reactions resulting from interpersonal interactions involve such a threat and may be expected to evoke patterns of response similar to those resulting from test-induced anxiety.

The Goals of the Current Study

Like most psychological constructs, anxiety is not a simple phenomenon. Anxiety reactions are not unitary but are patterns of response which are elicited by a wide variety of individually-relevant stimuli. The characteristics of a particular anxiety reaction depend upon the interaction between the individual and the stimulus situation.

Recently, a number of theorists (I. Sarason, 1972; Wine, 1973) have suggested that the debilitating effect of anxiety on performance may result from ways in which anxious individuals deploy their focal attention. This notion stems from the fact that since anxiety states are unpleasant, they may be attentionally demanding. Anxious individuals are hypothesized to alternate their attention between their anxiety reaction and task-relevant variables. Wine (1973) reviewed a large number of studies and concluded that previous research was consistent with the hypothesis that attentional focus was affected by anxiety. I. Sarason (1972) also found the attentional formulation to be consistent with previous anxiety research.

The cognitive-attentional formulations of Wine (1973) and I. Sarason (1972) suggest that anxiety reactions may interfere with rehearsal in short-term memory. Norman (1969a) has noted that rehearsal may be considered equivalent to attention. Attention withdrawn from short-term memory would reduce rehearsal and lead to decay of memory contents. This decay would have an adverse effect of task performance.

The current study investigated the relationship between test-anxiety and the short-term retention of letter-strings. It was hypothesized that anxiety would degrade performance on a task which was highly dependent upon short-term memory.

Chapter I reviews a number of important formulations of anxiety. The attentional alternation hypothesis is shown to be consistent with these formulations.

Chapter II reviews findings which suggest the hypothesis that anxiety would interfere with short-term memory rehearsal.

Chapter III describes the design of an experiment designed to investigate the hypothesis proposed in Chapter II.

Chapter IV presents the results of the experiment.

Chapter V discusses the findings of the experiment. The cognitive-attentional formulation is extended in the context of the theories discussed in Chapter I. Finally, areas for future research are suggested.

# CHAPTER I

## ANXIETY AS A THEORETICAL CONSTRUCT

Despite its ubiquity and introspective availability, anxiety is not a well-defined construct. Most definitions of anxiety lack operational precision. According to Cattell, for the past 50 years anxiety has wallowed in a "morass of complete terminological and conceptual confusion...[in which] there has certainly been no lack of definitions... at the verbal, non-operational level, beginning with Freud's distinction of Angst and Furcht. This literature, however, at its rare best, produces definitions as unstable as our turbulent language, and susceptible later to all the whims of exegesis" (1966, p. 24).

Although operational definitions have the advantages of rigor, they may fail to acknowledge subtleties of the construct being measured. For example, the common practice of defining anxiety operationally as the score received by a subject on a questionnaire such as the Manifest Anxiety Scale fails to adequately reflect the multidimensional nature of anxiety (Jessor and Hammond, 1957).

Thus, the theorist attempting to define anxiety is hard-pressed to choose between operational rigor and non-operational richness. In evaluating previous formulations, it is necessary to realize that the problem of defining anxiety is complicated by the need to explicate the relationships among the closely related constructs of anxiety, fear, phobia, and stress. The distinctions among these constructs are not clear-cut since all of them refer to psychological states with unpleasant affective overtones.

Izard and Tomkins have argued that "there are no theoretically useful distinctions between [anxiety and fear]" (1966, p. 99).

Mowrer (1939) has also suggested that anxiety and fear are equivalent, and that anxiety is the conditioned form of the fear reaction. Some theorists have distinguished between anxiety and fear by defining fear as a reaction to a perceived threat and defining anxiety as a special type of fear which is not directed at an external object. According to this view, anxiety may be regarded as the affective manifestation of cognitive perception. This view suggests that anxiety-evoking cues are largely internal but may be elicited by an external stimulus (phobic object).

Like fear, phobias are directed at an external object but the response is disproportionate to the actual threat. Freud (1923) regarded phobias as a form of neurotic anxiety which derived their intensity from free-floating anxiety. Salzman (1973) suggested that in "true" phobias the phobic object was symbolically (conceptually) linked to a conditioned fear-provoking stimulus while conditioned fear reactions (which closely resemble phobias behaviorally) result from simple stimulus generalizations. As with the distinction between anxiety and fear, the distinction between fear and phobia is not always clear. At what point should a fear of dogs, for example, be regarded as phobic? While there are instances in which a reaction may unambiguously be classified as fear, anxiety, or phobia, most cases are ambiguous.

Stress is often used as a synonym for anxiety. Levitt (1967) suggests that this usage is popular for stylistic rather than theoretical reasons. In the current study, stress is used as an adjective which describes a stimulus situation; stress situation, is a situation which contains cues intended to arouse anxiety; stressed individual is one who encounters a stress situation; and stress reaction is the result of such an encounter in terms of the individual's response to stress. This usage follows Levitt's (1967) suggestions.

The inability of theorists to agree upon precise definitions of anxiety, fear, stress, and phobia stems from the fact that these labels are not associated with specific responses. Rather, they

classify patterns of response which vary across individuals and time. For example, two individuals who generally experience anxiety reactions to dogs may manifest entirely different reactions upon encountering a particular dog -- one person might flee; the other might call for help. Similarly, a single individual's reaction to a given dog may vary over occasions -- both in terms of the intensity of the perceived affect and the specific responses elicited.

Accordingly, the construct of anxiety must be understood as describing a class of complex and variable response patterns. To date, no somatic or behavioral response unique to anxiety has been found and it is unlikely that one exists. There is no single "correct" definition of anxiety, because all anxiety is not the same. And as Schachter (1964) has shown, the label assigned to a particular response pattern depends upon the individual's perception of somatic cues. Individuals may be inconsistent in the labels that they assign to their own patterns of response, depending upon their context.

## Review of Major Theories

This chapter reviews a number of major theories of anxiety which are the direct predecessors of the formulation investigated in the current study. Each theory has focused upon selected aspects of the complex phenomenon of anxiety; each is therefore incomplete.

Although none of the theories of anxiety to be discussed is sufficiently broad to account for all anxiety-related phenomena, within its domain, each is supported by a body of empirical research. Aspects of each have contributed to the view of anxiety which underlies the current study.

The theories to be reviewed include Freud's (1923) psychoanalytic formulation; Dollard and Miller's (1950) learning-theoretic formulation, K.W. Spence's (1958) drive theory; Spielberger's (1972) trait-state theory; Mandler and Sarason's (1952) theory of test anxiety and Wine's (1971) restatement of that theory in attentional terms; and Liebert and Morris' (1967) worry/emotionality factors.

Because each theory has focused on selected aspects of anxiety responses, most have been associated with a technique or scale for anxiety measurement. Since these measures reflect the orientation of the particular theory, all have proven inadequate as complete descriptions of anxiety; however, each has proven useful within the particular theory. The measurement methodology associated with each of the theories is discussed in conjunction with the theory.

## Freud's Theory of Anxiety

It is appropriate to begin a survey of theories of anxiety with a consideration of Freud's contribution because, more than any other psychologist of his time, Freud recognized the centrality of anxiety in psychopathology. Strangely, this recognition was slow in coming. Originally, Freud conceived of anxiety as the result of repression. In his early theorizing, Freud saw anxiety as an affective discharge which resulted from the inability of a sexual impulse to be expressed (repressed libido).

In 1926, however, Freud published The Problem of Anxiety[1] in which he assigned anxiety a far more central role than he had in his earlier theory. In this work, Freud distinguished between three types of anxiety: reality (objective) anxiety, neurotic anxiety, and moral anxiety. Freud equated reality anxiety (or objective anxiety) to fear--a reaction to a perceived external threat. In objective anxiety, the amount of anxiety aroused would be a direct function of the magnitude of the perceived threat. Objective anxiety has been schematized by Spielberger (1966b, p. 10) as follows:

external danger ⟶ perception of danger ⟶ objective anxiety

Because of the unpleasant affect associated with anxiety, people experiencing objective anxiety will strive to avoid the threat by removing themselves from the source of danger or by otherwise protecting themselves.

---

[1] English Translation, 1936.

Neurotic anxiety results from impulses which, carried out in the past, led to punishment. In the sense that the impulses are, in fact, dangerous since they lead to punishment, neurotic anxiety is similar to objective anxiety. The dangers perceived are the consequences of impulsive (id-directed) action. Neurotic anxiety differs from objective anxiety in that the cues which serve as the danger signal to trigger it (the id impulses) are not apparent to the individual. Since the perception of the unacceptable impulse raises feelings of apprehension of punishment, the person attempts to alleviate the objective anxiety by repressing the cues which evoke it; but, the impulses are demanding and cannot always be repressed. Whenever the repression mechanism fails, partial cues of the impulse impinge upon awareness and arouse neurotic anxiety. Since the impulse which is the source of the anxiety is largely repressed, the sufferer is unaware of its cause. Hence, neurotic anxiety is experienced as objectless or free floating. Spielberger (1966b, p. 10) has diagrammed the sequence of events:

internal impulses → external danger (punishment) → objective anxiety → repression

partial breakdown of repression → derivatives of internal impulses → neurotic anxiety

Thus, the source of neurotic anxiety is internal rather than external. Both the partially repressed impulse and the source of threatened punishment (superego) have become part of the personality of the person experiencing anxiety.

Moral anxiety results from the perception by the superego that an action or thought is incongruous with the standards of appropriate behavior incorporated into that aspect of self-concept which Freud termed the ego-ideal. Moral anxiety is usually experienced as shame or guilt. As with neurotic anxiety, the source of moral anxiety is internal although the cue which elicits it may be external.

Freud's description of anxiety has served as the starting point for most subsequent formulations. Although Freud's ideas have had a profound effect on the clinical treatment of anxiety, they have proven less useful for purposes of research.

The assessment techniques most often associated with Freudian theory are projective instruments such as the Rorschach ink blots and the Thematic Apperception Test. The rationale for the use of projective measures was based on the assumption that such methods were capable of disclosing aspects of the individual's private world of meanings, significances, patterns and feelings (Frank, 1939). While projectives are well-suited to the clinical environment in which the individual's patterns of response are of primary interest, research results have been disappointing. For example, movement, a common Rorschach indicator of anxiety, was inversely related to anxiety in four out of eight studies; only three of the relationships were statistically significant.

Because the relationship between projective indicators and questionnaire methods of anxiety measurement tend to be low to moderate, projective instruments are generally employed for certain types of individual clinical assessment (Iacino and Cook, 1974).

Learning Theory

American behaviorism was less than sympathetic to Freud's "mentalistic terminology" (Mowrer, 1939) and sought alternative formulations which relied on observable behavior rather than metaphor. Early work by Pavlov, Watson, and Thorndike and, particularly Hull's (1943) hypothetico-deductive system have provided a foundation for the development of theories of anxiety.

The basis of these theories is that "anxiety (fear) is the conditioned form of the pain reaction" (Mowrer, 1939, p. 555). Thus, if a pain-producing stimulus is paired with neutral stimuli, the neutral stimuli will come to elicit a fear or anxiety reaction. The most integrative of the learning theories was Dollard and Miller's (1950) learning theoretic reformulation of Freud's theory.

Dollard and Miller conceived of anxiety as a secondary (learned) drive which served to energize the organism and produce behavior. The internal responses evoked by an anxiety-producing stimulus serve as cues to elicit further responses; anxiety reduction, like all drive reduction, is reinforcing.

Thus, a neutral stimulus paired with a painful or anxiety-provoking stimulus would come to elicit internal responses which we label "an anxiety reaction." The anxiety reaction serves to elicit behaviors which, in the past, have been anxiety-reducing. "Phobias, inhibitions, avoidances, compulsions, rationalizations, and psychosomatic symptoms ... are responses that tend to reduce the conflict, and in part they succeed. When a successful symptom occurs, it is reinforced ...[and] ... is thus learned as a habit" (Dollard and Miller, 1950, p. 15). The acquisition of defense behaviors may therefore be interpreted in instrumental conditioning terms.

Of particular interest to the current study is Dollard and Miller's interpretation of repression in drive-reduction terms. According to this formulation, repression may be considered a learned response in which the individual is reinforced, by anxiety reduction, for not attending to the anxiety-provoking thoughts. Thus, Dollard and Miller postulated that anxiety could condition the deployment of focal attention.

Dollard and Miller, as members of the Institute of Human Relations at Yale University, were deeply influenced by the ideas of Clark Hull. Another theory whose view of anxiety stems from Hull's theory is the drive-theoretic formulation of K. W. Spence.

## Hull-Spence Drive Theory

Spence's drive theory had as its main focus the verification and refinement of Clark Hull's (1943) hypothetico-deductive systematic behavior theory. Thus, while drive theory research was often concerned with the effects of anxiety on learning, the central focus of the theory was on the effects of drive on learning generally. The choice of anxiety as the specific drive to be studied was almost incidental (Taylor, 1956). Because of the close relationship between drive theory and Hull's hypothetico-deductive system, it is necessary to briefly review some relevant parts of Hull's theory.

Hull (1943) developed his theory to demonstrate that behavior theory could be extended, within the constraints imposed by behaviorism, to explain goal-seeking purposive behavior such as maze learning. Hull thus proposed to explain such phenomena as foresight and purpose using a stimulus-response model.

A major problem that Hull faced was to explain how a future goal could reinforce antecedent behaviors; that is, Hull had to account for the temporal non-contiguity of behavior and reinforcement. For example, the dogs in Pavlov's conditioning experiments, salivated before the actual food was present. Similarly, food ingestion terminates food-seeking behavior before the nutrients in the food have been released to compensate for tissue deficits.

Hull's construct of fractional anticipatory goal response provided an integrative link to explain anticipatory behavior. The fractional anticipatory goal response was conceived of as an intervening response which by itself does not totally reduce drive and therefore does not lead to a cessation of goal directed behavior. But the fractional anticipatory response can serve as a cue which elicits subsequent (goal-directed) responses.

Atkinson (1964) pointed out a number of consequences of Hull's theory with regard to "purposive" goal-seeking behavior:

- If the organism fails to reach a goal, it will continue to attempt to seek the goal because of the persistence of the internal drive, and goal stimulus.
- If the organism fails to achieve the goal, the original response will tend to become extinguished and an alternate, weaker, response will become dominant.
- Individual differences in behavior result from the different antecedent response histories of the organism.

- The temporal sequence of responses is a function of the strengths of the competing responses which is dependent upon the organism's antecedent reinforcement history.
- Useless responses (e.g., those that do not lead to reinforcement) may reappear through the process of spontaneous recovery.

K. W. Spence carried on Hull's hypothetico-deductive approach and the confluence of the two theories has become known as Hull-Spence drive theory.

One aspect of Spence's investigations concerned the effects of drive on learning. In conjunction with Janet Taylor, Spence conducted experiments investigating the effects of aversive motivational factors in learning (Spence, 1958). Spence-Hull drive theory was a significant impetus to research in test anxiety (Spence and Spence, 1966), although the theory was not concerned with the higher level cognitive processes characteristic of most academic tasks.

In its most general terms, drive theory conceptualized anxiety as an acquired drive which had the property of energizing responses by increasing their magnitude. The magnifying effects of anxiety on response magnitude is a readily observed phenomenon. "Clinically, one thinks of the tense, 'jumpy' person who responds quickly and with relative intensity to minor stimuli" (Levitt, 1967, p. 112). In the case of very simple learning situations (such as respondent conditioning) in which only one response is possible, drive theory predicts that anxiety will facilitate learning. The effects of anxiety on more complex learning are not so straightforward, and in certain situations anxiety will have a deleterious effect on learning.

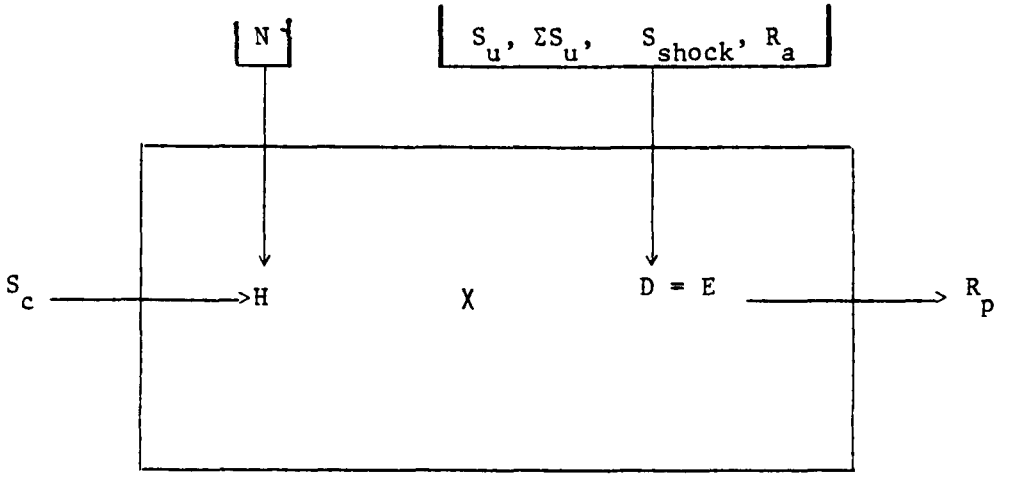
Spence's anxiety theory was derived from some basic assumptions of Hull's learning theory. According to Hull (1943) the magnitude of a response may be a function of an intervening variable E (excitatory potential) which is itself a function of habit strength, H and a generalized drive level, D. In particular, E is assumed to be a multiplicative function of habit strength and drive level.

$$E = F(H \times D)$$

According to Hull, "habit strength is a simple positive growth function of the number of reinforcements" (1943, p. 179).

Drive, the basic multiplier of habit strength, activates habit into reaction potential. Drive reduction is primary reinforcement. When a stimulus is associated with primary reinforcement, it becomes the object of a conditioned or acquired drive.

Figure 1 diagrams the relationships postulated by drive theory in the case of simple aversive conditioning.




N: the number of paired conditioning trials

$S_c$: the conditioned stimulus

$S_u$, $\Sigma S_u$, $S_{shock}$, $R_a$: independent variables which have been manipulated in various studies

$S_u$: the unconditioned stimulus

$\Sigma S_u$: the number of prior presentations of the unconditioned stimulus

$S_{shock}$: shock not paired with the unconditioned or conditioned stimulus

$R_a$: some measure of emotional responsiveness (such as the score on the Manifest Anxiety Scale).

Figure 1. Spence's postulated relationships in the case of respondent aversive conditioning. Adapted from Spence and Spence, 1966.

As can be seen from Figure 1, the probability and magnitude of the response, $R_p$, is the multiplicitive function described above. It should be noted that habit strength, H, is conceived of as a direct function of the number of pairings. Drive is mediated by a hypothetical mechanism $r_e$ which is a "persistent emotional response aroused by aversive stimuli" (Spence and Spence, 1966, p. 293).

Spence drew two implications from the above model: (1) D would be a function of the intensity of $S_u$ (hence $R_p$ would also vary with $S_u$) and (2) there would be individual differences in response to a noxious stimulus; that is, individuals with a high level of emotional responsiveness would tend to exhibit faster conditioning for a given number of trials than would an individual with less emotional responsiveness. The Taylor Manifest Anxiety Scale (Taylor, 1953) was designed to assess individual differences in emotional responsiveness.

In general, research has supported the drive theory with respect to simple learning tasks such as eyelid conditioning (Spence, 1964). Similar results have been shown in paired-associated learning tasks (Atkinson, 1964). Atkinson noted that when the strength of association is controlled for inpaired associate learning tasks, Ss with a high MAS score (hence presumably Ss high in $r_e$) do better than Ss with low MAS scores if the association has high initial habit strength (blue-sky) or low initial habit strength (book-dog). Thus, when there is a single response or when habit strength is initially very high for the correct response, anxiety has a facilitating effect on learning (Spence, 1958).

The effect of anxiety drive on more complex tasks is not as easily determined. One problem is that it is difficult to define exactly what is meant by a complex task. A discussion of this problem may be found in Spence and Spence (1966) in which the problems of translating the concept of intra-task competition into task complexity are considered. In general, since anxiety is presumed to have a non-specific, energizing effect on all competing habits, the theory would predict that the performance of the high anxiety and low anxiety

groups would be a function of the relative strengths of the competing response tendencies (Taylor, 1956). Because the relationship between drive and habit strength is multiplicative, an increase in drive strength would tend to increase the difference between competing responses. If the correct response were initially weaker than one or more incorrect competitors, the effect would be to degrade performance more for high-anxious than for low-anxious subjects. If drive were strong it may multiply very weak responses enough to make them major competitors in the response hierarchy and thus further decrease the probability of a correct response (Taylor, 1956).

A number of studies have supported the hypothesis that low MAS subjects tend to perform better than high MAS subjects where response competition is a factor (Atkinson, 1964). When verbal or stylus mazes were used, more errors were made by high-anxious subjects at the most difficult choice points.

Spence and Spence (1966) note that the data on intra-task competition should not be generalized to statements about task difficulty. They point out that depending upon the degree of intra-task competition, the results in paired-associate tasks can either be the same as in conditioning (that is, high-anxious individuals are superior to low-anxious individuals) or the reverse may be the case. The theory does not deal with problem-solving tasks and hence, predictions about this type of behavior cannot be made.

Because drive theory is not relevant to problem-solving environments, it is surprising that much research on anxiety in academic situations has been linked to drive theory. It is probable that much of this work was inspired by the availability of the Manifest Anxiety Scale (MAS), a questionnaire measure of anxiety developed by Janet Taylor.

The suggestion that a self-inventory instrument which would reflect differences in manifest anxiety could be a useful means of assessing Hull's $\underline{D}$ was initially presented by Taylor (1951) in her doctoral dissertation. Because Taylor's purpose was the measurement of drive, "the construction of the test was not aimed at developing a clinically useful instrument which would diagnose anxiety but rather was designed solely to select Ss differing in general drive level" (Taylor, 1953, p. 303). Thus, the Manifest Anxiety Scale (MAS) was

not developed with regard to a theoretical definition of anxiety embedded in a nomological network. It is on these grounds that the MAS has been criticized as lacking construct validity (Jessor and Hammond, 1957). Despite various criticisms, however, the MAS has become a widely used instrument; perhaps its popularity derives, in part, from its origination from the popular Minnesota Multiphasic Personality Inventory (MMPI).

The MAS was constructed by submitting approximately 200 items from the MMPI to five clinicians who judged the items as being indicative or non-indicative of manifest anxiety. Sixty-five items on which at least 80% agreement was obtained were combined with 135 "buffer items" and were administered to an initial sample of college undergraduates. On the basis of correlations between individual items and total anxiety score, the number of items was reduced to 50. Expansion of the buffer items to 175 resulted in a version of the test with 225 true-false items. In a later version, some of the items were reworded in order to reduce their reading level and their ambiguity (Taylor, 1953).

Taylor reported test-retest correlations in the range of .68 to .89 with the correlations generally in the range of .81 to .89 (Taylor, 1953).

Significant correlations have also been reported among the MAS, a self-rating scale of anxiety, and the Psycho-somatic Inventory (Davids, 1955). A high correlation between the MAS and the Pt scale of the MMPI has been reported (Brackbill and Little, 1954). The MAS has also been shown to correlate with the Winne Neuroticism Scale (Kerrick, 1955). A number of variants of the MAS have been published including a forced choice version, a 20 item short form, and a version for use with elementary school children (Levitt, 1967).

Spence and his co-workers have performed numerous studies using the MAS. Reviews of this work will be found in: (I. Sarason, (1960); Spence, (1958); Spence & Spence, (1966); and Taylor, (1956). In general, the subjects who score high on the MAS tend to exhibit faster respondent conditioning than do subjects who score low on the scale. With more complex types of learning, the results are less clear.

Because the MAS is a very general measure of anxiety, it is not a useful predictor of anxiety reactions in response to test-induced stress. Accordingly, the MAS was deemed unsuitable for the current study. A more appropriate instrument for the purpose emerged from Mandler and Sarason's (1952) interference hypothesis.

## The Mandler-Sarason Interference Model

Prior to 1950, there were relatively few studies of the effects of anxiety on learning. In 1950, S. Sarason noted that the nature and role of drive states was both theoretically and practically relevant to the testing situation. Two years later, Mandler and Sarason (1952) published their seminal article which is generally credited with having introduced the construct of test anxiety to the psychological community.

In their article introducing test anxiety, Mandler and Sarason (1952) proposed a formulation involving two types of drives: task-drives ($S_t$) and anxiety-drive ($S_a$). Task-drives were considered learned drives which are a function of both the particular task presented to the subject and the instructions which accompany it. Task-drives were presumed to include the need to achieve and the need to complete the task. Task-responses, denoted by the symbol $R_t$, were defined as responses (or response sequences) which lead to a reduction in $S_t$ and to completion of the task.

Anxiety-drive ($S_a$) was considered to be a learned drive which developed in response to anxiety reactions previously encountered in the testing situation. The manifestation of anxiety-drive was therefore the result of generalization from previous testing experiences in which anxiety was aroused. Two classes of responses which could reduce the anxiety-drive were postulated. The first type of response, denoted by the symbol, $R_{at}$, were responses which tended to reduce anxiety-drive by facilitating the completion of the task. These responses were considered functionally equivalent to the task-drive reducing responses $R_t$. In contrast, a second class of responses, denoted by the symbol $R_a$, were considered self-directed and would be manifested by attempts to escape from the test situation, by somatic

arousal, by feelings of helplessness and fear of loss of esteem. Responses which are $R_a$ would not facilitate completion of the task.

In their model (Figure 2), Mandler and Sarason postulated that the overt responses of the subject were mediated by intervening responses which lead either to task-relevant activity which would facilitate task completion or task-irrelevant activity which would interfere with task completion.

As can be seen from the model in Figure 2, anxiety may either facilitate or interfere with task completion depending upon the responses evoked. Mandler and Sarason proposed that the $R_{at}$ responses which are facilitating would be task-specific and thus would not be in the response repertoire of the subject. They would therefore be learned during the course of task performance. $R_a$ responses, on the other hand, were not assumed to be task-specific but were presumed to be in the subject's repertoire and would be evoked in the test situation because of stimulus generalization from previous testing situations. Since individuals with a high anxiety drive would tend to have a large number of $R_a$ responses available, they would tend to make large numbers of these responses. Individuals with a low anxiety drive would presumably have fewer $R_a$ responses available to them and would therefore tend to learn and exhibit more $R_{at}$ responses than the high anxiety subject.

Whereas the Spence-Taylor theory of anxiety as an energizing drive (D) treated anxiety as a general personality trait, the Mandler-Sarason theory was more concerned with situational anxiety. Levitt noted that "[in the Mandler-Sarason hypothesis] The effect of anxiety is ... a function of ... the attitude of the experimenter or teacher and the meaning of the task as perceived by the individual. These factors are of greater significance than the complexity or difficulty per se" (1967, p. 115). This concern with the situational aspects of test anxiety is reflected in an early investigation (Sarason, Mandler, & Craighill, 1952), in which the type of instructions presented to subjects were varied. One group received <u>expected to finish</u> instructions which indicated that the "average college student" would be able to finish the task in the time allowed. A second group

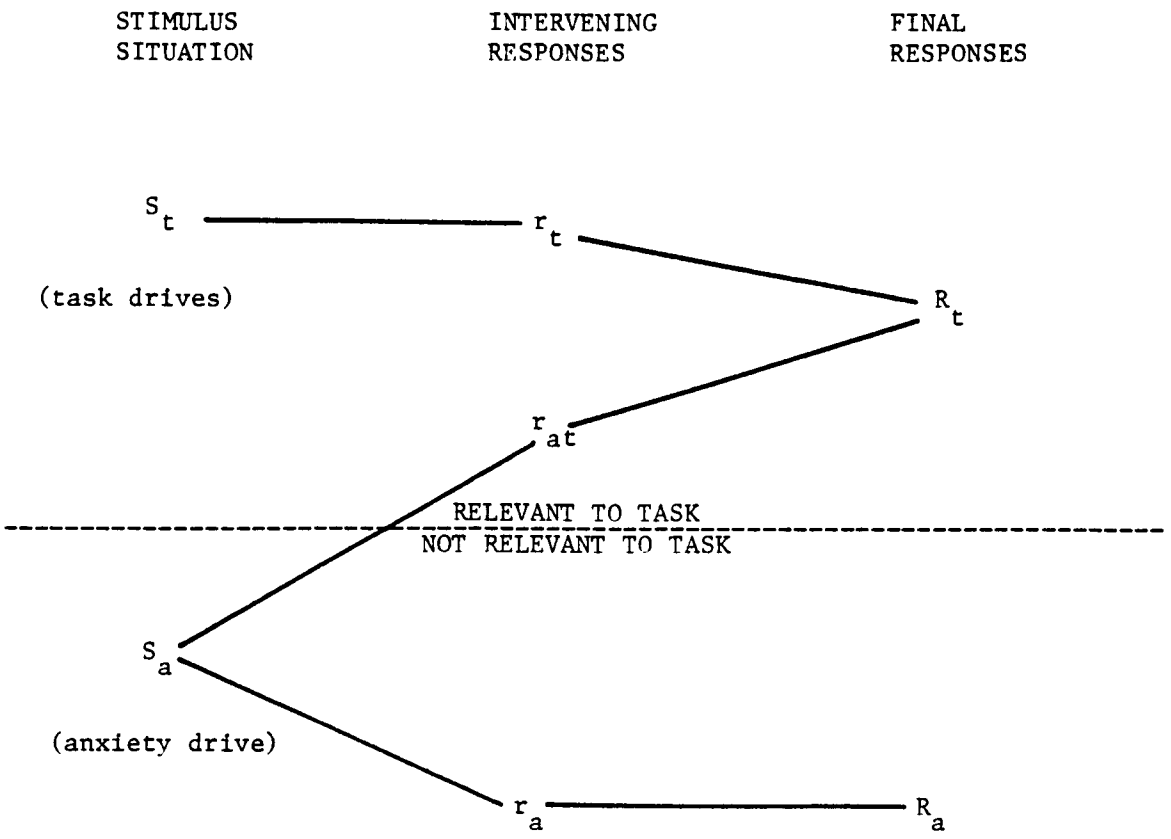



Figure 2. Drive-Response relationships in the Mandler-Sarason Model. Adapted from Mandler and Sarason (1952).

received not expected to finish instructions which indicated that the task was too difficult for anyone to finish in the time allotted. Actually, the task was too difficult for anyone to finish. It was anticipated that, in accordance with the theory described above, stressful instructions would facilitate performance of low anxiety groups while interfering with the performance of high anxiety groups: in general, these predictions were confirmed.

In summary, the Mandler-Sarason hypothesis predicts that high anxiety subjects will tend to exhibit task-irrelevant responses in a stressful situation while low anxiety subjects will tend to exhibit task-facilitating responses in a stressful situation. A differential effect on performance as a function of anxiety level is thus predicted.

It is interesting to compare the Mandler-Sarason text anxiety model with the achievement motivation models of McClelland and Atkinson, (cf. Atkinson, 1964; McClelland, Atkinson, Clark, and Lowell, 1953). The task-drives postulated by the Mandler-Sarason model are similar to the need for achievement (n ach) state which McClelland and Atkinson investigated. Atkinson (1964) described two "need states" that were presumed to be evoked in an achievement situation: need for achievement and fear of failure. These two need states are quite similar to Mandler and Sarason's $S_t$ and $S_a$. In fact, while the TAT is usually used to measure n ach, the most commonly used measure of fear of failure is the Test Anxiety Questionnaire developed in conjunction with Mandler-Sarason interference theory.

The most widely used instrument for the assessment of test anxiety has been the Mandler-Sarason Test Anxiety Questionnaire (TAQ). The original TAQ was used in the initial study of test anxiety (Mandler and S. Sarason, 1952). The first version of the TAQ asked the student to rate various questions on a 15 centimeter scale. An example of a TAQ item is:

Before taking an examination, to what extent do you worry?

| | |
|---|---|
| Worry a lot | Worry not at all |

The student would mark the appropriate point on the line. Scoring of the TAQ was complex (Levitt, 1967). Each student's responses were measured and scored according to how many centimeters from the edge of the line the mark was made. When all subjects were scored, the group median for each item was computed. Students whose mark fell above the group median received a score of 1 for the item. If the point on the line fell below the group median for the item, a score of 0 was assigned. The total anxiety score was obtained by summing the individual item scores. In effect, this scoring technique indicated the number of items for which the individual's response was above the group median.

Scoring the TAQ was a tedious process and S. Sarason and Gordon (1953) developed norms for Yale undergraduates. However, the applicability of these norms to other populations is questionable.

I. Sarason (1972) has developed a true-false test anxiety scale. Known as the Test Anxiety Scale (TAS) this inventory consists of 37 items such as:

> During a course examination I frequently get so nervous that I forget facts I really do know.

The TAS is highly correlated with the TAQ but is significantly easier to administer. Because of its similarity to the TAQ, and the ease of scoring, the TAS was used in the current study.

Morris and Liebert's Worry-Emotionality

The generally low correlations between autonomic arousal and pencil and paper measures of anxiety such as the Taylor MAS and the Mandler-Sarason TAQ have led psychologists to speculate that these inventories may be measuring a component of anxiety other than arousal. Liebert and Morris (1967) noted that factor analytic studies of the TAQ tended to reveal two classes of factors. They labeled one class as worry (W) factors and the other class as emotionality (E) factors.

Worry factors are cognitive. They relate to cognitive concern about failure and self-image. They are expressed as statements of

inadequacy and lack of confidence. Emotional factors, on the other hand, reflect perceptions of autonomic arousal. Liebert and Morris hypothesized that worry would be inversely related to the perceived expectancy. Presumably, individuals who perceive that they are likely to fail at a task will be concerned with the consequences of that failure; while those who anticipate success will not express such concern.

In order to test the hypothesis, Liebert and Morris (1967) administered a modified form of the TAQ to students just prior to course examination. The modified TAQ consisted of 11 items. Five items were presumed to measure worry while five items were presumed to measure emotionality. Unlike the standard TAQ, the subjects were asked to report their state anxiety with respect to the immediately pending examination.

The remaining item asked the students to rate their expectation of success on the examination relative to their aspirations. This rating was expressed as a probability and was used to divide the subjects into High (.7 to 1.0), Medium (.4 to .6), and Low (0.0 to .3) expectancy groups. The relationship between expectancy group to the five item worry subscale was significant at the .0005 level. A significant relationship was not obtained between expectancy level and the emotionality subscale.

Doctor and Altman (1969) reasoned that worry, because of its cognitive nature, should have an interfering effect upon intellective performance. Emotionality was not hypothesized to have this effect unless the autonomic arousal reached a level which was annoying. In a pretest-posttest design, Doctor and Altman (1969) found that both worry and emotionality dropped significantly following completion of a final examination in psychology. Worry seemed to have an interfering effect on test performance, irrespective of the students expectancies of success.

Since emotionality is assumed to be a reflection of autonomic arousal, it would be expected to correlate with physiological measures. If such correlations were observed, the low correlations between

physiological measures and standard anxiety inventories could be ascribed to the confounding presence of worry factors in the overall anxiety scores.

Morris and Liebert (1970) measured pulse rate changes from a neutral (normal class) to a stress (examination) situation. Pulse rate change scores were related to worry, emotionality, and expectancy scores. They found that both worry and emotionality were related to pulse rate change; differences between the correlations were not significant.

In the current study, worry and emotionality were measured by the state worry-emotionality scale (Morris and Fulmer, 1977). The students' expectancies of success were measured on a ten-point scale similar to that used by Liebert and Morris (1967).

Spielberger's State-Trait Theory

Although some people are considered more anxious than others, even the most anxious person is not experiencing anxiety every moment of every day. In all people there are temporal fluctuations in the manifestations of anxiety reactions; fluctuations that are the result of environmental factors and the person's perception of anxiety provoking stimuli.

R. B. Cattell (1966) distinguished between anxiety as a trait (characterological anxiety) and anxiety as an emotional state.

Spielberger (1966b; 1972) has formalized a state-trait conception of anxiety. According to Spielberger's model, trait anxiety (A-trait) "implies a motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively non-dangerous circumstances and threatening, and to respond to these with A-state reactions disproportionate in intensity to the magnitude of the objective danger." (1966b, p. 17). Trait-State anxiety theory postulates (Spielberger, 1972), that when a stimulus is perceived as threatening:

(1) an A-State reaction will occur

(2) the intensity of the A-State reaction will be a function of the perceived magnitude of the threat.

(3) the duration of the reaction will depend upon the persistence of the evoking stimulus

(4) A-State reactions are experienced as unpleasant and perception of this unpleasant state via cognitive and sensory mechanisms will tend to evoke defense reactions which have, in the past, reduced A-State.

(5) Some individuals will develop effective, as opposed to defensive, reactions to A-State and will therefore respond to A-State arousal by initiating effective coping reactions.

Spielberger has developed a model which illustrates the relationship between state and trait anxiety in Figure 3. According to this model, the cognitive appraisal of a stimulus as dangerous or threatening evokes a state anxiety reaction. The appraisal of a particular stimulus situation as threatening is influenced in part, by the person's acquired disposition to respond anxiously to evaluative situations (trait-anxiety). The occurrence of an anxiety reaction may initiate behavioral sequences intended to avoid the danger situation. Sequences intended to reduce state anxiety by cognitive reappraisal of the situation are called defense mechanisms, and may be general responses or coping maneuvers specific to the stimulus situation.

Because of his concern that the state and trait anxiety be operationally, as well as theoretically, distinct, Spielberger developed two scales which collectively are known as the State Trait Anxiety Inventory (STAI). A description of the scale, its construction and validation will be found in Spielberger, Gorsuch and Lushene (1970). For experimental use where it is desired to measure fluctuations in state anxiety, a special short form of the scale may be used. There is also a children's version (Spielberger, Edwards, Montuori, and Lushene, 1973). In the current study, trait anxiety was measured by the Test Anxiety Scale (I. Sarason, 1972) and state anxiety was measured by the State Worry/Emotionality scale (Morris and Fulmer, 1976).

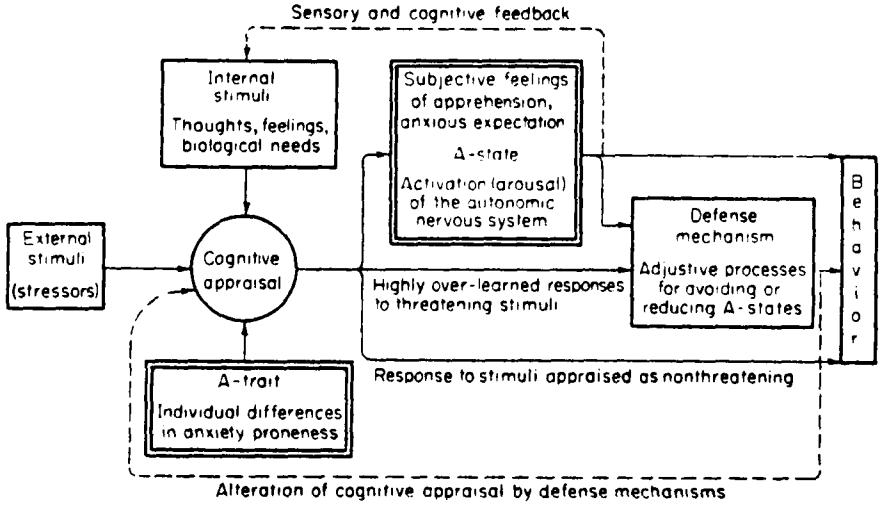



Figure 3. Spielberger's model of the relationship between state and trait anxiety. Adapted from Spielberger (1966).

Attentional Formulations

An attentional reinterpretation of the Mandler-Sarason theory was proposed by Wine (1970) in a doctoral dissertation, and subsequently published in Psychological Bulletin (1971). Wine's formulation (which has been called the cognitive-attentional or alternation hypothesis) attempted to explain the performance differences between high and low test anxious persons in terms of the different ways in which these persons are presumed to deploy their attentional focus.

According to Wine (1970, p. 1) "the low test anxious person is focused on task-relevant variable while performing tasks. The highly test anxious person is internally focused on self-evaluative, self-deprecatory thinking, and perception of his autonomic responses. Since the difficult tasks on which the test anxious person does poorly require full attention for adequate performance, he cannot perform adequately while dividing his attention between internal cues and task cues."

Subsequent to Wine's (1971) publication of the alternation model, I. Sarason (1972) published a review of a number of studies in which he reached a similar conclusion. In this review, Sarason noted that "what distinguishes the high test anxious individual are (1) the manner in which he attends to the events of his environment and (2) how he interprets and utilizes the information provided by these events." He noted that pre-performance variables (e.g. instructions, audience observation) play a crucial role in the way that high-anxious persons perform. Evaluative or achievement-oriented environments seem to have a negative effect on the performance of high anxious subjects but a positive effect on the performance of low-anxious subjects. Sarason argued that low-anxious people in an achievement-oriented condition are motivated to perform at high levels and tend to focus their attention more fully on the task at hand. In contrast, the high-anxious person tends to personalize the achievement-oriented situation and "(1) neglects or misinterprets information cues that may be readily available to him or (2) experiences attentional blocks."

The relationship between attention and anxiety is central to the current study and will be discussed in Chapter II. The remainder of the current chapter is devoted to an explicated, integrated view of the anxiety construct derived from the theories discussed above.

## An Integrative View of Anxiety

Although psychologists differ in their description of anxiety, few would dispute that anxiety is experienced primarily as an affect or feeling-state which, as Freud (1923) noted, is identifiable by its specific unpleasurable quality. In his review of theories of anxiety, Fischer (1970) stressed that anxiety is always a mode of experiencing. A person does not feel anxious except within the context of experiencing a situation--that is, a person experiences anxiously rather than experiencing anxiety. This is true even in the case of "free-floating" anxiety.

Anxiety is generally distinguished from fear in that anxiety either occurs in the absence of an objectively dangerous stimulus situation or is disproportionate to the objective threat. However, anxiety and fear appear to be essentially similar constructs (Mowrer, 1939); anxiety may be regarded as a fear reaction whose source is not attributable to the stimulus situation. Since the source of the fear is not in the environment, it must come from the individual.

The notion that the source of anxiety is within the individual was advanced by James (1890), although he regarded anxiety reactions as instinctive rather than learned. However, Pavlov in his studies of experimental neurosis and Watson in his studies of emotional conditioning soon discovered that anxiety was a learned reaction which could be conditioned by associating a neutral stimulus (CS) with a stimulus which elicited a pain or fear reaction (UCS). Following conditioning, presentation of the previously neutral stimulus would elicit a conditioned anxiety reaction (Mowrer, 1939).

It appears, therefore, that anxiety is a learned reaction which is based on previous pain or fear experiences. Through association with painful and fear-evoking stimuli, neutral stimuli acquire the ability to elicit anxiety reactions.

The elicitation of an affective state by a stimulus which serves as a partial memory cue is a common experience which has been termed redintegration. Redintegrated affect is central to McClelland's hedonic motivation theory which suggests that approach and avoidance behaviors can be explained in terms of redintegrated pleasurable and unpleasurable affects. Although McClelland's theory is not adequate to explain all motivated behavior, the role of redintegrated affect in motivation is extremely important.

## The Role of Generalization

The role of redintegrated affect in controlling behavior is important to the survival of the individual.

In particular, the conditioned anxiety response is highly adaptive because it provides the organism with a motive to avoid potentially dangerous situations. A child who touches a hot stove and burns her hand will experience an anxiety reaction in the future when she approaches the stove and will avoid it. Dollard and Miller (1950) have shown that the gradient of the avoidance behavior increases as the stimulus object is approached.

If an organism were forced to experience every possible danger situation before it learned appropriate avoidance behaviors, it might not survive very long. Fortunately, the anxiety reaction is not specific to the original fear producing stimulus. Through stimulus generalization, cues similar to the original fear-producing stimulus will elicit an anxiety-reaction. Thus, the child who burned her hand on a hot stove will avoid all stoves in the future and probably other objects perceived as similar.

Both human and infrahuman organisms are capable of stimulus generalization. However, humans alone interpret their environment cognitively because they possess a rich and deeply integrated conceptual structure which affects their perception, interpretation, and organization of stimuli in memory. Because of their cognitive capabilities, the process of generalization in humans is more complex than in other organisms.

Through the process of generalization, a stimulus will redintegrate anxiety states if it is perceived as similar to stimuli that were previously associated with anxiety or pain. When perceived similarity is conceptual rather than physical, the relationship between the anxiety-evoking object and the original source of the fear may not be obvious. Thus, a pilot may become fearful of elevators following a plane crash; the similarity of the elevator to the plane is more conceptual than configural. Salzman (1973) suggested that the distinction between simple stimulus generalization and conceptual or "symbolic" generalization was a very important one. He argued that simple avoidance conditioning should be distinguished from "true phobia" on the grounds that the former is generally readily extinguished by appropriate conditioning techniques while the latter is less responsive to reduction by reciprocal inhibition. The distinction between stimuli which evoke anxiety states as a result of simple generalization and those which involve a conceptual association ("symbolic transformation") is often ignored in psychological research.

The reason that few psychological researchers have studied the role of conceptual generalization in anxiety lies in the highly idiosyncratic nature of conceptual phenomenon. Every concept, in addition to its denotative structure, carries with it a personalized connotative structure which is formed as a result of the individual's experiences. Because of the idiosyncratic nature of these experiences, the connotative structure (unlike the denotative structure) does not have a high degree of social concensus.

For example, the denotative structure of the concept "dog" includes such criterial attributes as size, general shape, type of vocalization, eating habits, and typical modes of motor activity. In most cases, the identification of an animal as a dog poses no problem; most people will agree as to whether a particular quadraped is a dog or cat.

The connotative aspects of the concept "dog," however, will vary considerably among individuals. To some people, the concept "dog" carries connotations like: pet, furry, friendly, companion, guardian; to others the connotations might include dirty, noisy, and dangerous.

Although a person's classification of a particular animal as a dog is generally unaffected by the idiosyncratic connotative structure, the person's affective reaction to a dog is governed by the connotative structure. The highly affective nature and the lack of social consensus regarding a concept's connotative structure is obvious when one considers concepts such as "sex-education," "marijuana," and "abortion."

Not only are stimuli which evoke anxiety through conceptual generalization idiosynratic, but they may be illogical as well. It is well-known that irrelevant stimuli often become conditioned as a result of incidental continuity with a reinforcer. This is the basis of classical conditioning since any CS (e.g., Pavlov's bell) may be causally irrelevant to the response evoked by the UCS. Dollard and Miller (1950) have pointed out the importance of incidental stimuli which become cues to evoke anxiety.

For example, consider the experience of an infant, left unattended by its mother at night. The mother's failure to respond to the child's discomfort means that the infant is left in a helpless and unpleasant feeling-state for some period of time. The darkness, originally a neutral stimulus, by association will become a cue to elicit anxiety states. Because the experience of being alone and uncomfortable in the dark is an almost universal experience, fear of the dark in later life is a common, and socially shared, experience. However, other neutral stimuli may acquire similar significance in individual situations. If the infant were exposed to the sound of a radio playing in an adjoining room, during the period of abandonment, in later life the individual might experience anxiety when exposed to the sound of a radio or television.

## The Spread of Anxiety

In addition, the individual might generalize along conceptual (symbolic) lines and develop anxiety reactions to objects or situations associated with radios. Thus, the individual might experience anxiety in a movie theater, a car, or a concert. The relationship between these fears and the original conditioned stimulus would appear quite remote to the outside observer.

It is well-known that some anxiety reactions have a characteristic tendency to spread over time (Salzman, 1973). This spread may occur in two ways: an anxiety-evoking stimulus may come to elicit more affect than previously and the range of cues which elicit an anxiety reaction may increase.

The spread of anxiety may be accounted for by conditioning through reflective thought. When an individual perceives that a neutral stimulus is conceptually associated with an anxiety-provoking stimulus the two concepts are associated in the presence of anxiety evoked by the latter. The previously neutral stimulus, acquires the attribute of evoking anxiety by conditioning.

The more often an anxiety-evoking concept is attended to, the more often the individual will experience an anxiety response. The individual is, therefore, reinforced by anxiety-reduction for shifting focal attention away from anxiety-evoking memories. It is probable that the individual's style of concept formation is influenced by this factor. If a stimulus is not adequately attended-to it cannot be fully processed. Concepts which arouse anxiety will tend to form less rich associations than those which do not arouse anxiety. This has important implications for school learning.

A factor contributing to school failure is the student's inability to learn in a sufficiently meaningful way. In these students school experiences are not integrated into an increasingly rich academic cognitive structure but are stored in disconnected, skeletal compartments. The view set forth here suggests that this type of school failure may be traced to cognitive avoidance responses to aspects of the school situation which evoke anxiety and prevent the student from fully attending to school experiences. This notion is consistent with Spielberger's (1966a) findings relating anxiety to academic failure.

The school environment is a complex social system which is of major importance in the reinforcement history of the child and, therefore, is a potent force in the connotative structures the child develops in the context of school. The fact that the child is part of a peer group whose social approval is deeply important and is under

the constant scrutiny of an authoratative adult makes the school environment a highly potent source of social reinforcement. Few individuals cannot recall a number of school-linked experiences which affected them deeply. Because the school environment is so potent, anxiety responses learned in the early grades may affect the acquisition of appropriate learning strategies and produce lasting patterns of maladaptive school behavior. For example, a child who is disliked by her first grade teacher may tend to develop strong anxiety feelings associated with the concept "teacher". Such an individual is unlikely to develop good relationships with teachers in the future because every subsequent teacher, by definition, will be an anxiety-provoking stimulus.

Anxiety Reducing Behaviors

Defense behaviors are behaviors which function to reduce anxiety states (Spielberger, 1972). Many defenses are attentional because a stimulus not attended to cannot sustain an anxiety reaction. Many defense behaviors are habits that are conditioned by anxiety reduction (Dollard and Miller, 1950); since a behavior which effects anxiety reduction will be reinforced, it may become habitually evoked by anxiety cues.

One of Dollard and Miller's most important contributions to the construct of anxiety was their recognition of the fact that anxiety arousal involved elements which could function as cues to elicit operant responses. This notion has been incorporated in Spielberger's (1972) model and is related to Schacter's (1964) investigations of affect labeling.

Worry and Emotionality

It has long been recognized that anxiety has both physiological and cognitive components. A number of theorists have suggested that the physiological responses are the primary cues that permit the individual to recognize anxiety; this notion may be traced back to the James-Lange theory of emotion. More recently Schacter (1964) has presented evidence for a two factor theory of emotion. Liebert and

Morris (1967) have developed research scales to measure the worry and emotionality components of anxiety.

The distinction between emotionality and worry is both intuitively satisfying and theoretically consistent with the view presented here. An individual describing an acute anxiety experience is apt to characterize its onset as a "sudden icyness". This feeling appears to occur immediately following perception of an anxiety-provoking stimulus and before cognitive appraisal of the stimulus situation really occurs. This pattern is especially dramatic in the case of extreme phobic anxiety reactions in which a person may experience so rapid and strong a physiological reaction as to become faint upon exposure to an objectively harmless stimulus (such as seeing another person injured).

The primacy of the emotionality component of anxiety follows from its nature as a conditioned response. It has been pointed out that anxiety may be regarded as redintigrated physical discomfort. Classical conditioning is the learning of physiological responses to a previously neutral stimulus through association with a stimulus which already

The formulations reviewed above suggest that the individual's first reaction to an anxiety-provoking stimulus may be physiological. At low levels of anxiety this probably results in an elevation of arousal level and generally increased alertness and vigilence. If the level of arousal is low, the increased alertness and vigilence will tend to improve performance; this factor explains why researchers have consistently found that low levels of anxiety enhance performance--particularly on simple tasks (Spence, 1968).

As the level of anxiety increases, the individual's heightened emotionality becomes more attention-demanding and because of its unpleasurable character will elicit behaviors which, in the past, have been reinforced by anxiety reduction. Some defense behaviors are physiological and are antagonistic to the anxiety response; thus, the individual may attempt to relax skeletal muscles, or may attempt to reduce heartrate by deep breathing. Young children may suck on their thumb which probably elicits food-related somatic responses.

Cognitive defense behaviors attempt to divert the individual's attention from the threatening aspects of the stimulus situation. If the stimulus is not sufficiently attention-compelling this may be accomplished but the individual may lose the opportunity to fully process all aspects of the stimulus configuration.

Some common defenses may be interpreted as shifts in attentional focus. The obsessive defense (Salzman, 1973) may be explained in attentional terms as may repression (Fischer, 1970). However, not all cognitive behaviors elicited by anxiety reduce the attention focused on the anxiety-provoking stimulus situation.

If habitual defense behaviors are inadequate to effect a decrease in anxiety behaviors, the individual will need to allocate attention to evaluating the nature of the threat and determining what behaviors will reduce it. This may be a difficult problem to solve since the individual may not be aware of the cause of the anxiety. The anxious individual will seek to account for his anxiety reactions. As Schacter's (1964) research has so vividly demonstrated, the labels that people use to explain their affective reactions may not be accurate.

In the case of test-anxiety, many of the evaluative thoughts appear to be personalized and self-deprecatory (Wine, 1971; I. Sarason, 1972). This is not surprising considering that the most obvious threat in the testing situation is the evaluation, by authority, of intellectual inadequacy.

# CHAPTER II

## THE RELATIONSHIP AMONG ANXIETY, ATTENTION, AND SHORT-TERM MEMORY

The construct of anxiety was discussed in Chapter I from the perspectives of a number of theorists who have contributed significantly to its description. When the complementary aspects of the various theories are viewed as contributing to a unified description of anxiety, a reasonably comprehensive formulation emerges.

One aspect of anxiety which has been an implicit component of all the theories reviewed, is the notion that the occurrence of an anxiety reaction affects the way that the individual attends to the environment. The relationship between anxiety and attention has recently been the subject of considerable interest among researchers (Wine, 1971; I. Sarason, 1972).

The current study investigated the hypothesis that anxiety, through its influence on attention, impairs rehearsal in short-term memory. In this chapter, the research evidence which supported the formulation of the hypothesis is reviewed.

### Attention

Attention is a construct whose importance in learning is well understood. Children are exhorted to "pay attention" to their lessons in order to learn. Much the same idea was expressed in 400 B.C. when orators were told that "if you pay attention the judgement will better perceive the things going through it", (Norman, 1969a, p. 1). William James (1890) said that "an object once attended to will remain in the memory whilst one inattentively allowed to pass will leave no traces behind".

Although attention is an important part of everyday experience, it fell out of favor among psychologists in the second third of this

century (Murray, 1974). According to Kahneman (1973) this decline in interest was the result of the pre-eminence of the Gestalt and Behaviorist schools. Attention, with its connotations of volition and purpose, was too "mentalistic" for American Behaviorism while the Gestaltists were more concerned with finding simple rules of perception. To both schools of psychology, attention was an unnecessary and unwanted construct.

Attention re-emerged in England with Mackworth's (1961) classic studies in vigilance and in America with Cherry's (1953) paper on the "cocktail party problem." The development of information processing approaches to psychology and, in particular, the information processing models of attention developed by Broadbent (1958) and Triesman (1964) have spurred research in attention.

Although William James felt that "every one knows what attention is," there has been considerable debate regarding its dimensions. This debate stems from the fact that attention is a multidimensional construct which reflects a system of complex, interactive cognitive processes. Posner and Boies (1971) have suggested that attention be considered as having three distinct but related components: alertness, selectivity, and processing capacity.

Although all theorists would not accept this taxonomy as complete, it provides a useful structure for the discussion which follows. Accordingly, each of the components is discussed below.

## Alertness

The alertness component of attention has been investigated through studies of vigilance. Vigilance refers to a state of readiness in which an organism is alert to the occurrence of novel stimuli. Mackworth (1961) investigated vigilance by means of a special clock which had a hand that occasionally advanced two units in one jump. The subject was required to indicate the occurrence of a double jump by depressing a response key. Mackworth found that the number of errors increased with the time that the subject spent on the task. After about 30 minutes, adult subjects began to make many more errors. Adults became habituated

more easily than children but Mackworth found that re-orienting the subject to the task decreased the error rate. Maximal alertness is attained when individuals receive a warning to prepare for an oncoming stimulus (Posner and Boies, 1971).

Closely tied to the concept of alertness or vigilance, is the much-studied orienting response. The orienting response (also called the orienting reaction or orienting reflex) was first studied by Pavlov who became interested in it as an element of his conditioning studies.

The orienting reaction is a complex physiological response to the introduction of novel stimuli into the environment. Its components include sensory orientation toward the stimulus. Physiological reactions include: dilation of the blood vessels in the head, constriction of the peripheral blood vessels, changes in EEG, muscle tone, heart rate, and respiration.

The orienting reaction thus prepares the organism to receive and react to novel stimuli. The orienting reaction is dominant when it occurs simultaneously with a stimulus (such as sudden immersion of a hand in hot water) which would normally produce an antagonistic physiological reaction (Kahneman, 1973).

The orienting reaction habituates over time. Uno and Grings (1965) found that when a subject was exposed to a sequence of three tones, a strong GSR was elicited by the first and second tones but by the third tone, GSR was greatly reduced. The results of the Uno and Grings experiment and similar studies support the idea that the orienting response is related to expectation on the part of the organism; a pattern that is interrupted will elicit an orienting response while stimuli that are anticipated will not.

## Selectivity

The notion of alertness is closely related to the notion of selectivity. Individuals select aspects of the environment to attend to; the orienting response is a highly adaptive mechanism which ensures that novel stimuli of potential importance to the organism's survival will not be ignored. Interest in selective attention was spurred by

Cherry's (1953) investigation of the "cocktail party problem."

The cocktail party phenomenon is a familiar one to most people. A person standing in a large room is able to separate conversation directed at him from the babble of voices composed of many irrelevant comments. The problem of how the individual manages to attenuate the undesirable signals and focus upon the personally-relevant signal was investigated by Cherry (1953) and Cherry and Taylor (1954).

Cherry used shadowing tasks in which the subject was required to shadow (reproduce) an aural message. Shadowing tasks differ from monitoring tasks such as those used in experiments of vigilance in that the subject in a shadowing task is required to repeat every word. Shadowing tasks normally use dichotic presentation methods in which the message to be shadowed is presented to one ear while an interfering message is presented to the other.

Cherry found that subjects were aware of the interfering message but could not reproduce its content. In one experiment (Cherry, 1953) the interfering message was changed from English to German but the subjects were unaware of the switch.

The ease with which a subject can shadow a message depends upon the type of material being shadowed. Technical material is more difficult to shadow than prose and random words are harder than both; nonsense syllables are the most difficult to shadow (Norman, 1969a). Thus, meaning is an important element in shadowing as is grammatical structure.

Shadowing tasks are more difficult than monitoring tasks. The ability of a subject to respond to a target word ("press the response key when you hear the name of an animal") is not disturbed by the presence of an irrelevant message (Ninio and Kahneman, 1973). A monitoring task which is part of the cocktail party problem is the familiar sensation of hearing one's name in the midst of a babble of voices. Evidently, at least enough processing of the rejected message takes place to allow recognition of a critical phonemic sequence and initiate an orienting response.

Processing Capacity

The hypothesis that attentional capacity varies with the individual's level of arousal is in accord with common sense notions of attention. In a relaxed state, the individual cannot pay close attention to stimuli; as the demands on attention increase, the individual's arousal increases as well.

Kahneman (1973) reviewed a series of split-span experiments conducted by Broadbent in the mid-1950's, in which the subjects were required to process two inputs simultaneously on different sensory channels (dichotic or aural-visual separation). When the stimulus rate exceeded one stimulus pair per second, subjects tended to group the inputs by channel or modality. It is interesting to note that the split-span phenomenon was known to 19th century astronomers because it caused confounding of their measurements and was discussed by James (1890) as the "law of prior entry."

Although individuals are able perform adequately in many tasks of divided attention, there are also situations in which the division of attention between messages becomes impossible. Mowbray (1953) found that subjects could not read a prose passage while listening to a different passage even when they attempted to divide their attention between the two. Other experimenters have found tasks in which divided attention was not possible.

According to Kahneman, "an even distribution of attention among concurrent activities is possible only at a low level of total effort. When total effort is high, one of the activities typically draws most of the attention leaving little room for the others ...[this]... implies that attention is divisable at low levels and more nearly unitary at high levels of effort" (1973, p. 149).

Considerable research evidence exists to suggest that at high levels of arousal the allocation of attention becomes concentrated on the dominant aspects of the stimulus situation at the expense of peripheral aspects (Easterbrook, 1959).

The increased focalization of attention at high levels of arousal is a commonly observed phenomenon. A person absorbed in intense activity may fail to process task-irrelevant cues. Thus, a driver, negotiating a difficult road, may ignore the conversation of her passengers. Generally, the increased focalization of attention at high levels of arousal facilitates completion of the task. However, under certain circumstances, the increased focalization accompanying arousal may reduce the individual's ability to complete the task.

In particular, there are three situations in which increased focalization may impair task performance (Kahneman, 1973):

1. When the task is complex and successful performance requires that attention be deployed over a wide range of cues.
2. When the task requires that the individual make fine discriminations in order to determine which cues are relevant. High arousal tends to impair fine discrimination and results in reduced ability to focus on relevant cues.
3. When the nature of the task requires divided rather than unitary attention.

The first two situations (tasks requiring a wide range of cue processing and tasks requiring fine discriminations) are characteristic of many academic problem-solving tasks. This suggests that if anxiety produces high levels of arousal, academic performance will tend to be impaired. Additionally, since high test anxiety appears to result in alternation of focal attention between task-relevant and anxiety-related cues, the third situation (divided attention at high levels of arousal) will serve to further disrupt performance.

The relationship between arousal level and task performance was the subject of a recent review (Broverman, Klaiber, Vogel, and Kobayashi, 1974). This review covered two classes of tasks: serially repetitive overlearned tasks and perceptual restructuring tasks.

Serially repetitive overlearned tasks are tasks which require that established chains of responses be made to serially repetitive stimuli. Broverman and his co-workers noted that "short-term stress should tend to enhance the maintenance of a narrow, well-focused, attention, thereby enhancing performance of tasks that do not require major response modification, utilization of novel cues, or change in set ...", (1974, p. 673). Facilitating effects of arousal have been observed in such tasks as: color naming, card sorting, simple addition, visual counting, and eyelid conditioning. These results appear to be consistent with the predictions of drive theory (Spence, 1964).

Broverman and his co-workers found that arousal impaired performance on serially repetitive tasks that were not overlearned; these tasks include simple perceptual-motor tasks, verbal learning tasks, and the Minnesota Clerical and Form Board Tests. This effect is apparantly due to the fact that learning is still in process and the learning curve has not yet reached a plateau (Broverman, et. al., 1974). These findings are also consistent with the notion of response competition derived from drive theory (Spence, 1964).

Perceptual restructuring tasks are defined as tasks which require the individual to set aside or inhibit immediate responses to obvious stimulus characteristics in favor of responses to nonobvious stimulus attributes. These tasks are likely to fit the three conditions specified above for which successful performance is likely to be impaired by narrowing of attentional focus.

Broverman and his co-workers noted that the expectation that short-term stress should impair performance on perceptual restructuring tasks has been repeatedly confirmed. "Failure-induced stress" has been reported to impair task performance on: anagrams, scrambled words, mathematical problems, verbal coding, complex mazes, abstract reasoning, and a wide variety of similar tasks. The impaired performance of individuals on tasks of this type has been explained as resulting from rigid set and narrowed attentional focus (Broverman, et. al., 1974).

## The Hypothesized Relationship between Anxiety and Attention

As Liebert and Morris (1967) have noted, anxiety arousal has both a cognitive component and a somatic component. The somatic component, "emotionality," involves arousal, and drive theory has considered anxiety arousal to be equivalent to arousal by stressors such as hunger or thirst (Taylor, 1956). Accordingly, anxiety reactions would be expected to impair task performance due to narrowed attentional focus; numerous studies have confirmed this expectation (Broverman, et.al., 1974; Harlston, 1962; Wine, 1971).

When individuals become anxious during task performance, their level of arousal will tend to increase. Their sub-optimal performance will tend to reinforce their anxiety reaction which will ultimately become attention-compelling itself. The attention-compelling aspect of the anxiety reaction will tend to conflict with the unitary attentional focus characteristic of high arousal and this leads to disorganized patterns of responding.

According to Wine, "the low test anxious person is focused on task-relevant variables while performing tasks. The highly test anxious person is internally focused on self-evaluative, self-deprecatory thinking, and perception of his autonomic responses. Since the difficult tasks on which the test anxious person does poorly require full attention for adequate performance, he cannot perform adequately while dividing his attention between internal cues and task cues" (1970, p. 1).

I. Sarason (1972) published a review in which he reached a similar conclusion. In this review, Sarason noted that "what distinguishes the high test anxious individual are (1) the manner in which he attends to the events of his environment and (2) how he interprets and utilizes the information provided by these events." Sarason noted that the pre-performance variables (e.g. instructions, audience observation) play a crucial role in the way that high anxious persons perform. Evaluative

or achievement-oriented environments seem to have a negative effect on the performance of high-anxious subjects but a positive effect on the performance of low-anxious subjects. Sarason argued that low-anxious people in an achievement-oriented condition would be motivated to perform at high levels and tend to focus their attention more fully on the task at hand. In contrast, high-anxious people would tend to personalize the achievement-oriented situation and (1) neglect or misinterpret information cues that may be readily available or (2) experience attentional blocks.

The research literature which relates increased arousal to reduced width of attentional focus has previously been discussed (Broverman et. al., 1974; Easterbrook, 1959). Following is a review of the key studies which support the hypothesis of attentional alternation. As noted, reviews of this issue have been published by Wine (1971) and I. Sarason (1972).

The Alternation Hypothesis*

In a review of the relationship between scores on anxiety scales and scores on other questionnaire measures of personality, I. Sarason (1960) reported that persons who scored high on anxiety scales tended to describe themselves in self-deprecatory terms on other personality inventories. According to I. Sarason, "low scoring Ss may react to ... [threat] ... with increased effort and attention to the task at hand, high scoring Ss respond to threat with self-oriented personalizing responses" (1960, p.405).

In an experimental study, Doris and S. Sarason (1955), found that when subjects were arbitrarily failed on a number of tasks and were required to rank order statements which included "self-blame" and "other-than-self" blame items, anxious individuals blamed themselves for their failures significantly more than did their less anxious counterparts. Trapp and Kausler (1958) investigated performance and level of aspiration of high and low test anxious individuals on the

*This section generally follows Wine's (1971) review.

Wechsler-Bellvue digit-symbol subtest. Though the performance of the high and low groups did not differ, the level of aspiration of high-anxious subjects degraded over four trials. Even though high-anxious subjects performed as well as low-anxious subjects, the high-anxious Ss became more pessimistic about their future performance over the four trials. Similar results were reported by Meunier and Rule (1967) who investigated the effects of positive, negative and no-feedback on subjects' confidence concerning their judgment of the length of lines. On negative and no-feedback trials, highly test anxious subjects rated their confidence level as low. In contrast, low test anxious subjects expressed high confidence in their judgment on no-feedback trials.

Wine (1970) cited three studies (I. Sarason and Koenig, 1965; I. Sarason and Ganzer, 1962, 1963) in which subjects were required to describe themselves orally for approximately one-half hour. Non-reinforcement, reinforcement of negative self-references, and reinforcement of positive self-references were compared. Wine summarized these findings noting that: "(a) Regardless of experimental condition, highly test anxious subjects generally describe themselves in more negative terms than do low test anxious subjects. (b) High test anxious subjects are extremely responsive to reinforcement when the response class being reinforced is negative self-references. (c) However, when the response class being reinforced is positive self-references, high-anxious subjects do not produce more positive self-references as a result of verbal reinforcement" (1971, p. 94).

Following a series of tasks, Mandler and Watson (1966) administered a questionnaire to extreme low and high anxiety groups. Subjects responded to the question, "How often during the testing did you find yourself thinking how well, or how badly you seemed to be doing?", on a 10 point rating scale. High test anxious subjects indicated markedly greater occurrence of such thoughts than did the low test anxious group. In addition, high-anxious subjects engaged in more social comparison than low-anxious subjects. Neale and Katahn (1968) reported identical

results on this questionnaire item. In a similar study (Marlett and Watson, 1968), ninth grade boys were arbitrarily failed for twelve trials on a button-pressing task. The subjects responded to the question, "How often did you think about how well or badly you were doing?" High test anxious subjects indicated that they were significantly more disturbed by such self-focused thoughts.

Ganzer (1968) investigated the effects of audience presence and test anxiety on serial verbal learning and found that high TAS scorers emitted more task-irrelevant comments than any other group, and that most of these comments were self-evaluative or apologetic.

The studies cited above suggest that the test anxious person tends to become negatively self-focused under conditions of anxiety arousal and this self-preoccupation will tend to interfere with task-focused attention.

## The Hypothesized Effect of Anxiety on Short-Term Memory

The normal human adult can easily repeat a list of from five to nine arbitrary digits, letters, or monosyllabic words. The storage medium for this data has been called short-term (or primary) memory. Primary memory is used both for the storage of auditory stimuli and for the storage of information recoded from visual input (Neisser, 1967). It has been hypothesized that all information to be stored in secondary (long-term) memory must first pass through a primary memory stage (Neisser, 1967; Norman, 1969a).

Miller (1956), in a comprehensive review of the literature, noted that the average adult could store seven arbitrary verbal symbols. Strings of longer length could be stored if they were encoded ("chunked") into more inclusive cognitive units. It is normally most efficient to chunk data into the largest meaningful groupings. Thus, a meaningful symbol such as NBC, Ph.D., or CAT can be stored as a single chunk while a non-meaningful symbol such as XQM must be stored as three arbitrary

verbal words ( ex - queue - em). Even arbitrary lists, however, are subject to reformulation into rhythmic clusters or groups (Neisser, 1967).

The notion of rehearsal in primary memory is due to Brown (1958) and has been explicated by Sperling (1967). According to Sperling (1967), rehearsal may be conceptualized as a form of "inner speech" (cf. Vygotsky, 1934) which protects data in primary memory from decay. In addition, rehearsal is postulated to facilitate (or even cause) the transfer of data to secondary memory. Norman (1969a) points out that very little is known about rehearsal except that it is facilitating (if not essential) to the learning of verbal material. Rehearsal is closely related to speech; mistakes in retention often bear acoustical relation to the correct item even if the item was presented visually (Norman, 1969a). This implies the existence of an auditory encoding process which is applied to visual material.

It is clear, however, that rehearsal is closely linked to attention. According to Norman:

> [One may note] the similarity of conditions that are known to disrupt rehearsal and conditions which disrupt the amount of attention which can be given to a task. In fact, rehearsal of material is sometimes equated to the attention one pays to the material. Anything which interferes with that attention also interferes with rehearsal. The same variables, types of tasks, and theories which one applies to attention appear to be relevant to rehearsal as well (1969a, p. 69).

Norman's argument equating attention with rehearsal suggests that the attentional aspects of anxiety (narrow focus and alternation) would affect short-term memory processing.

Tobias (1977) has developed an information-processing model to clarify the relationship between anxiety and stages of cognitive processing. He noted that "Anxiety does <u>not</u> generally affect instructional outcomes directly. Instead, anxiety affects the cognitive processes required by the instructional methods, and these, in turn, affect outcomes indirectly...anxiety may affect output in three ways...prior to processing, during processing, and after processing has been completed" (1977, p. 225). The focus of the current study is the effect of

anxiety during processing; after input has been registered and during time when the individual is rehearsing the input to maintain its stability.

The Interference Hypothesis

When anxious subjects are asked to verbalize their thoughts, a significant quantity of self-deprecatory, worried thoughts emerge (I. Sarason, 1960, 1972; Wine, 1971). The alternation hypothesis posits that such thoughts are evoked on a sub-verbal level when the anxious person is engaged in task performance. These thoughts need not be conceptualized as silent vocalization. Vygotsky, in his classic analysis of the relationship between language and thought concluded that "Inner speech is not the interior aspect of external speech -- it is a function in itself. It still remains speech, i.e., thought connected with words ... [But] ... it is a dynamic shifting unstable thing", (1934, p. 149).

Although inner speech is silent, it can be quite compelling. According to Neisser "... attention can be withdrawn from every external channel and focused on the subject's own train of thought ... inner speech is necessarily attention-compelling ... [external] input ... remains 'unheard' like the irrelevant message in a shadowing experiment". (1967, pp. 214-215).

The hypothesis investigated in the current study was that anxiety, because of its influence on focal attention, would reduce the effectiveness of the individual's short-term memory processing. The interference is hypothesized because task data in short-term memory would not be rehearsed during periods of inward attentional focus. Personalized thoughts would compete with task relevant data for processing capacity and attention paid to inner speech would dominate over other input channels causing the premature decay of task-relevant information. Furthermore, the intrusion of personalized thoughts would conflict with the increased attentional focalization characteristic of high levels of arousal.

Interference from a Rejected Channel

Fundamental to the interference hypothesis being advanced, is the assumption that stimuli from a rejected channel contact memory. If this were not the case, an anxious person might filter-out the task-irrelevant thoughts before they affected memory processing. However, research evidence suggests that irrelevant stimuli do contact memory.

Lewis (1970) demonstrated that an ignored message in a shadowing task reaches memory. Using dichotic presentation techniques, Lewis found that shadowing performance degrades when a synonym to a shadowed word is presented on the rejected ear. In order for shadowing latency to have increased, both the relevant and irrelevant word must have been processed and the semantic equivalence noted. Kahneman (1973) noted that under some circumstances, the rejected message will trigger an orienting response and will thus impinge upon consciousness.

The well-known Stroop phenomenon provides additional support for the idea that irrelevant information reaches memory. Stroop (1935) devised an interference task in which the subject is required to name the colors in which a set of words is printed. The words, however, are color words which do not correspond to the color of the ink used. For example, the subject might see the word red printed in green ink. The correct response would be "green". Since subjects have a great deal of difficulty in filtering out the irrelevant information, the semantic content of the word must be decoded prior to rejection. Keele (1972) investigated the Stroop phenomenon using tachistiscopic presentation of the color words. Colors of ink were associated with response keys and reaction time latencies were noted. Key presses were used in preference to verbal responses in order to determine if response competition rather than output interference is the delaying factor. Using a repeated measures design, Keele found that reaction time was significantly increased when subjects were responding to color words. No differences were obtained when non-semantic forms, scrambled color words, or non-color words were used.

It has been pointed out that memory for a rejected message in a dichotic shadowing task is minimal. Cherry (1953) reported that subjects were not aware when a message presented to the rejected ear switched from English to German. Moray (1959) has shown that even

with multiple presentations of words to the rejected ear, subjects do not retain them. However, Norman (1969b) using a dichotic shadowing technique interrupted subjects and tested them for memory of the items which had been presented immediately prior to the interruption. Norman found that the subjects exhibited temporary memory for the rejected message although there was no long term storage of it. Norman (1969a) has called this the "what-did-you-say" phenomenon. When a person is not attending to a question, the first reaction is to ask "what did you say?" But, before the question is repeated, the listener retrives it from memory.

Thus, there is considerable evidence to support the notion that information on a rejected channel is not simply filtered-out but reaches memory. In general, focal attention is deployed so as to minimize the amount of processing capacity allocated to a rejected message. If the allocated capacity is insufficient to deal with the rejected message, an orienting reflex occurs forcing attentional redeployment.

## The Effect of Rehearsal Disruption on Short-Term Memory

An implicit assumption of the current hypothesis is that the self-deprecatory thoughts of high anxious persons are sufficiently similar to the inner speech used for rehearsal (Brown, 1958) to compete with it and hence allow premature decay of relevant information in short-term memory. If primary memory had an unlimited capacity for rehearsal, the irrelevant thoughts would not pose a problem. It is therefore necessary to show that the division of attention between two tasks will tend to reduce the amount of data which can be held in short-term memory.

Murdock (1965) hypothesized that if short-term memory operated in accordance with a limited capacity mechanism, a subsidiary task should decrease retention. A study by Broadbent and Heron (1962) had revealed that performance on a primary task varied with memory load on a subsidiary task; Murdock's (1965) study was intended as a further test of the limited capacity hypothesis. Murdock performed two experiments to test the hypothesis.

In the first experiment, subjects were presented with 20 two-syllable words at a rate of one word/second. Subjects were able to recall 7.4 words on the average in a free recall task. A subsidiary task was then introduced in which subjects were required to sort a deck of cards according to one of three rules. In the plain condition subjects merely dealt out cards; in the color condition subjects sorted the cards into red and black; while in the suit condition subjects sorted the cards into their respective suits.

Although in the absence of the subsidiary task, the subjects had been able to recall 7.4 words, free recall dropped to 5.82 words, 4.65 words, and 4.35 words in the plain, color, and suit conditions respectively. Thus, Murdock's results indicate that the difficulty of a subsidiary task inversely affects free recall.

In the second experiment, Murdock instructed the subjects to concentrate on the card sorting or free recall tasks. As predicted, directing the subject's attention to one of the tasks improved performance on the attended-to task at the expense of the other. Murdock's explanation of these results is compatible with the current hypothesis: "One possibility is ... that the subsidiary task prevents rehearsal ... [which] is necessary to prevent decay. The more demanding the subsidiary task or the more attention given it, the more effectively is rehearsal prevented", (1965, p. 418).

Broadbent and Heron (1962) used an ingenious technique to distinguish between data which decayed while in primary memory and data which failed to reach primary memory. Subjects were presented with sheets of paper on which a series of random digits were printed. A cardboard overlay with a window prevented the subject from seeing more than one digit at a time. Subjects were required to respond to every occurrence of a target digit. For example, the subject might be asked to cross out every "2" encountered. A new target digit might be embedded in the list and was indicated by a circle. When a circled digit was encountered, the subject was to begin searching for an occurrence of the new target. For example, the subject might be crossing out every 2 but upon encountering a 6 was instructed to begin

crossing out every occurrence of a 6. Because of the slot in the overlay, the subjects could not refresh their memory with regard to the current digit.

Broadbent and Heron found that in some instances, a subject would make some correct responses after encountering a circled digit but later had entered a series of errors. These errors could not result from the subject's having failed to note the circled digits (else there would not have been the initial correct responses) but from having forgotten which digit to check for. The incidence of these errors was significantly increased by distraction. The major findings were that: (1) no significant difference in speed was observed in a no-memory task without distraction; (2) the type of error ("circle forgotten") described above was significantly increased by distraction; (3) distraction slowed performance on the short-term memory task. According to the authors, "search for a signal when the subject has to remember which signal is required is likely to be affected by a distraction task ... continuous tasks which involve even a slight load on memory are very vulnerable to distraction when compared with similar tasks which avoid this load ... results emphasize the importance of rehearsal as a possible means of combatting interference" (Broadbent and Heron, 1962).

Posner and Rossman described a series of experiments which are consistent with the idea that "retention in short-term memory is an active process which is extremely liable to disruption" (1965, p. 503). Posner and Rossman noted that although rehearsal requires a portion of central capacity and that a task which demands the attention of the subject is said to 'prevent rehearsal', the degree to which attentional demands block rehearsal varies with the nature of the task. They concluded that individuals have "a limited capacity for information processing. The rehearsal process requires a part of this capacity and can co-exist to a greater degree with tasks which require a small amount of this capacity than with those requiring a larger amount" (1965, p. 504).

Previous Research Relating Anxiety to Short-Term Memory

A number of investigators have investigated aspects of the relationship between anxiety arousal and short-term memory processes. Sieber, Kameya, and Paulson (1970) studied memory errors and performance errors in children as a function of test anxiety level and memory support, in a puzzle and a concept-formation task. They found that anxiety interfered with short-term memory, and memory support reduced the performance differences between high and low anxious children.

Sandison and Burgess (1971) failed to find differences between high and low anxious individuals in retention of lists of 16 single digits. The digits were presented aurally and the probe digit technique used to measure short-term retention. However, very few subjects participated in the experiment (N=18) and these were selected on the basis of extreme scores on the Achievement Anxiety Test (Alpert and Haber, 1960). No stress induction procedure was employed so it is not clear to what extent the high anxiety group was actually experiencing anxiety.

Borkowski and Mann (1968) selected high anxious and low anxious students on the basis of the MAS. Presenting lists of CCCC's which were designed to produce inter-item interference, they fould that low anxious students performed somewhat better than high anxious students overall. Zubrzycki and Borkowski (1973) suggested that the effect of anxiety on short-term memory might be localized to the trace formation stage of short-term memory rather than in the process of retrieval.

Performance on the Digit Span subtest of the Wechsler Intelligence Scale has been assumed to reflect anxiety as well as intelligence (Walker and Spence, 1964). Moldawsky and Moldawsky (1952) reported a significant relationship between experimentally induced anxiety and Digit Span performance. Calvin, Koons, Bingham and Fink (1955) found significant relationships between scores on the Manifest Anxiety Scale and Digit Span performance; Walker and Spence (1964) found significant correlations between Digit Span and both MAS and TAQ scores. Hodges and Spielberger (1969) found that state anxiety (measured by the

Zuckerman Adjective Check List) was related to Digit Span performance but failed to find a relationship with MAS score.

Leherissy, O'Neil, Heinrich and Hansen (1971) investigated the effects of memory support on learning in a computer-assisted instruction task. The instructional task consisted of a difficult tutorial lesson on the field properties of complex numbers. Students in the memory support condition were provided with a list of their previous errors while students in the control condition were not given memory support. High-anxious students given memory support made significantly fewer errors than did high-anxious students without memory support. Memory support did not improve the performance of low and medium anxious students. Overall, high-anxious students made more errors than their low- and medium-anxious peers.

Deffenbacher (1978) tested the attentional alternation theory using performance on an anagrams task under conditions of high and low-stress. Subjects were divided into high-anxious and low-anxious groups on the basis of TAS score (high-anxious >20, low-anxious <12). High-anxious individuals in the high-stress condition solved significantly fewer anagrams than high-anxious individuals in the low-stress condition ( $\bar{x}$ = 3.29 vs. $\bar{x}$ = 5.65). High-anxious individuals indicated that they were more distracted by anxiety-related interference than low-anxious individuals with the greatest interference occurring in the high-anxiety-high-stress group. Although both worry and emotionality scores were related to interference, worry appeared a more important factor than emotionality.

## Current Study

The current study investigated the hypothesis that anxiety would impair short-term memory performance. It differed from preceeding studies in the following ways:

1. Both a neutral (low stress) and a testlike (high stress) condition were incorporated into the experimental design.
2. Both trait anxiety and state anxiety measures were employed.

3. Two control (meaningful string) trials were included to make certain that all subjects were attentionally focusing on the to-be-remembered stimuli.
4. An interpolated-distractor-task paradigm was used to control rehearsal.

The specific hypotheses investigated by the current study are:

1. When presented with to-be-recalled strings consisting of seven consonants followed by an interpolated arithmetic task, high anxious individuals will recall fewer letters than low anxious individuals.
2. The effect of anxiety on recall will be greater in a test-like (high-stress) condition than in a non-test-like (low-stress) condition.
3. Individuals in the high-stress condition will recall fewer letters than those in the low-stress condition.
4. The effects due to anxiety will be more related to state (situational) than trait anxiety.
5. There will be no differences in the recall of meaningful seven letter words as a function of anxiety.

# CHAPTER III

## METHOD

The main investigation was conducted to test the hypothesis that anxiety would interfere with short-term memory rehearsal.

### Subjects

The subjects for the main experiment consisted of 179 undergraduates from Trenton State College. They were recruited from classes within the Psychology Department and were either paid $2.00 or offered class credit for their participation. No student, present on the day of the experiment, elected not to participate. Twenty-nine protocols had to be discarded because students either failed to complete them during the experiment or it was obvious that the student had not understood the instructions. Complete protocols were therefore available for 150 subjects.[1] Thirty-eight of these subjects were male and 112 were female. The ages of the subjects ranged from 19 to 54; the mean age was 23 years.

### Experimental Groups

Subjects were run in seven groups. Each group was randomly assigned to one of two stress-level conditions: a high-stress condition (N=87) or a low-stress condition (N=63). Subjects in the high-stress condition were led to believe that they were taking an experimental version of a newly developed intelligence test and were asked to perform an initial task that was extremely difficult. Subjects in the low-stress condition were asked to help out in an "educational experiment," and were asked to perform a simple initial task. The purpose of the two conditions was to compare the subjects' behavior under test-like (high

---

[1] Due to a coding error, one subject was excluded from some analyses; therefore, in some cases N=149.

aroused-anxiety) and non-test-like (low aroused-anxiety) conditions. The experimental tasks for both groups were identical. Details of the stress induction procedures are given below.

Experimental Task

The basic task employed in this study was structurally similar to commonly employed "distractor" paradigms for recall in short-term memory. Subjects were shown a to-be-recalled stimulus, performed an interpolated task, and, on presentation of a cue, were asked to write down the to-be-recalled stimulus.

The to-be-recalled stimuli consisted of seven-letter strings. The choice of string length was based on Miller's (1956) hypothesis that seven units of information is the average retention capacity of adult short-term memory, and on the results of a pilot study.

Without rehearsal, data in short-term memory decays completely within 30-40 seconds (Norman, 1969a). Thus, stimulus recall after 40 seconds indicates that rehearsal has been employed; increases in rehearsal produce increases in retention (Murdock, 1965). The task interpolated between string presentation and recall served two functions:

1. To delay the recall attempt for at least 40 seconds.
2. To limit the amount of rehearsal that the subject could devote to the to-be-recalled string. This was intended to accentuate differences in recall as a function of rehearsal.

It was decided that the interpolated task should involve arithmetic manipulation and should be sufficiently attention-compelling to effect a 50% loss in recall under low stress conditions. Various tasks were investigated in a series of pilot studies which are described in Appendix A.

The interpolated task consisted of a series of arithmetic problems of the form 3 + 5 + 13 + 4 = | | which the subjects were to compute mentally. Each problem was displayed for five seconds, followed by a two second blank display during which students were to write down their answer. Following the series of arithmetic problems, a question mark (?) was displayed. The question mark served as a recall cue; on presentation of the question mark, subjects were to write down as many letters

of the to-be-recalled string as they could recall. Depending upon the trial, the interpolated task consisted of either six (trials 1-4) or eight (trials 5-8) arithmetic problems. However, subjects did not know how many problems would be interpolated between presentation and recall and could not anticipate when the recall symbol (?) would appear. Figure 4, illustrates the structure of the basic task.

Meaningful and Arbitrary Strings

The to-be-recalled strings employed were of two types: arbitrary and meaningful. The arbitrary strings consisted of seven distinct consonants. As there are 21 consonants (counting "y") in the alphabet, it was possible to construct three strings of seven consonants, using each consonant once. Two sets of strings were assembled; thus, there were a total of six arbitrary strings with each consonant appearing once in two strings. The six strings were assembled by two judges who agreed that the final letter sequences had minimal associative value; this was important since "chunkable" strings would provide less of a short-term memory load than strings of low associative value and would result in some strings being easier to rehearse than others.

In addition to the six arbitrary strings, two meaningful strings were employed. Like the arbitrary strings, the meaningful strings consisted of seven letters each, with no letter occurring more than once in a given string. Unlike the arbitrary strings, however, the meaningful strings included vowels and formed a common seven-letter word. As the meaningful strings could be coded as a single unit of information, they imposed a smaller short-term memory load than the arbitrary strings.

Trials

The experimental task consisted of eight replications of the basic task using different strings and arithmetic problems. Six of the trials used arbitrary strings while two trials used meaningful strings. The eight trials were divided into two groups of four; between trials four and five, subjects completed a state anxiety scale (WE3).

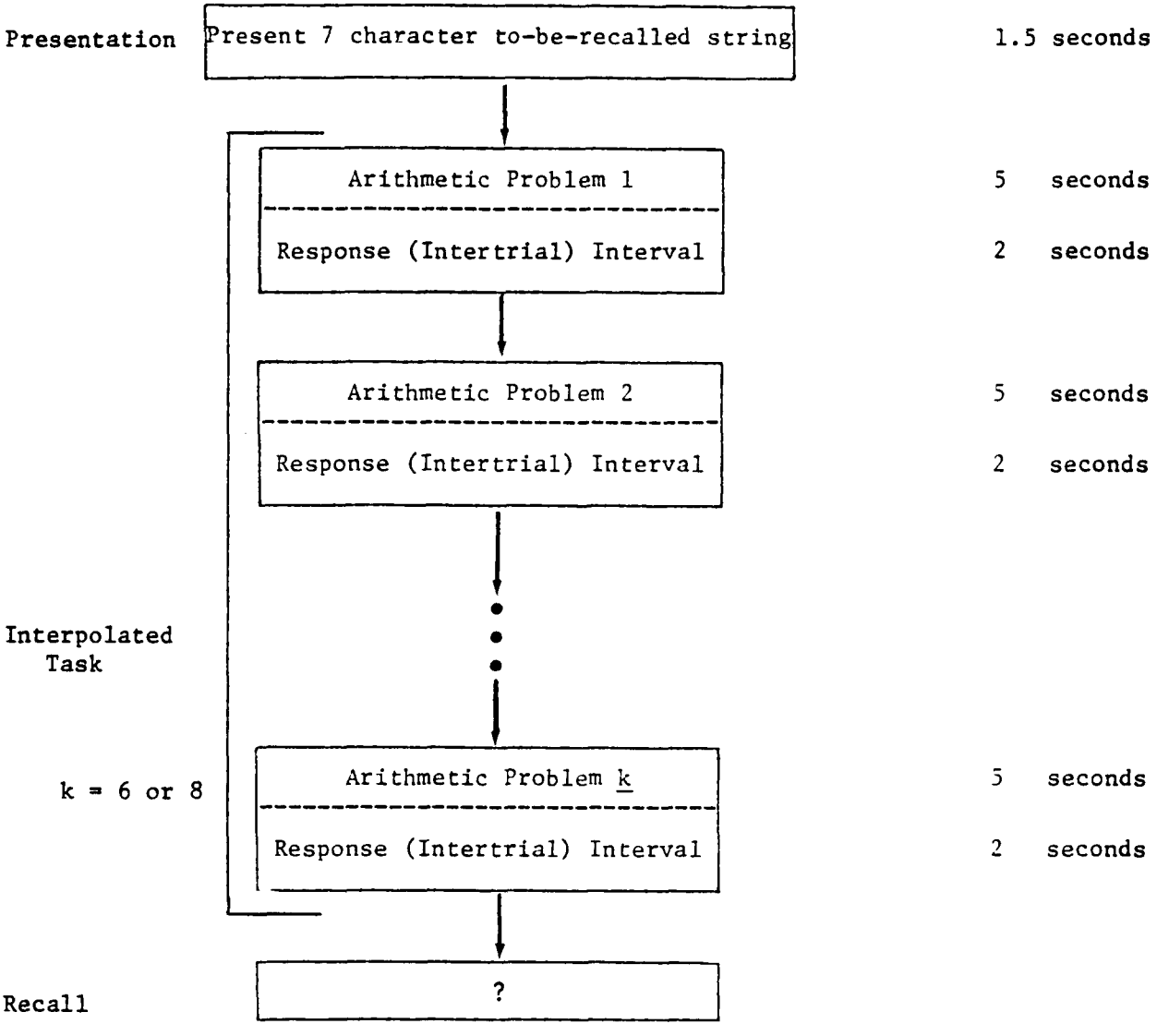



Figure 4. Structure of the Basic Task.

Each group of four trials consisted of three arbitrary strings followed by a meaningful string. The meaningful string was placed at the end of the blocks because it was felt that any other position would compromise the maintenance of stress level. Table 1 shows the eight strings used in the experiment. The order shown in this table was the order generally used; however, some subjects received the blocks in inverted order (5.6,7,8,1,2,3,4) to permit analysis of possible order effects.

As mentioned above, there were six arithmetic interpolated problems for trials 5-8. This was done for two reasons:

1. Varying the number of interpolated problems prevented the subjects from knowing exactly when the recall cue (?) would appear. If the subjects knew how many problems would be interpolated, some anxious subjects might have attempted to "beat" the experiment by writing the to-be-recalled stimulus on the appropriate line, when it was first presented.
2. The pilot studies suggested that stress levels tended to decrease over time as the students became accustomed to the task. The use of eight interpolated problems made the second four trials slightly more difficult than the first four and helped maintain the stress level.

Procedure[1]

During the class period prior to the experiment, the true-false form of the Test Anxiety Scale (I. Sarason, 1972) was administered.

Students were not made aware of the relationship between the TAS and the impending experiment.

On the day of the experiment, students were invited to participate in the study. All students present agreed to participate. The students were then asked to complete the State Worry-Emotionality Scale (WE1) and indicate their expectancy of success (EX1). These measures of state (aroused) anxiety are discussed in the next section.

The students were then asked to assemble in the room where the experiment was to take place. When all students were seated, the

[1]The instructions used in the experiment will be found in Appendix B.

Table 1

Strings Used In The Experimental Task

| Trial | String[a] | Type | Number of Interpolated Problems |
|---|---|---|---|
| 1 | GBNQWRF | arbitrary | 6 |
| 2 | YTCXDVK | arbitrary | 6 |
| 3 | JSLHMZP | arbitrary | 6 |
| 4 | KITCHEN | meaningful | 6 |
| 5 | YGBFSJT | arbitrary | 8 |
| 6 | HCXNQKL | arbitrary | 8 |
| 7 | RVZMDWP | arbitrary | 8 |
| 8 | TADPOLE | meaningful | 8 |

[a]Approximately 25% of the subjects were presented with the strings in the order: 5, 6, 7, 8, 1, 2, 3, 4.

experimental protocols were handed out.

If the group was in the low-stress condition, the stack of booklets was given to the first student of each row and passed back. The booklets were not sealed and had a simple typed cover (see Appendix C for sample).

In the high-stress condition, booklets were individually handed out by a "proctor." The booklets had printed covers which identified them as "experimental editions" of the "National Intelligence Test." Each booklet was sealed and printed on the cover was an admonition not to break the seal until told to do so (see Appendix C for sample). The booklets were plastic wrapped in bundles of ten, and the "proctor" ostentatiously unwrapped them as needed.

When all students had received their booklets, they were asked to perform an initial task. This task was not scored; its purpose was to manipulate the students' anxiety level by creating an initial failure experience (for the high-stress condition) or a mild success experience (for the low-stress condition).

Like the short-term memory tasks used in the recall trials, the initial task required recall of letter strings. It consisted of a series of ten strings which were presented one at a time. Each string was projected for two seconds; this was followed by an eight-second interval during which students were to recall the string from memory.

Although the procedural instructions and examples were the same for the high-stress and low-stress conditions, the strings displayed were different. Subjects in the low-stress condition were shown four-letter strings, such as "PZNF," which were easily memorized. Subjects in the high-stress group were shown ten-letter consonant strings which exceeded their short-term memory span. As these strings were not readily "chunkable," everyone in the high-stress condition performed imperfectly. Thus, the low-stressed subjects had a moderate success experience while the high-stressed subjects had a failure experience.

Following completion of the stress induction (or low-stress control task), the students were asked to fill out the second worry-emotionality and expectancy scales (WE2, EX2).

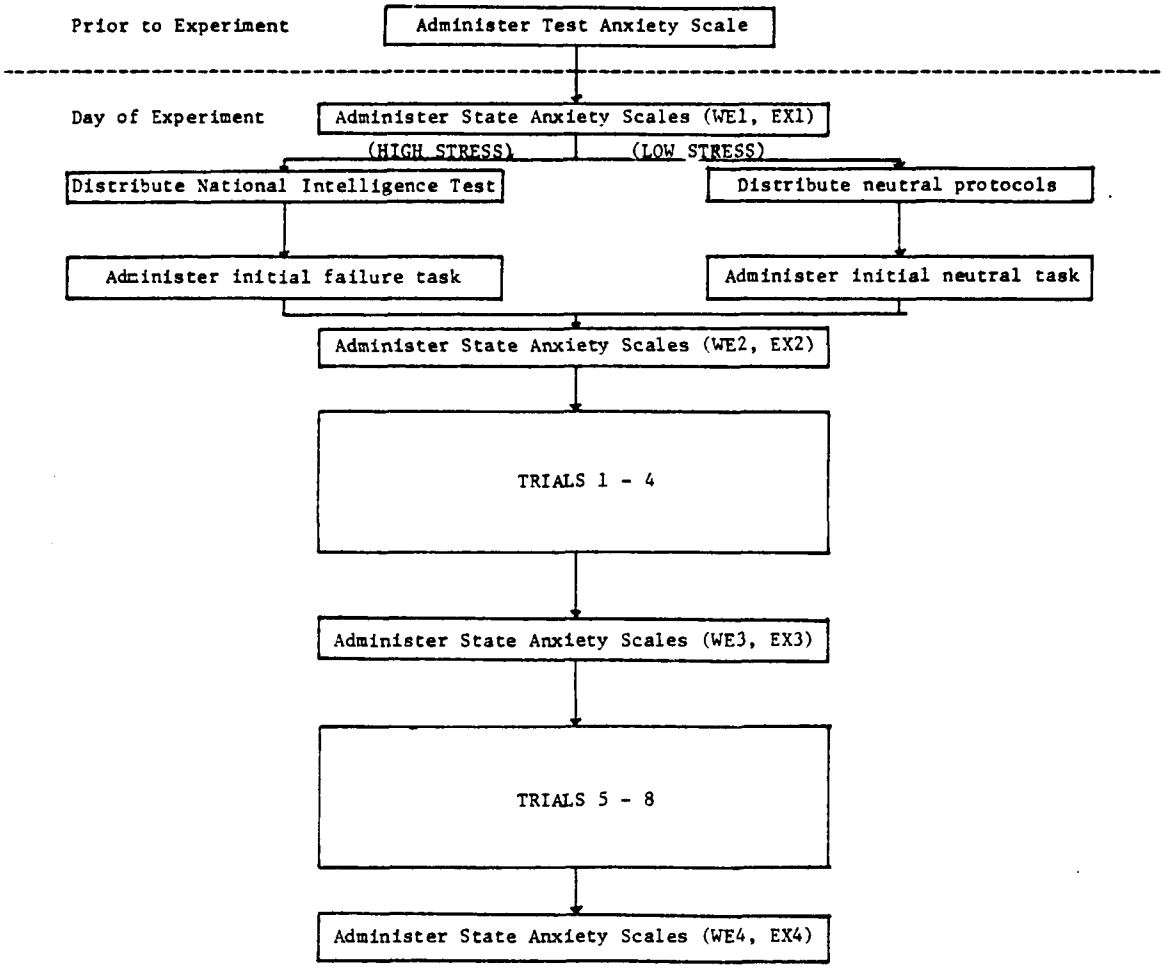



Figure 5. Experimental Procedure

Experimental Trials

Following administration of the initial task, the short-term recall trials were administered. State anxiety measures were administered following trials four and eight. Figure 5 presents the sequence of the procedures followed.

When the last state anxiety measure was completed, the subjects' booklets were collected. Subjects in the stress condition were "debriefed" to remove any residual stress and all subjects were given an explanation of the experimental hypotheses and design; they were requested not to discuss the experiment with future participants.

Anxiety Measures

Three measures of anxiety were used in the experiment. The Test Anxiety Scale (I. Sarason, 1972) is a commonly used measure of "trait" anxiety or anxiety-proneness in an academic testing situation. The State Worry-Emotionality Scale (Richardson, O'Neil, and Grant, 1977) is a measure of aroused anxiety (situational anxiety) developed for experimental situations. In addition, students were asked to rate their expectancy of success (on a scale of 0-10) four times during the course of the experiment. This simple measure has been shown to be related to worry (Morris and Liebert, 1970).

TAS. The Text Anxiety Scale (TAS) is a 37-item true-false measure of tendency toward test anxiety (I. Sarason, 1972). Scores on the TAS range from a low of 0 to a high of 37 with higher scores indicating relatively more anxiety-proneness. The TAS was developed from the original Test Anxiety Questionnaire (TAQ) but avoids the cumbersome and unnecessary "length in centimeters" scoring used in the original TAQ (Levitt, 1967).

Because the TAS is a measure of trait anxiety, it was administered prior to the experiment. To minimize possible student unease about self-disclosure, the TAS was presented as a scale of attitudes to testing rather than as a measure of anxiety. The items were represented

as statements regarding examinations which other students had made; students were asked to endorse those which were representative of their own feelings. The TAS along with the instructions used to administer it may be found in Appendix D.

State Worry/Emotionality. The State Worry/Emotionality Scale is a 10-item scale designed to measure state anxiety in a testing situation. Scores range from a low of 10 to a high of 50. The score may be partitioned into two components: a worry component ranging from 5 to 25, and an emotionality component which also ranges from 5 to 25 (Liebert and Morris, 1967). As shown in Figure 5, the worry/emotionality scale was administered at four points during the experiment: pretreatment (stress induction), postreatment, following the fourth trial (midpoint of experiment), and following the eighth trial (end of experiment). These scores are designated WE1, WE2, WE3, and WE4 respectively. When component scores are reported, they are designated similarly; thus, WE1 = W1 + E1. Two subjects failed to complete the WE4 scale. For purposes of data analysis, the sum of the two state anxiety measures administered during the course of the experiment, WE2 + WE3 was computed. This score reflects the state anxiety aroused during the experiment and is referred to as WE23; its theoretical range is from a low of 20 to a high of 100.

An alternative measure of state anxiety aroused during the experiment could have included WE4 (i.e., WE234 = WE2 + WE3 + WE4). This measure was not used because it was not clear if the anxiety reported at the end of the experiment (WE4) was due entirely to the task itself or if it was confounded by the subjects' retrospective evaluation of their performance. Because of this uncertainty, WE23 appeared to be a more "pure" measure of state anxiety aroused during the experiment.

Expectancy. As a measure of belief as to how well they were performing, students evaluated their expectancy of success at four points during the experiment (immediately after each administration of the worry/emotionality scale). The expectancies were rated on a scale of 0 (certain to fail) to 10 (certain to succeed). Expectancy scores are designated: EX1, EX2, EX3, and EX4.

Table 2

Intercorrelations Among Anxiety Scores

for the Total Sample (N=150)

| | TAS | WE1 | WE2 | WE3 | WE4 | EX1[a] | EX2 | EX3 | EX4 |
|---|---|---|---|---|---|---|---|---|---|
| TAS | 1.00 | .38 | .36 | .44 | .41 | -.46 | -.27 | -.39 | -.28 |
| WE1 | | 1.00 | .55 | .52 | .51 | -.42 | -.20* | -.41 | -.34 |
| WE2 | | | 1.00 | .76 | .73 | -.29 | -.56 | -.46 | -.41 |
| WE3 | | | | 1.00 | .92 | -.35 | -.40 | -.58 | -.52 |
| WE4 | | | | | 1.00 | -.35 | -.42 | -.59 | -.56 |
| EX1 | | | | | | 1.00 | .42 | .52 | .35 |
| EX2 | | | | | | | 1.00 | .58 | .47 |
| EX3 | | | | | | | | 1.00 | .79 |
| EX4 | | | | | | | | | 1.00 |

* Significant at $p < .05$. All other correlations are significant at $p < .01$.

[a] Note that expectancy scores are in the reverse direction from the other two anxiety measures; that is, high expectancy of success is indicative of low anxiety.

# CHAPTER IV

# RESULTS

This chapter presents the results of the study. The first section describes the levels of anxiety reported over the course of the study. The second section presents analyses of the relationship between anxiety level and performance on the short-term memory task. The third section presents analyses of the relationship between anxiety level and performance on the interpolated arithmetic task.

## Reported Anxiety

Observed scores on the TAS ranged from a low of 2 to a high of 36; the mean score was 18.5 with a standard deviation of 7.8. Since the assignment of students to the high and low-stress conditions was random, the mean TAS score of the two groups would not be expected to differ ($t(148)<1$, n.s.).

The observed range of the state anxiety score WE23 was from 20 to 83. The mean WE23 score for the high-stress condition was 37.4 (s.d. = 15.2); for the low-stress condition the mean score was 29.3 (s.d. = 9.5).

## Correlations Among Measures of Anxiety

Table 2 shows the intercorrelations among the various measures of anxiety for the total group. The TAS correlates moderately with the state measures of anxiety. The TAS was most highly correlated with the students' initial expectancy of success (EX1). The high correlation between TAS and EX1 was found for the high-stress ($r = -.40$) and low-stress ($r = -.55$) groups as well as the total group. Thus, the TAS tended to best predict the subjects' belief about how well they would do when their judgments were made prior to their learning about the task. However, as task data became available (EX2, EX3, EX4), the relationship was somewhat reduced.

The WE scales were moderately intercorrelated. However, the correlations were sufficiently low to indicate that subjects were responding based on their state anxiety rather than consistently repeating the same responses. Each WE score was most highly correlated with the WE score immediately following; thus, WE1 correlated highest with WE2, WE2 with WE3, and WE3 with WE4. The correlations became increasingly greater for each pair indicating an increasing stability of responding.

State Anxiety Over Time

While the TAS score, as a measure of anxiety-proneness, would be expected to remain reasonably stable over time, the WE scores, as measures of state anxiety, were expected to fluctuate over time. Similarly, the students' expectancy of success was expected to vary over time, generally declining as the subjects' worry increased.

Table 3 presents the means and standard deviations of the state anxiety measures over the course of the experiment. The worry and emotionality components of the WE scales are presented separately and as combined scores.

From a theoretical point of view worry has been shown to be a more important factor in terms of performance than emotionality (Deffenbacher, 1978; Morris and Liebert, 1970). However, the patterns of results obtained with emotionality tend to be the same as those obtained with worry but be somewhat weaker. Because the correlations between the worry and emotionality scores were quite high, it was decided to use the combined worry-emotionality scores in the analyses that follow. Data on the component scores will be found in Appendix C.

The state anxiety scores at time 1 were measured prior to the start were generally quite high; and the combined score was more highly correlated with the dependent variables than the component scores. The state anxiety scores at time 1 were measured prior to the start of the experiment. These may be considered base or control scores as they reflected the students' reported level of anxiety prior to their experiencing anxiety resulting from the experimental manipulation (stress induction) or from the experimental task itself.

Table 3

Means and SD for State Anxiety Measures

| Anxiety Measure[a] | High-Stress (N=87) | | Low-Stress (N=62) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Worry 1 | 6.89 | 2.15 | 6.84 | 2.40 |
| Worry 2 | 9.98 | 3.90 | 6.52 | 2.19 |
| Worry 3 | 9.87 | 4.25 | 8.79 | 3.76 |
| Worry 4 | 9.49 | 4.58 | 8.40 | 3.95 |
| Emotionality 1 | 6.45 | 2.29 | 6.30 | 2.11 |
| Emotionality 2 | 8.58 | 4.08 | 6.31 | 1.96 |
| Emotionality 3 | 8.94 | 4.45 | 7.74 | 3.54 |
| Emotionality 4 | 8.62 | 4.48 | 7.18 | 3.73 |
| W/E[b] 1 | 13.33 | 4.20 | 13.15 | 4.35 |
| W/E 2 | 18.55 | 7.45 | 12.82 | 3.86 |
| W/E 3 | 18.82 | 8.34 | 16.53 | 6.99 |
| W/E 4 | 18.12 | 8.70 | 15.58 | 7.46 |
| Expectancy 1 | 7.38 | 1.71 | 7.08 | 2.12 |
| Expectancy 2 | 5.77 | 2.24 | 8.18 | 1.73 |
| Expectancy 3 | 5.55 | 2.34 | 6.02 | 2.34 |
| Expectancy 4 | 5.11 | 2.79 | 5.76 | 2.73 |

a The numbers following the measure name refer to the time at which the measure was administered. 1 = before stress induction, 2 = after stress induction, 3 = after 4th trial, 4 = after 8th trial.

b The W/E score is the sum of the respective worry and emotionality scores, e.g. W/E 1 = worry 1 + emotionality 1.

The state anxiety scores at time 2 were measured following the stress induction (high-stress condition) or control (low-stress condition) task. As expected, state anxiety increased for the high-stress subjects and their expectancy of success declined. For the low-stress subjects, state anxiety levels remained approximately the same (or declined slightly) following the control task which paralleled the stress-induction task. The expectancy of success of the low-stress subjects increased. Only 9.7% of the low-stress subjects rated their expectancy of success 5 or less; the lowest rating (1 subject) was 3. In contrast, 52.9% of the high-stress subjects rated their expectancy of success as 5 or less; half of these ratings were 3 or less.

The variance of anxiety scores increased for the high-stress groups following the stress-induction procedure (partly as a result of a few students reporting very high stress levels) while the variance of scores decreased for the low-stress group from time 1 to time 2.

The third set of state anxiety scores were obtained following the fourth trial. These scores were influenced by the stress associated with the task. The state anxiety of the high-stress group remained at approximately the same level as time 2 while the scores of the low-stress group increased sharply. Apparently, this increase resulted from the stress of the experimental task itself; this is supported by the fact that the expectancies of the low-stress group dropped two points following exposure to the task.

The fourth set of state anxiety scores were obtained following completion of the eighth trial. The WE scores of the high-stress group remained about the same while the corresponding scores of the low-stress group dropped one point.

It is possible that the state anxiety scores measured at times 3 and 4 are somewhat depressed. This effect may have occurred for two reasons. First, the trials ending each block (trial 4 and trial 8) used meaningful strings and were therefore easier than the preceeding three trials. Second, the interval during which the students completed the anxiety scales was in itself less stressful than the fast-paced experimental task. Accordingly, the anxiety scores reported at times

3 and 4 are probably somewhat conservative. Figure 6 is a graph of the mean state WE scores for the high and the low-stress groups and Figure 7 depicts the mean expectancy scores of the two groups over time.

In order to assess the significance of the differences among the state anxiety indices, a series of ANOVAs were performed. Table 4 summarizes the results of an analysis of variance for the dependent variable worry-emotionality as a function of stress level (high vs. low) and time (WE1, WE2, WE3, WE4). As can be seen in the table, there was a significant main effect for both stress-level and time and a significant interaction. Post-hoc repeated measures t-tests were performed in order to locate the differences underlying the interaction. As predicted, the state anxiety of the high-stress group increased following stress induction ($t(86) = 8.03$, $p<.001$). The state anxiety of the low-stress group increased following exposure to the experimental task ($t(61) = 6.49$ , $p<.001$) but never reached the level reported by the high-stress group.

Table 5 reports an analysis of variance for the dependent variable, expectancy as a function of stress-level and time. Again, there was a significant main effect for both stress-level and time and a significant interaction. The expectancies of the high stress group declined, predictably, following exposure to the failure task ($t(86) = 8.00$, $p<.001$). The expectancy of success for the low-stress group declined following their exposure to the experimental task ($t(61) = 22.00$, $p<.001$).

Anxiety and Performance

The subsequent sections of this chapter report the results on the effects of anxiety on performance. Two types of performance variables will be considered: letters recalled correctly and performance on the interpolated arithmetic task. Table 6 shows the correlations of the three measures of anxiety with three performance variables: total letters recalled on arbitrary strings (LC123567), total arithmetic problems answered correctly on arbitrary trials (AC123567), and total arithmetic problems omitted on arbitrary trials (AO123567).

It is interesting to note that the direction of the correlations are consistently the same for both the high and low-stress groups; however, the correlations for the low-stress group are generally substantially higher than those for the high-stress group. The only

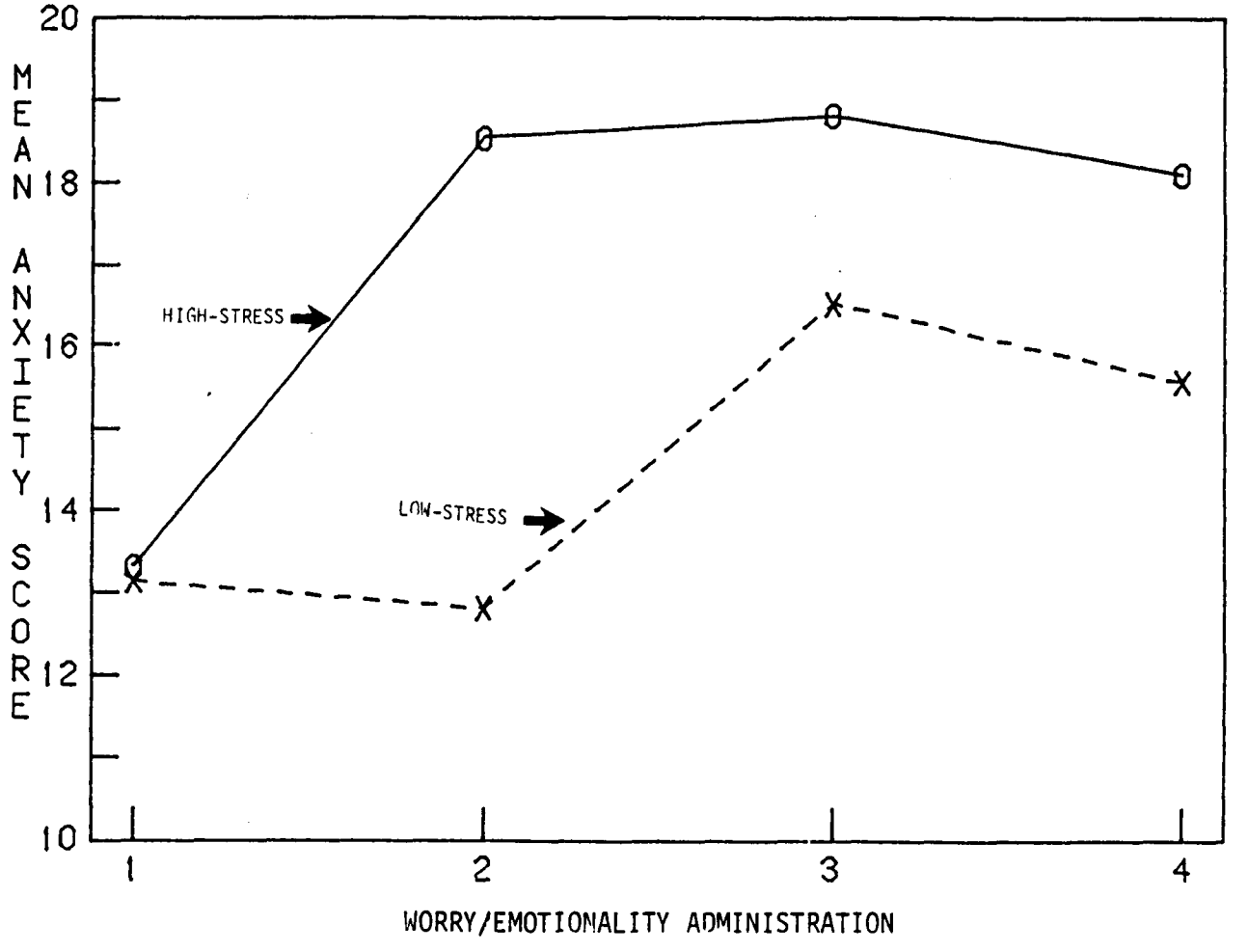



Figure 6. Mean state anxiety for high-stress and low-stress conditions at four points during the experiment.

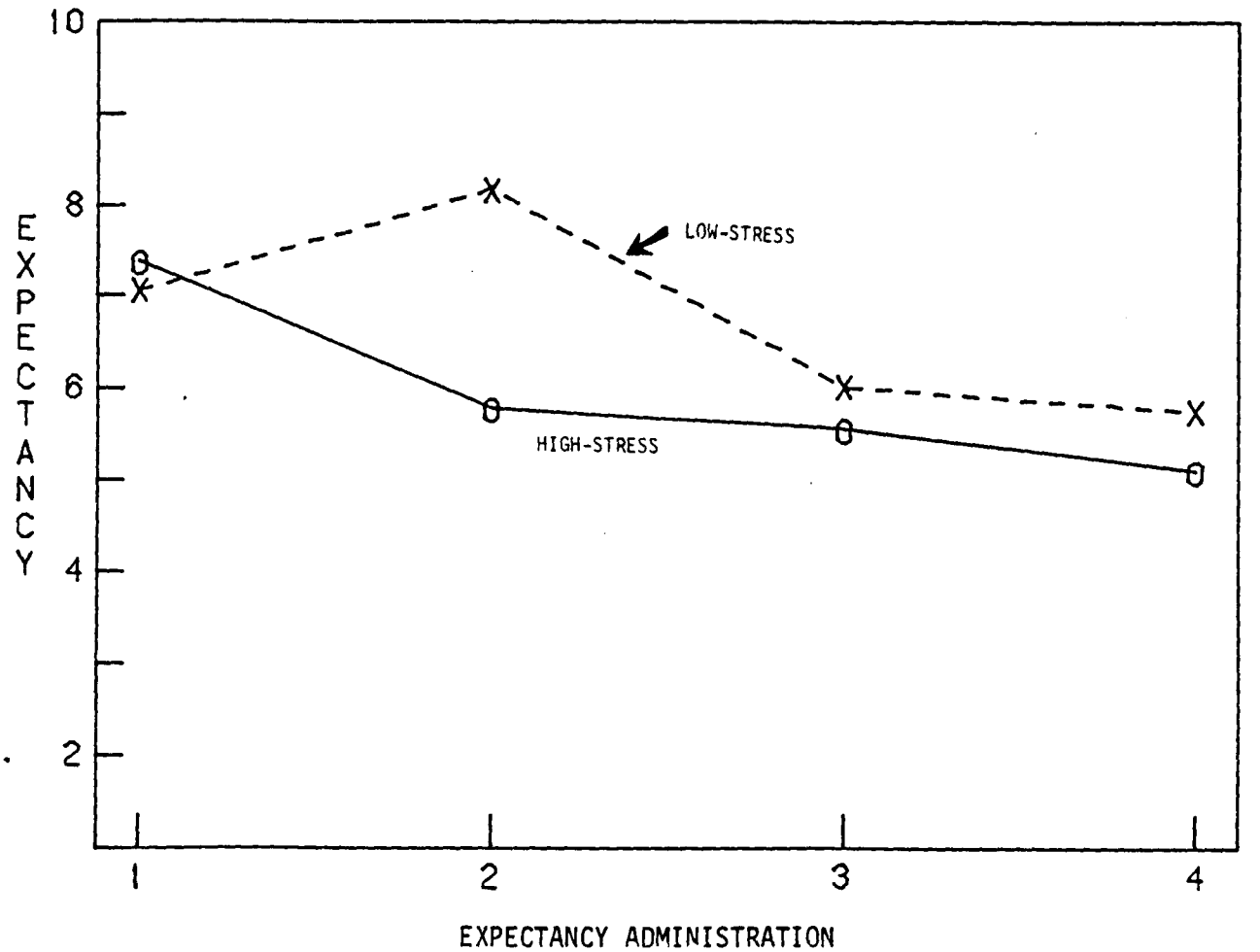



Figure 7. Mean expectancy of success for high-stress and low-stress conditions at four points during the experiment.

Table 4

Analysis of Variance Table for Worry/Emotionality

| Source | df | M.S. | F | p | % Total SS |
|---|---|---|---|---|---|
| Condition (Stress/Nonstress) | 1 | 1045.27 | 7.53 | <.007 | 3.44 |
| Subjects | 147 | 138.78 | | | |
| Time | 3 | 539.93 | 35.25 | <.001 | 5.33 |
| Condition x Time | 3 | 189.16 | 12.35 | <.001 | 1.87 |
| Time x Subject | 441 | 15.32 | | | |

Table 5

Analysis of Variance Table for Expectancy of Success

| Source | df | M.S. | F | p | % Total SS |
|---|---|---|---|---|---|
| Condition (Stress/Nonstress) | 1 | 93.61 | 6.81 | <.01 | 2.57 |
| Subjects | 147 | 13.74 | | | |
| Time (1-4) | 3 | 111.90 | 47.09 | <.001 | 9.22 |
| Condition x Time | 3 | 47.40 | 19.94 | <.001 | 3.91 |
| Time x Subject | 441 | 2.38 | | | |

exceptions to this are in the correlations of expectancy of success with performance, some of which were not significant.

TAS, was not significantly correlated with recall for either group. However, TAS was significantly correlated with arithmetic problems correct, and arithmetic problems omitted for the low-stress group. Although worry/emotionality was significantly correlated with recall for the low-stress group, only the fourth state anxiety measure (W4, E4, WE4) was significantly related to recall for the high-stress group. In the case of arithmetic performance, worry/emotionality was significantly correlated with arithmetic problems correct and arithmetic problems omitted with the exception of the correlation of WE3 with arithmetic problems omitted by the high-stress group.

## Analyses of Letters Recalled

The major hypothesis investigated in this study was that high-anxious subjects would recall fewer letters than low-anxious subjects. This section presents analyses of letters recalled as a function of anxiety score.

Figure 8 shows the mean letters recalled by the low and high-stress groups for each of the eight trials. This figure shows that, as expected, the high stressed subjects recalled fewer letters than their low-stressed counterparts in the trials in which arbitrary strings were used (1, 2, 3, 5, 6). The only exception to this pattern was in trial seven. No order effects were found ($t<1$, n.s.).

Trials four and eight used meaningful strings which did not require rehearsal. Accordingly, it was predicted that the two groups would perform equally well on these trials and, in fact, both groups achieved essentially error-free performance. On trial 4, the high-stress group recalled an average of 6.86 letters; the low-stress group recalled 7.00 letters. On trial 8, the high-stress group recalled 6.94 letters, while the low-stress group recalled an average of 6.89 letters. No partial recall was exhibited on the meaningful trials; the only errors were subjects who omitted the entire string.

Table 6

Correlations of Anxiety Measures with Performance for Stress and Nonstress Groups

| Anxiety Measure | Letters Correct | | Arithmetic Correct | | Arithmetic Omit | |
|---|---|---|---|---|---|---|
| | HIGH STRESS | LOW STRESS | HIGH STRESS | LOW STRESS | HIGH STRESS | LOW STRESS |
| TAS | -.06 | -.15 | -.23* | -.30** | .15 | .32** |
| W 1 | -.03 | -.28* | -.27* | -.50** | .18 | .37** |
| W 2 | -.08 | -.24* | -.23* | -.47** | .14 | .31** |
| W 3 | -.16 | -.24* | -.42** | -.55** | .32** | .46** |
| W 4 | -.24* | -.32** | -.46** | -.51** | .36** | .44** |
| E 1 | .00 | -.25* | -.40** | -.44** | .28** | .30** |
| E 2 | -.09 | -.36** | -.26* | -.63** | .19 | .51** |
| E 3 | -.09 | -.33** | -.36** | -.56** | .21* | .53** |
| E 4 | -.28** | -.37** | -.38** | -.58** | .26* | .50** |
| WE 1 | -.02 | -.28* | -.36** | -.49** | .25* | .34** |
| WE 2 | -.09 | -.32** | -.26* | -.58** | .18 | .44** |
| WE 3 | -.13 | -.30** | -.41** | -.58** | .27* | .52** |
| WE 4 | -.22* | -.35** | -.44** | -.56** | .32** | .48** |
| EX 1 | .23* | .10 | .16 | .32** | -.13 | -.20 |
| EX 2 | .12 | .03 | .19 | .16 | -.13 | -.08 |
| EX 3 | .18 | .36** | .36** | .49** | -.30** | -.28* |
| EX 4 | .05 | .40** | .36** | .48** | -.30** | -.37** |

** $p < .01$
* $p < .05$

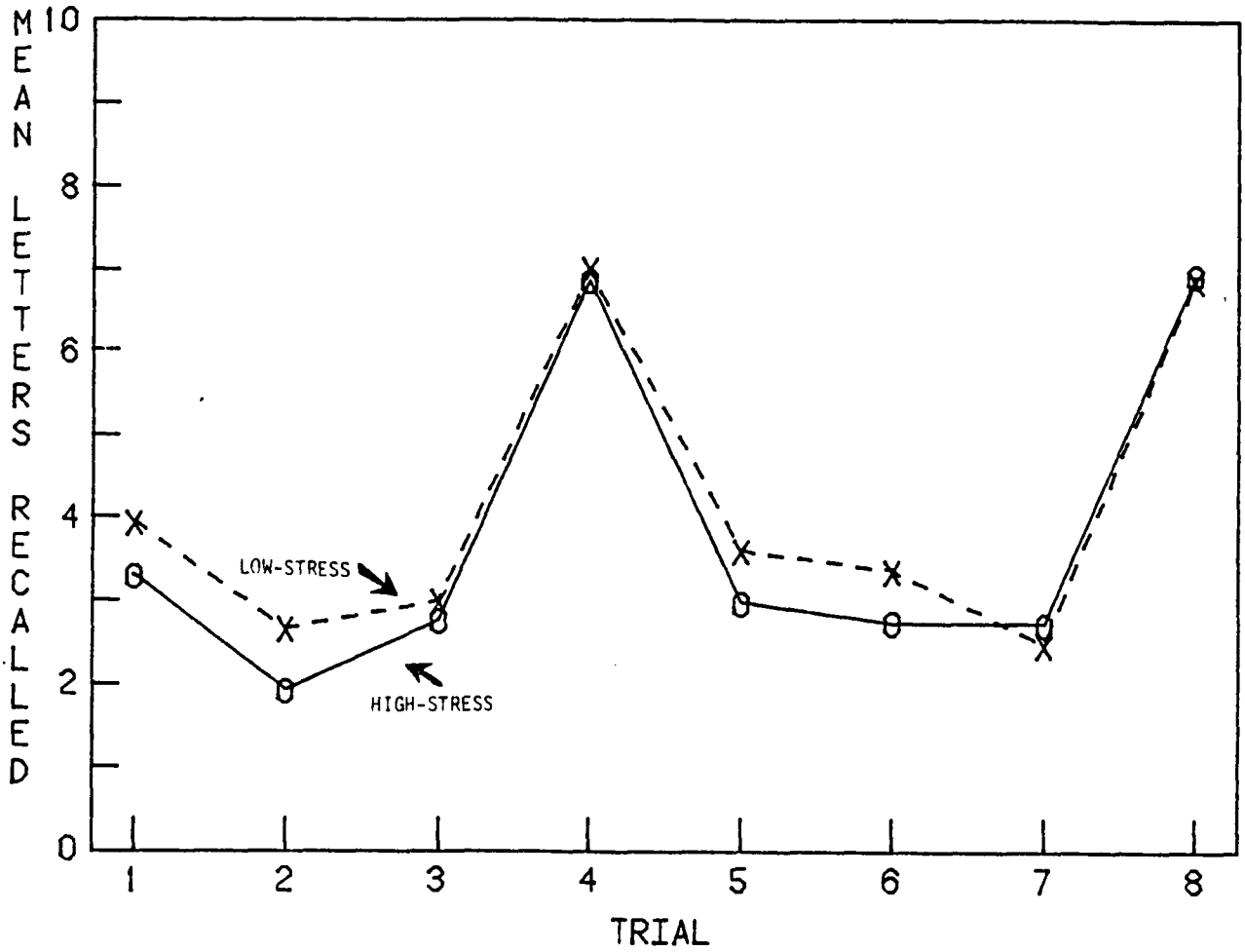



Figure 8. Mean letter recall by trial for high-stress and low-stress conditions.

Data Analysis

The relationships between the performance variables (letters recalled, arithmetic problems answered correctly, and arithmetic problems omitted) and the anxiety variables (TAS, state worry/emotionality, and stress level) were analyzed using multiple linear regression analysis. In the technique employed (Cohen, 1968), the unique (independent) variance contributed by each variable was tested for significance. Since the independent variables in a regression analysis tend to be correlated (i.e., to have overlapping variance) the interpretation of a multiple regression equation in which all terms are evaluated simultaneously may be misleading. The technique employed in the current analysis avoids this problem by successive partialing of the independent variables.

The significance of the incremental contribution of independent variable $X_i + 1$ to the prediction of Y over the contributions of $X_1, X_2, \ldots, X_i$ was tested. In particular, the increment to $R^2$ due to the addition of $X_i + 1$ was tested by the F ratio:

$$F = \frac{(R^2 y.x_1,\ldots,x_i,x_i+1 - R^2 y.x_1,\ldots,x_i)}{(1-R^2 y.x_1,\ldots x_i,x_i+1)/(n-i-2)}$$

with df = 1 and n-i-2; this formula is a special case of Formula 7 given by Cohen (1968, p. 435). A significant F value implies that $b_{i+1} \neq 0$.

The analyses used in the experiment investigated the effects of anxiety and stress-level on the performance variables. The overall model used was

$$Y = b_0 + b_1 A + b_2 S + b_3 (A \times S) + e$$

where:

A denotes score on the relevant anxiety questionnaire (either TAS or WE2 + WE3)

S identifies the stress condition of the subject (1=high stress, -1=low stress)

A x S was the anxiety by stress interaction

Three performance variables were used as dependent variables:

LC123567 - the total number of letters recalled on the arbitrary strings

AC123567 - the total number of arithmetic problems correct on arbitrary trials

AO123567 - the total number of arithmetic problems omitted during arbitrary trials

The quadratic term, $A^2$, and the quadratic interaction term $A^2$ x S were also evaluated because some investigators have postulated a cuvilinear relationship between anxiety and performance. The classic inverted - U curve (known as the Yerkes - Dodson principle) relating arousal level to learning, is appropriately described as a quadratic function. However, the quadratic terms did not contribute significant additional variance to Y in any of the models, nor did trend analysis reveal significant departures from linearity. Accordingly, these terms were excluded from the model.

The analyses were based upon the following four regression models:

(1) $Y = b_0 + b_1$ (anxiety score) + e

(2) $Y = b_0 + b_2$ (stress level) + e

(3) $Y = b_0 + b_1$ (anxiety score) + $b_2$ (stress level) + e

(4) $Y = b_0 + b_1$ (anxiety score) + $b_2$ (stress level) + $b_3$ (anxiety score x stress level) + e

The unique contribution of the stress condition to the prediction of performance was evaluated by comparing model (3) with model (1) by use of the F-statistic described above. Similarly, the unique contribution of the anxiety score to the prediction of performance was evaluated by comparison of model (2) to model (3). Finally, the significance of the anxiety x stress interaction was evaluated by comparing model (3) with model (4).

The analyses are thus similar to analyses of covariance and are reported in terms of the significance of an effect for anxiety, a main effect for stress level, and an interaction (Cohen, 1968).

TAS and Letters Recalled

The technique described above was employed to analyze the effects of test anxiety-proneness (TAS score) and stress condition (high-stress vs. low-stress) on total letters recalled in arbitrary trials (LC123567). Since stress level was a nominal variable, the subjects' "scores" were coded as +1 (high-stress) or -1 (low-stress). High-stress subjects recalled significantly fewer letters than the low-stress group. The subjects in the high-stress group correctly recalled an average of 16.4 letters (s.d.=6.3), while subjects in the low-stress group correctly recalled an average of 39% of the stimulus letters while the high-stress group correctly recalled an average of 45% of the letters. The biserial correlation between stress level and letters recalled was .22.

Table 7 summarizes the results of the multiple regression analysis, predicting LC123567 from TAS and stress-level. TAS and stress-level. TAS did not contribute significantly to the prediction of letters correct beyond stress condition although the sign of the coefficient suggested a relationship in the predicted (negative) direction.

The contribution of stress condition (beyond that of TAS) was significant; as reported above, subjects in the high-stress condition recalled fewer letters than their low-stress counterparts. The TAS x stress condition interaction did not contribute significant additional information beyond the combined contribution of TAS and stress-level to the prediction of letters recalled correctly.

The TAS is a measure of an individual's anxiety-proneness in testing situations. An individual who scores high on the TAS is more likely to experience anxiety in evaluative situations than one whose score is low. But TAS predicts little about a particular individual's anxiety responses to a given situation. Consequently, the relationship between an individual's TAS score and the actual level of anxiety experienced in a given situation may be small.

To the extent that an individual is able and willing to accurately report anxious thoughts and feelings, state anxiety measures more accurately reflect the anxiety felt by the individual in the experimental

Table 7

Results of Multiple Linear Regression
Analysis of the Effect of Anxiety (TAS) on
Letters Recalled (Arbitrary Strings)

| Source | df | F | %Var[a] | Regression[b] Weight |
|---|---|---|---|---|
| TAS | 1,147 | 1.63 | 1.06 | -0.11 |
| Stress | 1,147 | 4.36* | 2.84 | -2.32 |
| TAS x Stress | 1,146 | <1 | 0.34 | 0.06 |

[a] Independent variance accounted for by effect

[b] Constant = 19.60

* $p < .05$

situation. It will be recalled that state anxiety was measured by the state worry/emotionality scale at four points during the experiment. As noted previously, the state anxiety measures WE2 and WE3 were summed to create a measure of anxiety during the experiment.

WE23 and Letters Recalled

Table 8 summarizes the results of the multiple linear regression analyses testing the prediction of LC123567 from state anxiety (WE23) and stress-condition. The state anxiety score is the sum of the second worry/emotionality score (immediately following treatment) and the third WE score (following trial 4). Figure 9 shows the nature of the anxiety x stress interaction.

Table 8

Results of Multiple Linear Regression Analysis of the Effect of Anxiety (WE23) on Letters Recalled (Arbitrary Strings)

| Source | df | F | % Var[a] | Regression[b] Weight |
|---|---|---|---|---|
| WE23 | 1,147 | 6.14* | 3.8 | -0.18 |
| STRESS | 1,147 | 2.33 | 1.4 | -5.12 |
| WE23 x STRESS | 1,146 | 6.77* | 4.1 | 0.14 |

[a]Independent variance accounted for by effect

[b]Constant = 23.36

*$p < .05$

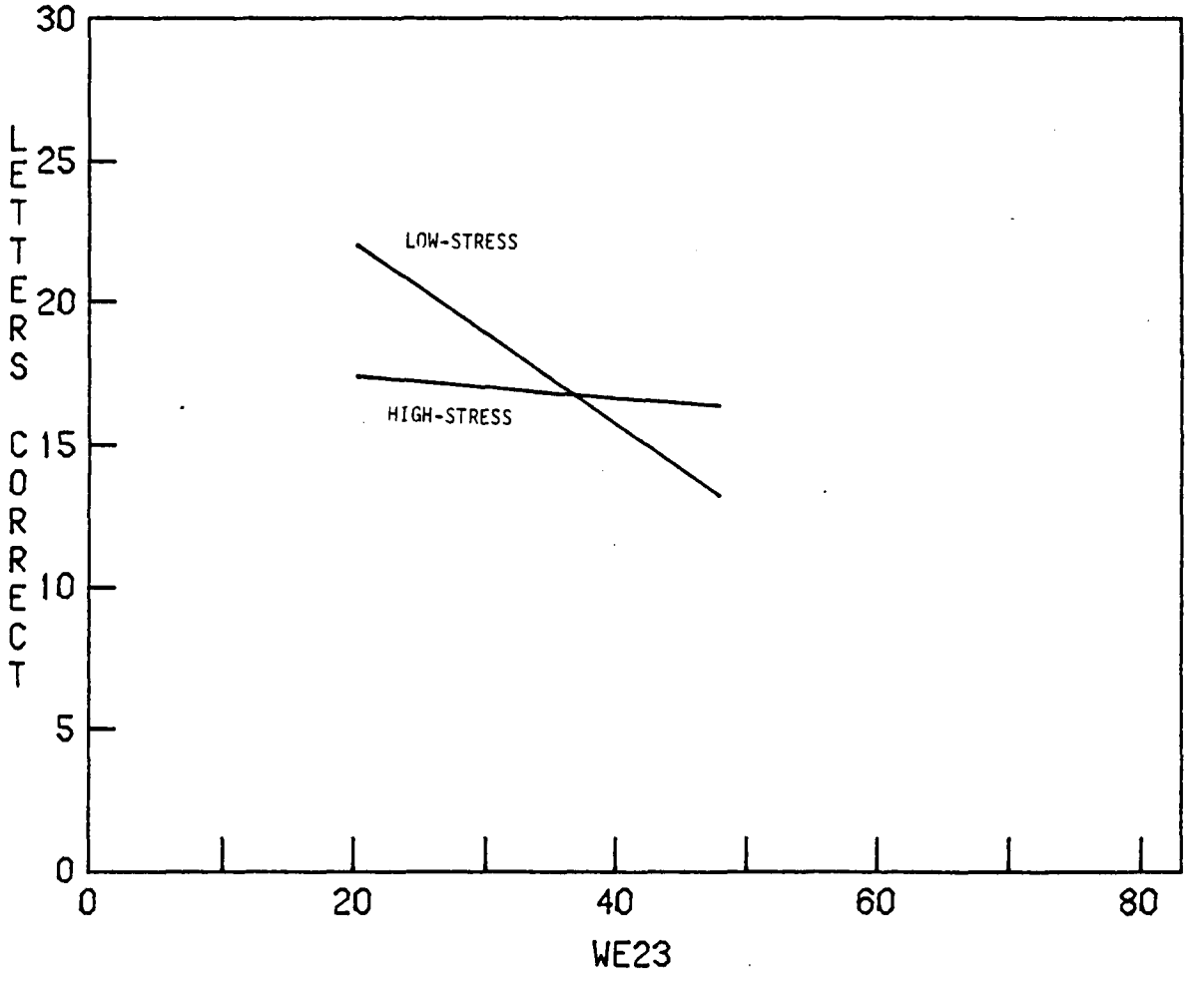



Figure 9. State anxiety by stress-condition interaction for letters recalled.

## Analysis of Arithmetic Performance

This section is concerned with performance on the interpolated arithmetic task. Arithmetic performance was measured by two scores: the number of arithmetic problems answered correctly (AC) and the number of arithmetic problems omitted (AO). Figure 10 shows the number of arithmetic problems answered correctly by the low-stress and the high-stress groups on each trial. Because trials 1-4 employed six interpolated arithmetic problems and trials 5-8 employed eight interpolated problems, the number of problems answered correctly has been transformed to a proportion correct to simplify comparison across trials.

Examination of Figure 10 shows that subjects in the high-stress condition performed better than subjects in the low-stress condition on all trials. This performance is the reverse of that observed for letter recall where high-stress subjects performed worse than low-stress subjects.

Subjects in the high-stress condition correctly answered an average of 39.9 (71%) of the problems while subjects in the low-stress condition correctly answered an average of 37.9 (68%) of the problems; performance of the two groups were therefore quite similar.

### TAS and Arithmetic Problems Correct

Table 9 summarizes the results of the multiple linear regression analysis of the prediction of arithmetic problems correct from TAS score and stress-level.

### WE23 and Arithmetic Problems Correct

The analyses described above relating anxiety and stress condition to arithmetic problems correct were repeated using WE23 as the anxiety measure instead of TAS since, as noted earlier, state anxiety is a more sensitive indicator of situational anxiety than trait anxiety.

There was a significant contribution for WE23 above stress-condition. As noted previously, stress-condition by itself was not a significant predictor of arithmetic problems correct. However,

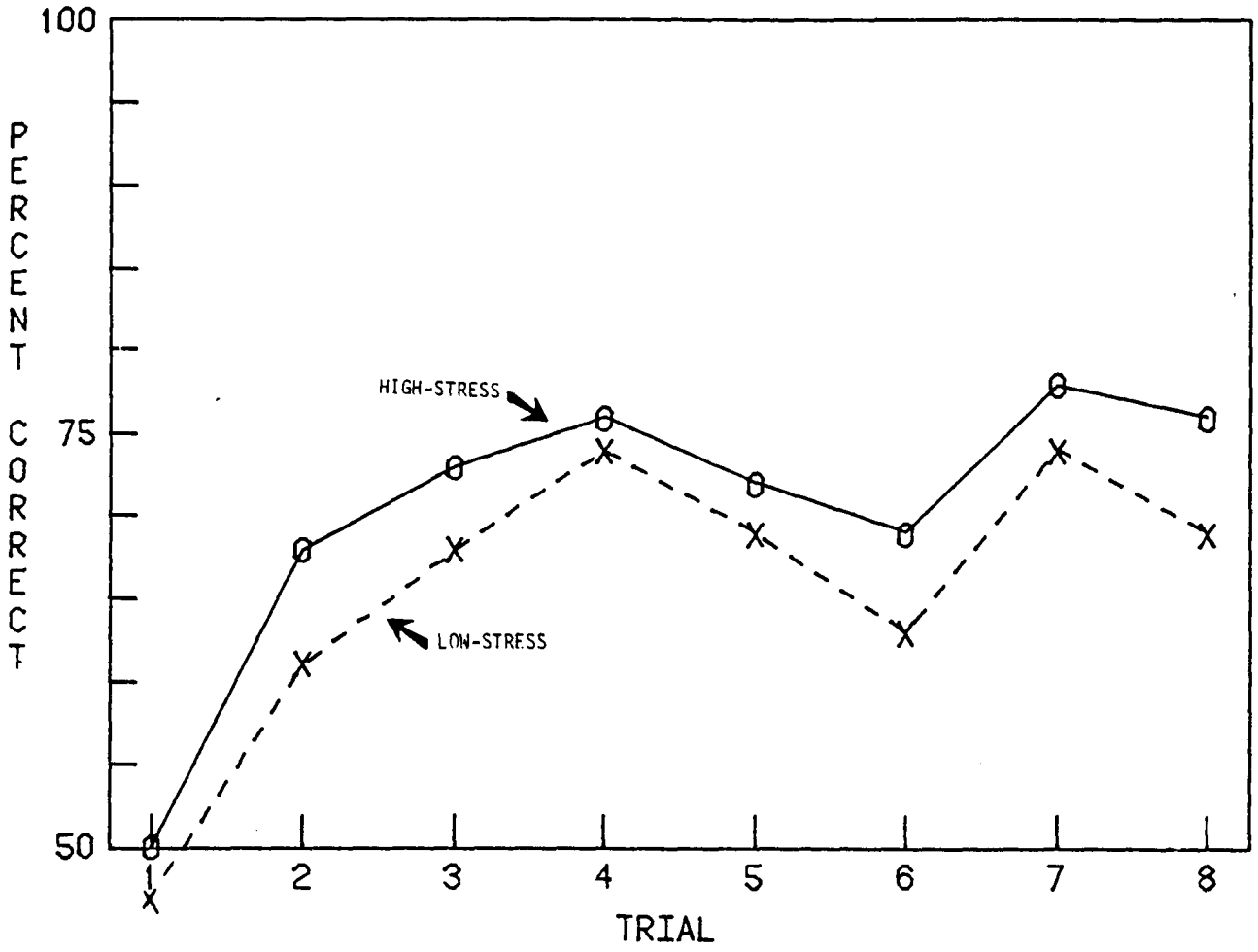



Figure 10. Mean percent of arithmetic problems answered correctly by trial for high-stress and low-stress conditions.

Table 9

Results of Multiple Linear Regression
Analysis of the Effect of Anxiety (TAS)
on Arithmetic Problems Correct (Arbitrary Strings)

| Source | df | F | % Var[a] | Regression Weight[b] |
|---|---|---|---|---|
| TAS | 1,147 | 10.63* | 6.7 | -0.31 |
| STRESS | 1,147 | 2.25 | 1.4 | 0.05 |
| TAS x STRESS | 1,146 | 0.38 | 0.2 | 0.06 |

[a]Independent variance accounted for by effect

[b]Constant = 33.77

*p < .01

Table 10

Results of Multiple Linear Regression
Analysis of the Effect of Anxiety (WE23)
on Arithmetic Problems Correct (Arbitrary Strings)

| Source | df | F | %Variance [a] | Regression Weight [b] |
|---|---|---|---|---|
| WE23 | 1,147 | 35.26* | 19.04 | -0.43 |
| STRESS | 1,147 | 9.90* | 5.36 | -5.05 |
| WE23 x STRESS | 1,146 | 16.34* | 8.01 | 0.23 |

[a] Independent variance accounted for by effect

[b] Constant = 41.49

* $p < .01$

knowledge of stress condition significantly improved the prediction of arithmetic performance over prediction from WE23 alone. The contribution of the WE23 x stress-condition interaction was significant.

Figure 11 depicts the interaction between WE23 and stress-condition. Regardless of stress condition as anxiety (WE23) increases, the number of arithmetic problems answered correctly decreases. However, the effect is stronger in the low-stress condition than in the high-stress condition.

Arithmetic Problems Omitted

In some cases, an arithmetic problem was not counted as correct because the student's answer was wrong; some answers, however, were omitted entirely. The number of arithmetic problems omitted (AO) was recorded for each subject and analyzed analagously to the other performance measures.

On the average, the students omitted 6.25 (s.d. = 7.66) of the 42 problems interpolated following arbitrary strings (15%) and 1.9 (s.d. = 2.85) of the 14 problems interpolated following the meaningful strings (14%). Subjects in the high-stress condition omitted an average of 5.6 (s.d. = 7.13) problems on the arbitrary trials while subjects in the low-stress condition omitted an average of 7.1 (s.d. = 8.31) on these trials. As can be seen from the standard deviations around the means, there was considerable variation among subjects in both conditions.

Figure 12 shows the number of arithmetic problems omitted by the low-stress and the high-stress groups on each trial. The numbers have been converted to percentages to simplify comparison of trials 1-4 (6 problems each) with trials 5-8 (8 problems each).

As can be seen from Figure 12, the low-stressed subjects consistantly omitted slightly more items than the high-stress group although the patterns were quite similar.

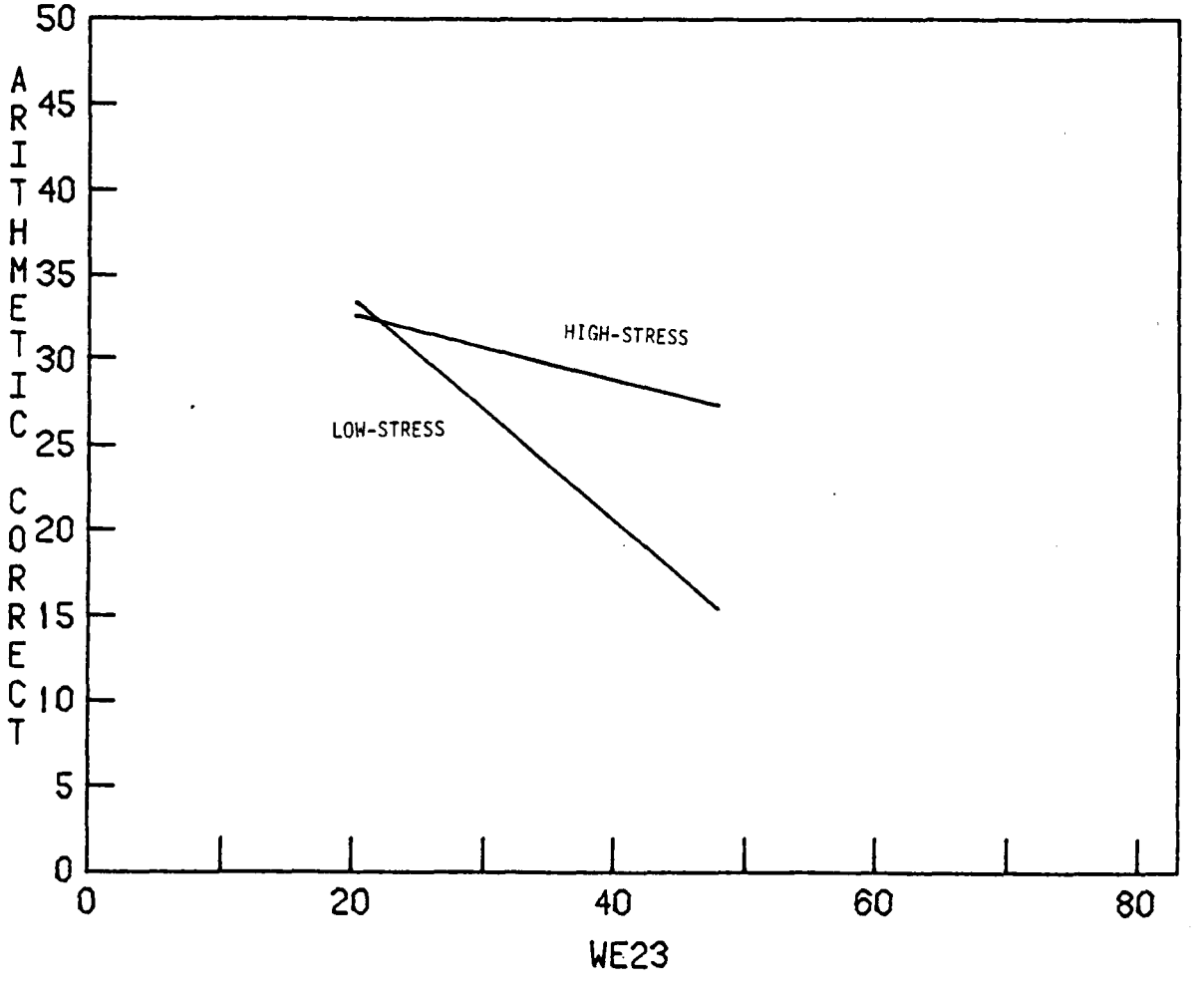



Figure 11. State anxiety by stress condition interaction for arithmetic problems correct.

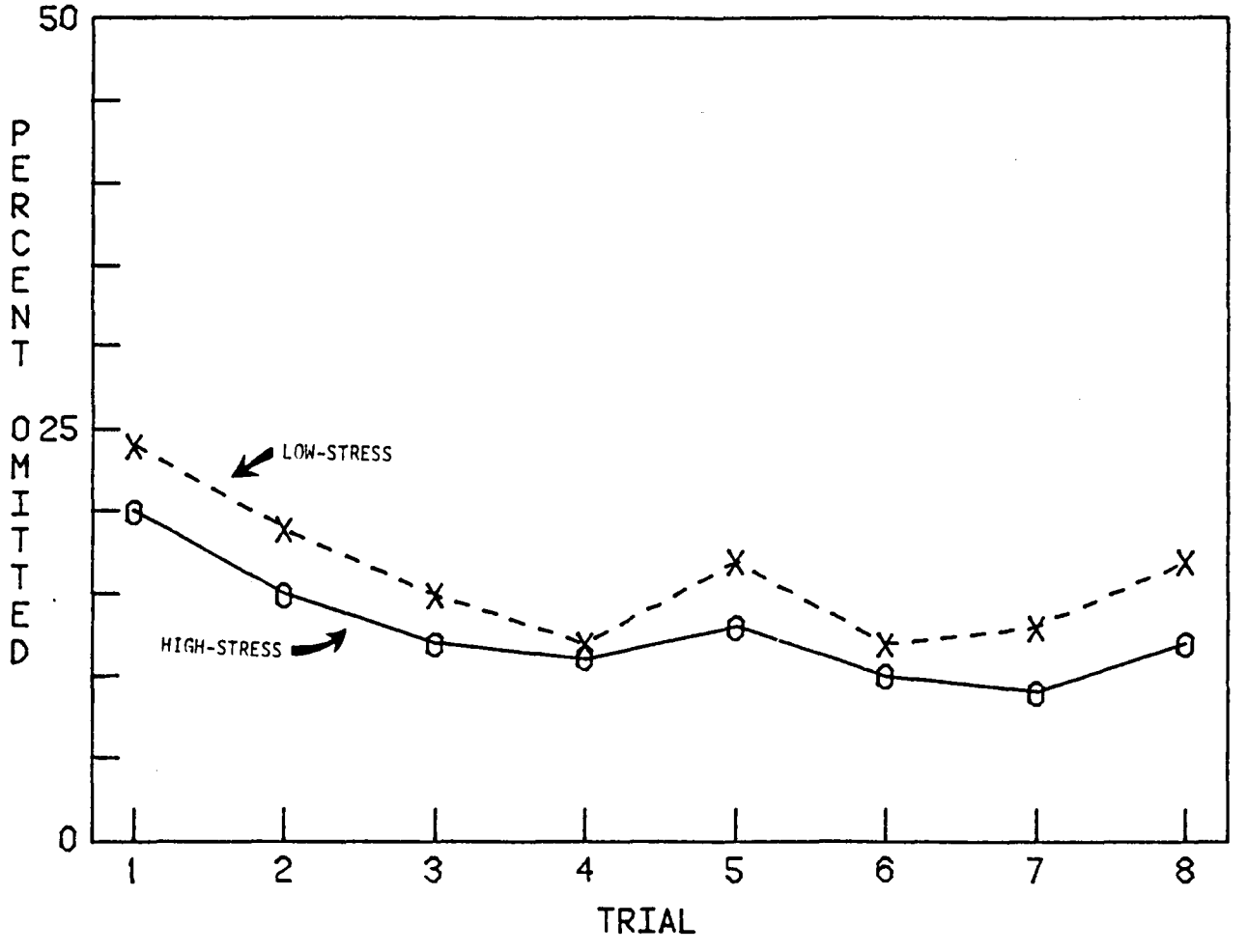



Figure 12. Mean percent of arithmetic problems omitted by trial for high-stress and low-stress conditions.

TAS and Arithmetic Problems Omitted

As with the other performance variables, the relationship between TAS, and stress-condition as predictors of arithmetic problems omitted was investigated using multiple linear regression. Table 11 summarizes the results of these analyses. There is considerable similarity between the results summarized in Table 9 (arithmetic problems correct) and the current analyses summarized in Table 11 (arithmetic problems omitted). This similarity is not surprising because problems omitted account for almost one-half of all errors on the interpolated task. The correlation between arithmetic problems correct and those omitted, on the arbitrary string trials, was -.87 (high-stress = -.89, low-stress = -.84).

As shown in Table 11, there was a significant contribution for TAS independent of stress-condition. Knowledge of stress-condition did not significantly add to the prediction of arithmetic problems omitted, and as with the prediction of arithmetic problems correct, there was no significant interaction between stress-condition and arithmetic problems omitted.

WE23 and Arithmetic Problems Omitted

The analyses described above were repeated using WE23 instead of TAS as the measure of anxiety. The results of these analyses are summarized in Table 12. Both WE23 and stress-condition contributed significant independent variance to the prediction of problems omitted.

The stress x WE23 interaction was significant. The interaction is depicted in Figure 13. This figure shows that, for both groups, the number of problems omitted increased as state anxiety increased. As with the other performance variables, the effect was stronger in the low-stress group than in the high-stress group.

Table 11

Results of Multiple Linear Regression
Analysis of the Effect of Anxiety (TAS)
on Arithmetic Problems Omitted (Arbitrary Strings)

| Source | df | F | %Variance[a] | Regression[b] Weight |
|---|---|---|---|---|
| TAS | 1,147 | 8.02* | 5.1 | 0.24 |
| STRESS | 1,147 | 1.71 | 1.1 | 0.95 |
| TAS x STRESS | 1,146 | 1.45 | 0.9 | -0.10 |

[a]Independent variance accounted for by effect

[b]Constant = 2.05

*p <.03

Table 12

Results of Multiple Linear Regression
Analysis of the Effect of Anxiety (WE23)
on Arithmetic Problems Omitted (Arbitrary Strings)

| Source | df | F | %Variance[a] | Regression[b] Weight |
|---|---|---|---|---|
| WE23 | 1,147 | 18.48** | 11.09 | 0.30 |
| STRESS | 1,147 | 5.96* | 3.58 | 4.31 |
| WE23 x STRESS | 1,146 | 12.92** | 7.11 | -0.19 |

[a]Independent variance accounted for by effect

[b]Constant = -2.88

*p <.05

**p <.01

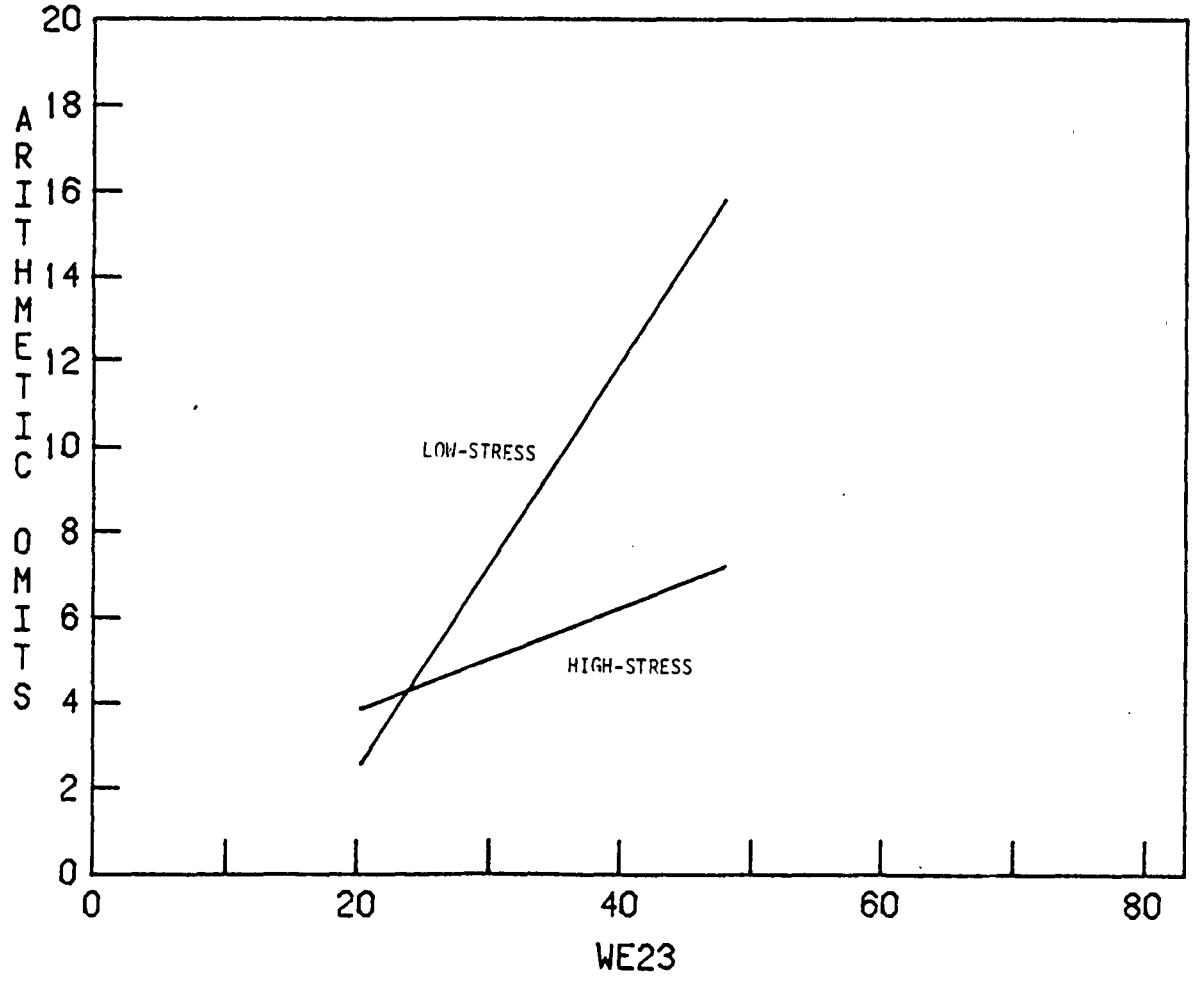



Figure 13. State anxiety by stress-condition interaction for arithmetic problems correct.

# CHAPTER V

# DISCUSSION

The experiment presented in Chapter III was designed to investigate the hypothesis that anxiety interferes with performance on tasks which depend upon short-term memory processes. The results of the experiment are generally consistent with this hypothesis.

This chapter is divided into three parts. The first part presents a summary of the experimental results. The second part discusses the findings in the context of previous and current research. Finally, the implications of the findings for educational practice and future research are considered.

## Summary of Results

The results of the experiment are summarized in the following sections. The first section discusses the fluctuation in state anxiety arousal as a result of experimental stress. The second section describes the relationship between state anxiety and performance. The third section discusses the relationship between anxiety and performance.

### State Anxiety Arousal

Students participating in the experiment were subject to stress from two sources: the experimental manipulation and the experimental task. Students in the high-stress condition were exposed to both sources of stress while students in the low-stress condition were stressed only by the experimental task. Levels of perceived stress were assessed by asking the students to complete the state worry/emotionality scale at four points during the experiment. The state anxiety of the high-stress group was expected to rise as a result of their exposure to the stress induction procedure while the state anxiety of the low-stress group was expected to remain unaffected by the initial instructions and task.

As hypothesized, state anxiety scores increased for the high-stress group following stress induction but not for the low-stress group following the neutral task.

State anxiety was measured for the third time half-way through the experimental task. The state anxiety of the low-stress group increased following exposure to the experimental task. The anxiety scores of the high-stress group did not further increase, although their anxiety was maintained at its previous stress level.

### The Effect of State Anxiety on Performance

State anxiety had a disruptive effect on performance on both the recall task and the interpolated task. Inspection of the means revealed that high anxiety was associated with lower recall and fewer problems correct on the interpolated task. Although the direction of the relationship between anxiety and performance was in the predicted direction in all cases, the relationship was significant only in the low-stress group. This was an unexpected finding since it had been predicted that the relationship would be strongest under conditions of evaluative stress. Overall, subjects in the high-stress condition did not perform as well as those in the low-stress condition. But within condition, the relationship between reported state anxiety and performance was significant only for the low-stress group.

### The Relationship Between Trait Anxiety and Performance

High trait anxiety, as measured by the TAS, was associated with lower performance on both the recall task and the interpolated task. However, the relationship was significant only for the interpolated task. Knowledge of the students' stress condition did not add to the prediction of performance.

In summary, the findings support the hypotheses that anxiety disrupts short-term memory performance. However, contrary to expectations, the effect was strongest in the low-stress condition.

## Theoretical Significance

The findings summarized above are consistent with the hypothesis that anxiety interferes with short-term memory processing. Students in the high-stress group reported higher levels of state anxiety than those in the low-stress group and recalled fewer letters than the low-stress group. High state anxiety scores were associated with reduced

recall but this relationship was significant only for the low-stress group.

The inverse relationship between anxiety and recall is consistent with Posner and Rossman's (1965) characterization of short-term memory as an active process which is subject to attentional interference. These results are in accord with the experimental findings of Sieber, Kameya, and Paulson (1970).

The inverse relationship between anxiety and recall was observed for the trait anxiety measure but did not reach significance. This result is not surprising as the TAS is not a measure of aroused anxiety but is a measure of an individual's tendency to experience anxiety reactions in a test-like environment. A high score on the TAS does not predict the extent (or even the occurrence) of an anxiety reaction in a particular situation. Although, a group of high-scoring individuals on the TAS would tend to experience more anxiety than a group of low TAS scores in a given test-like situation, TAS score reveals little about the individual reactions to stress.

Because of this limitation, the TAS is a less useful tool for the study of experimentally-aroused anxiety than it is for selecting individuals who are prone to experience anxiety reactions. The failure of the relationship to reach significance is most probably due to the imprecise relationship between the TAS score and the aroused anxiety.

This hypothesis is consistent with findings reported by Hodges and Spielberger (1969) who found that state anxiety (as measured by the Zuckerman Adjective Check List) was related to short-term memory performance as measured by the Digit Span subtest of the Wechsler Intelligence scale. However, trait anxiety (as measured by the Taylor MAS) was not found to be related to Digit Span performance.

The finding that anxiety impaired task performance, generally, is in accord with previous research and the consistent finding that arousal impairs performance on tasks that are not serially repetetive and over-learned. (Broverman, Klaiber, Vogel, and Kobayashi, 1974).

One hypothesis often cited to explain the relationship between anxiety and task performance is that the arousal component of anxiety functions as a drive to increase response competition (Spence, 1964). This hypothesis has considerable empirical support and appears to be a determinant in the individual's response to anxiety.

A second hypothesis suggests that the occurrence of an anxiety reaction serves as a cue to elicit task-irrelevant responses. (Mandler and S. Sarason, 1952.) Because these responses are attentionally demanding (I. Sarason, 1960; Wine, 1971; I. Sarason, 1972), they disrupt the highly focalized attention needed to facilitate task performance.

These two hypotheses are not contradictory if the task-irrelevant responses are viewed as competing with task-facilitating responses. According to this view, anxiety, by increasing response competition, would tend to increase the probability of task-irrelevant responses to task cues.

In the current study, membership in the high-stress group was associated with impaired performance on the recall task but not on the interpolated task. If response competition were the only factor affecting performance, it would be expected that the arithmetic task would be the most impaired since it was more complex than the recall task.

As previously noted, performance on the meaningful strings was essentially error-free for most individuals. In the few cases in which an error occurred, the individual omitted the entire string. Because there were no significant differences between the high low-stress groups on the meaningful strings, the lower recall of the high-stress group cannot be attributed to their having failed to attend to the initial presentation of the to-be-recalled strings. In terms of Tobias' (1977) information-processing model, the lack of a significant relationship between anxiety and performance on the meaningful strings reinforces the notion that the disruption took place during processing rather than during input.

This finding thus supports the hypothesis of rehearsal interference due to attentional alternation. In information processing terms, the attentional alternation resulting from anxiety, acted like an interpolated

task which, in conjunction with the arithmetic task, exceeded the rehearsal capacity of the stressed individuals. A similar hypothesis was advanced by Sieber, Kameya, and Paulson (1970).

Although stress condition did not affect arithmetic performance, trait anxiety predicted performance on this task for both the high-stress and the low-stress groups. Since over 75% of the variance in arithmetic performance was accounted for by problems omitted, it appears that TAS may be largely measuring a motivational aspect of task performance. This notion is in accord with Atkinson's (1964) construct of fear of failure which is often considered identical to "trait test anxiety."

One of the most interesting results of the study was the unexpected finding that the relationship between WE score and performance was significant only in the low-stress condition.

A possible explanation of this finding is that individuals in the high-stress condition were less accurate in their self-reports of aroused anxiety than individuals in the low-stress group. This explanation is consistent with research that suggests that high levels of arousal tend to impair fine discriminations (Easterbrook, 1959). The unpleasantness of anxiety reactions makes it unlikely that the anxious individual will be disposed to carefully evaluate them.

The relationship between reported anxiety and performance may be described by five parameters: the means ($\bar{X}_{WE23}$, $\bar{X}_{TASK}$), the variances ( $s^2_{WE}$, $s^2_{TASK}$ ), and the correlation between them ($r_{WE,TASK}$). In the high stress condition, $s^2_{WE}$ was greater than in the low-stress condition but $r_{WE,TASK}$ was lower. This suggests that the increased variance in the WE score may have been due to error component. Inspection of the regression lines relating WE score to task performance (Figures 9, 11 and 13) reveals that, although regression lines for both high and low-stress have negative slope, the slope of the high-stress line appears to be attenuated and tending toward the mean. This pattern is consistent with the hypothesis of increased error in the high-stress condition.

In summary, the data appear consistent with the hypothesis that anxiety interferes with short-term memory rehearsal. State anxiety is a more useful predictor of performance than trait anxiety although trait

anxiety may be a useful measure of motivation. It is possible that individuals who are stressed by ego-involving task instructions are less accurate than unstressed individuals in their self-report measures of anxiety.

## Implications for Education and Future Research

Although the results of a single study cannot be considered conclusive, the study suggests a number of implications for educational practice and future research.

To the extent that test anxiety affects problem-solving behavior, it confounds the measurement of academic achievement. It is difficult to assess the magnitude of the effects which anxiety has upon learning because the available measures of anxiety are insufficiently precise to permit their estimation. It is probable that the disruptive effects of anxiety on school performance are considerable.

Anxiety is often considered to be an educational problem only when its manifestations are so dramatic that a student's maladaptive behavior comes to the attention of the teacher. A child who exhibits anxiety symptoms such as school-related phobias, may be referred to the school psychologist. But, the child who is inattentive, sloppy, or timid may equally be the victim of anxiety which results in sub-optimal school performance. Most individuals are test-anxious to some degree. The extent to which moderate amounts of anxiety reduce their ability to achieve needs to be investigated.

In particular, the relationship of anxiety to socio-economic status and academic achievement needs to be elaborated. It is a matter of current national concern that children from families of low socio-economic status appear to be at an educational disadvantage as compared to those whose families are economically more successful. Because education is so essential in our increasingly technological society, students who are not academically successful may find themselves unable to achieve financial success. The uncertainty and lack of environmental stability which accompanies poverty, the fact that academic success is often not reinforced by parental approval, and the belief that schools are agencies of the social system which the family has failed to master, suggest the hypothesis that the school performance of a large segment of the population is anxiety-impaired. Research is

needed to determine what aspects of the school environment are anxiety-evoking and how anxiety affects cognitive performance.

The current study addressed the issue of the relationship between anxiety and cognition. Further work is needed to extend the current findings. Because anxiety, attention, and short-term memory are all covert constructs, many studies will be needed to confirm inferences about their interrelationship. Aspects which need to be further investigated include: the relationship between response competition and attentional alternation, and the relationship between task characteristics and short-term memory requirements.

Both the current study and the recent study by Deffenbacher (1978) support the hypothesis of attentional alternation. Further research is needed to confirm and extend these results.

Broadbent and Heron (1962) have shown that short-term memory performance varies as a function of the rehearsal contention between two tasks. The rehearsal demands of the prompted-recall task employed in the current study could be varied by using to-be-recalled strings of different lengths. As string length increased, the effect of anxiety on retention would be expected to increase since the longer strings would require more rehearsal than shorter strings. Kahneman (1973) has noted that physiological arousal increases as task difficulty increases. Accordingly, it is possible that individuals who are asked to recall longer strings will experience higher levels of emotionality than those asked to recall shorter strings.

Deffenbacher (1978) employed a retrospective measure of attentional alternation. It would be desirable to obtain measures of attentional alternation concurrently with task performance. This might be accomplished in conjunction with a computer-assisted instructional task. By requesting that individuals indicate fluctuations in attention by pressing a special key, it would be possible to obtain a measure of distraction which is concurrent with task performance. The sensitivity of such a procedure would depend upon the individual's ability to detect periods of distraction. Previous work by Wine (1970) suggests that individuals can learn to recognize such periods.

More sophisticated measures of attention might be developed by tracking an individual's eye movements during task performance. Such measures might be useful for detecting very short periods of task-irrelevant attentional focus and would not depend on the individual's self-awareness.

The relationship between worry and emotionality needs to be further studied. Morris and Fulmer (1976) have suggested that emotionality responses may be classically-conditioned autonomic responses to cues in the test situation. Drive theory (Spence, 1958) and Spielberger's (1966) state-trait model predict that autonomic responses could serve as cues to maintain the anxiety reaction. A common approach to anxiety reduction is to condition relaxation responses antagonistic to anxiety arousal. Attentional theory would predict a reduction of task-irrelevant attentional focus as a result of such training due to the reduction in the autonomic cues.

If anxiety disrupts short-term memory processing, it may be possible to mitigate its effects by providing memory support to anxious students. This approach has been tried with some success by Sieber, Kameya, and Paulson (1970). An alternative approach to reducing the disruptive effects of anxiety would be to train anxious students to maintain focal attention on the relevant task; this approach has been investigated by Wine (1970), I. Sarason (1975), and I. Sarason and Stoops (1978).

A common classroom situation in which recall may be impaired has been termed the "next-in-line" effect (Walker and Orr, 1976). While waiting to be called upon, some students appear to focus on anxiety-related thoughts and fail to adequately process previous students' responses. Attentional training may help reduce this effect.

The confounding effects of anxiety in achievement testing can be minimized by reducing the stress-arousing cues in the environment, emphasizing power tests over speeded tests, and providing memory support where appropriate. The effects of anxiety on test scores probably varies with the nature of the assessment task; research into task characteristics most vulnerable to interference is needed (Morris and Fulmer, 1976).

The effect of anxiety on cognition involves processes in addition to short-term memory. Studies have shown anxiety to affect retrieval from long-term memory, creativity, and styles of concept formation. Anxiety impairs students' ability to accurately estimate time intervals (I. Sarason and Stoops, 1978). The relationships between anxiety and school learning need to be further explicated.

Finally, there is need for new developments in the measurement of anxiety. The limitations of self-report questionnaires are well-known and such instruments fail to adequately capture the idiosyncratic, multidimensional nature of the construct (Kendall, 1978). Observational data may prove a fruitful measurement technique -- particularly with respect to content analysis of self-description (Post, Wittmaier, and Radin, 1978; I. Sarason, 1960). To the extent that attentional focus can be observed, such measures may be useful in assessing the level of aroused anxiety.

Our understanding of the impact of anxiety on all aspects of human behavior is one of the most important insights to emerge from this century. The nature of that understanding has been increasingly elaborated by researchers and clinicians. The task is far from over but progress has been encouraging. And, the reward for understanding and controlling anxiety may well be the beginning of the evolution of a humanistic social structure in which freedom from fear and guilt permits the growth and expression of the finest aspects of human experience.

# APPENDIX A

## Preliminary Studies

## APPENDIX A

### Preliminary Studies

In order to verify the effectiveness of the experimental design and to determine values for critical task parameters, a number of preliminary studies were conducted. The major goals of these studies were:

1. To assess the effectiveness of the stress instructions in evoking anxiety,
2. To determine the appropriate length of the to-be-remembered string,
3. To design an interpolated task which would be sufficiently complex to limit subjects' rehearsal while simple enough to permit retention of the string under non-stress conditions.

Pilot Study 1 - The Effect of Varying Exposure

The first of informal study was carried out in order to determine if the duration of initial exposure to the to-be-remembered string affected retention. Exposure time to six letter consonant strings were varied from 0.5 to 5.0 seconds. Three subjects were asked to recall the strings after working for 45 seconds on an interpolated task which consisted of crossing out all occurrences of the letter "A" on a page of random letters. All subjects were able to accurately recall the strings, regardless of initial exposure time. Subjects reported that the interpolated task did not interfere with their ability to rehearse the string. As a result of this informal study, it was concluded that duration of exposure was a less critical variable than the difficulty of the interpolated task. Studies using the short-term memory distractor paradigm often employ an arithmetic interpolated task (Watkins, 1967).

In order to facilitate the design of an appropriate interpolated task, several variants on the first informal study were performed. Each

variant tested the recall of three subjects on a to-be-remembered to-be-remembered string of six consonants. String exposures of 1.0, 1.5, 2.0, 3.0, and 5.0 seconds were tested using different interpolated tasks. Results indicated that interpolated tasks involving the addition or multiplication of two one-digit numbers were too simple to interfere with the retention of the string. More complex multiplications proved too difficult for some subjects. The task which emerged as most appropriate, was the mental addition of four summands such as: 4 + 8 + 11 + 6 = ? Requiring the subjects to perform a series of these summations following exposure to a to-be-remembered string resulted in somewhat less than perfect retention during the relaxed and relatively informal studies. It was felt, therefore, that this task would create sufficient rehearsal interference to accentuate the effect of stress on short-term retention. A pilot study 2 was conducted in order to determine the effectiveness of this task in a more rigorous experimental environment.

Pilot Study 2 - The Interpolated Task

Method and Procedure. The subjects were 23 students at a public university enrolled in two class sections of an Educational Psychology course. Twelve of the subjects were males while eleven of the subjects were female. The first class section was treated as a low-stress group (N=15) while the second section was treated as a high-stress group (N=8).

Stimulus materials were typed on 35mm sprocketed acetate film using an IBM Selectric typewriter with a nylon film ribbon. Slides containing a large question mark (?) were produced using rub-on transfer letters and were mounted by the same technique as the typed slides.

The subjects were given response booklets in which they recorded their answers. The booklets were identical for both groups except for the cover; the cover for the low-stress group had the word "experiment" typed on it while the high-stress group received protocols which indicated that the booklet was an experimental edition of the "Wolenheim Intelligence Test". Serial numbers and copyright notices were printed on the stress booklets to give the impression of a professionally produced test.

The slide projector and screen were in place when the students arrived. In the low-stress condition, the students were asked to participate in an "educational experiment" to help the experimenter with his dissertation research. A similar setting was used for the high-stress condition but the students were asked to serve as an experimental group in the development of a new intelligence test.

The following instructions were read to the non stress group:

> As part of my psychology course, I am conducting a study about memory in which I would appreciate your help. Before I explain about the study, I will ask you to fill out a short questionnaire describing how you feel right now. I need this information for the study.

The corresponding instructions for the stress group were:

> We are doing some research in testing and would like your help in evaluating some new ideas. Before I explain exactly what we are doing, I will ask you to fill out a brief questionnaire on which you can describe how you are feeling right now. It is important that you accurately state your feelings so we know how this type of experience is interpreted by students.

The State Worry-Emotionality scale was then handed out. Students were also asked to rate their expectancy of success on a scale of 1 to 10. Following administration of the W-E scale, the following instructions were read to the non-stress group:

> As I told you, the study involves memory. The first task I will ask you to do is relatively simple.

While corresponding instructions were read to the high-stress group:

> Now I'll explain the purpose of this study.
>
> In the past, many psychologists have measured intelligence by using I.Q. tests, which measure

> what you know. The purpose of this study is to measure intelligence by how well you can perform on some memory and arithmetic tasks. The reason that we are using these tasks is simple; earlier research has shown that people who are able to do well on this type of task are brighter than those who do poorly. So we expect that your performance on these tasks will be an indication of your intelligence. The first task you are to attempt is relatively simple.

This was followed by instructions for the stress-induction (failure) or control task.

Although the instructions and sample slides administered to the two groups were the same, the task itself was not. Subjects in the low-stress condition were asked to recall four character consonant strings such as "PZNF"; the task proved to be a simple one. Subjects in the stress group were asked to recall ten character consonant strings such as "MLRWCXTVJQ". As these strings exceeded the capacity of the subjects' short term memory the task proved impossible to perform successfully. Following completion of the stress induction task, subjects were asked to complete out the State W-E scale.

The short-term memory task was then administered. The task consisted of eight to-be-recalled strings. The string was exposed for 1.5 seconds. Then a series of arithmetic computations were presented (interpolated task). A slide with a question mark (?) on it served as the cue for the subject to write down the to-be-recalled string. As shown in table A-1, the length of string, meaningfulness of string, and number of interpolated problems was varied across trials.

Following administration of the experimental task, the subjects were given 15 minutes to complete a questionnaire in which they described their feelings regarding the experiment. The test booklets were collected and the remainder of the class period was devoted to debriefing the students in order to remove any residual stress.

Table A-1

Stimulus Sequences for Pilot Study 1

Sequence 1: CLHRDWF

13 + 9 + 7 + 8 =
11 + 5 + 9 + 4 =
7 + 6 + 12 + 9 =
13 + 3 + 4 + 6 =
6 + 13 + 4 + 9 =
4 + 8 + 12 + 4 =
?

Sequence 2: CPWKTS

6 + 13 + 9 + 8 =
12 + 4 + 6 + 3 =
9 + 8 + 16 + 6 =
4 + 10 + 6 + 4 =
4 + 2 + 11 + 3 =
2 + 11 + 6 + 2 =
5 + 9 + 14 + 6 =
?

Sequence 3: PLANET

7 + 2 + 1 + 12
12 + 5 + 6 + 4
9 + 7 + 14 + 5
4 + 12 + 5 + 1
7 + 12 + 5 + 8
4 + 9 + 18 + 5
?

Sequence 4: JTNVS

2 + 13 + 8 + 7
11 + 8 + 6 + 7
8 + 9 + 16 + 4
11 + 3 + 7 + 2
13 + 2 + 5 + 9
10 + 1 + 3 + 6
7 + 8 + 11 + 5
?

Sequence 5: GOBPAV

11 + 3 + 2 + 4
11 + 7 + 4 + 8
9 + 6 + 18 + 5
7 + 11 + 9 + 6
5 + 11 + 7 + 4
11 + 5 + 8 + 6
6 + 8 + 17 + 5
?

Sequence 6: LDMQNZ

14 + 5 + 8 + 6
6 + 11 + 7 + 1
9 + 5 + 11 + 6
12 + 5 + 6 + 4
11 + 3 + 4 + 6
7 + 9 + 16 + 6
?

Sequence 7: DRIVES

8 + 11 + 2 + 1
13 + 4 + 6 + 5
9 + 6 + 8 + 17
4 + 11 + 6 + 2
11 + 3 + 5 + 4
14 + 6 + 7 + 4
5 + 7 + 14 + 9
?

Sequence 8: HRFBJV

12 + 6 + 7 + 5
5 + 12 + 6 + 3
4 + 8 + 11 + 3
13 + 2 + 6 + 3
5 + 13 + 4 + 3
6 + 13 + 3 + 7
5 + 8 + 11 + 4
?

Results. The effectiveness of the stress induction was assessed by computing the mean state anxiety scores before and after the stress induction (or control) task. For the high-stress group, state anxiety increased significantly ($\bar{X}pre = 17.25$, $\bar{X}post = 19.63$, $t(7) = -2.48$, $p < .025$). For the low-stress group, anxiety did not increase following the control task ($\bar{X}pre = 13.00$, $\bar{X}post = 13.74$, $t(14) = -0.76$, n.s.). Statistically controlling for the differences in pre-induction anxiety, analysis of covariance revealed that the high and low-stress groups differed significantly on post-induction anxiety ($F(1,20) = 11.16$, $p < .003$).

Table A-2 summarizes the performance of the high and low-stress groups in terms of letters correctly recalled. As can be seen from this table, the high-stress group generally recalled fewer strings than the low-stress group.

Table A-2

Letters Recalled Correctly

On Trials Employing Arbitrary Strings

| Trial | String Length | high-stress $\bar{X}$ | % | $\sigma$ | low-stress $\bar{X}$ | % | $\sigma$ | t | p* |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 4.62 | 66 | .92 | 5.47 | 78 | 1.06 | -1.90 | .035 |
| 2 | 6 | 3.38 | 56 | 1.92 | 4.40 | 73 | 1.60 | -1.37 | .09 |
| 4 | 5 | 4.50 | 90 | .76 | 4.60 | 92 | .74 | -0.31 | n.s. |
| 5 | 6 | 5.62 | 93 | .74 | 5.93 | 98 | .26 | -1.47 | .075 |
| 6 | 6 | 3.86 | 64 | 2.64 | 4.00 | 66 | 1.60 | -0.14 | n.s. |
| 8 | 6 | 3.86 | 64 | 1.89 | 3.87 | 64 | 1.89 | .01 | n.s. |

* probabilities reported are for rejection of a one-tailed hypothesis

Pilot Study 3 - The Optimal String Length

In order to obtain further information regarding optimal string length, a third pilot study was conducted.

Method and Procedure. Subjects in the second pilot study were 27 students (14 of whom were male) enrolled in an undergraduate educational psychology course at Trenton State College. Their ages ranged from 19 to 30 years. Because the purpose of the second study was to determine performance under optimum conditions, a stress induction procedure was not used.

The materials employed were similar to those used in pilot study one. Two strings of length six, two strings of length seven, and two of length eight were employed. All strings were arbitrary (non-meaningful). Because the intent was to assess different string lengths, the number of interpolated computation problems was kept constant (there were eight). Table A-3 contains the stimulus sequences for pilot study three.

The procedure used was the same as that used for the low-stress group in pilot study two, except that the state W-E scales and the neutral tasks were not administered.

Results. The results of pilot study two are presented in Table A-4. Inspection of string length did not appear to be a critical variable since the mean number of letters recalled in all cases except trial 6 was between two and four.

Table A-3

Stimulus Sequences for Pilot Study 3

Sequence 1: KGPYMB

6 + 13 + 9 + 8 =
12 + 4 + 6 + 3 =
9 + 8 + 16 + 6 =
4 +10 + 6 + 4 =
4 + 2 + 11 + 3 =
2 +11 + 6 + 2 =
5 + 9 + 14 + 6 =
7 + 2 + 1 + 12 =
?

Sequence 2: CLZRDWF

13 + 9 + 7 + 8 =
11 + 5 + 9 + 4 =
7 + 6 +12 + 9 =
13 + 3 + 4 + 6 =
6 +13 + 4 + 9 =
5 + 8 +12 + 4 =
10 + 1 + 3 + 6 =
7 + 8 +11 + 5 =
?

Sequence 3: VJNQSHKB

6 + 8 +17 + 5 =
5 +11 + 7 + 4 =
9 + 6 +18 + 5 =
7 +11 + 9 + 6 =
11 + 3 + 2 + 4 =
11 + 7 + 4 + 8 =
4 +12 + 5 + 1 =
11 + 5 + 8 + 6 =
?

Sequence 4: GCPJLV

14 + 5 + 8 + 6 =
6 +11 + 7 + 1 =
9 + 5 +11 + 6 =
12 + 5 + 6 + 4 =
11 + 3 + 4 + 6 =
7 + 9 +16 + 6 =
12 + 7 + 6 + 3 =
11 + 3 + 7 + 2 =
?

Sequence 5: RQFMZWTJ

8 +11 + 2 + 1 =
13 + 4 + 6 + 5 =
9 + 6 + 8 +17 =
4 +11 + 6 + 2 =
11 + 3 + 5 + 4 =
14 + 6 + 7 + 4 =
5 + 7 +14 + 9 =
7 +12 + 5 + 8 =
?

Sequence 6: KDYHBSN

12 + 6 + 7 + 5 =
5 +12 + 6 + 3 =
4 + 8 +11 + 3 =
13 + 2 + 6 + 3 =
5 +13 + 4 + 3 =
6 +13 + 3 + 7 =
5 + 8 +11 + 4 =
9 + 7 +14 + 5 =
?

Table A-4

Mean Recall as a Function of String Length

| Trial | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Length | 6 | 7 | 8 | 6 | 8 | 7 |
| Mean Recall | 3.96 | 2.48 | 3.18 | 3.22 | 3.66 | 5.00 |
| Percent Recall | 66 | 35 | 39 | 54 | 46 | 71 |

# APPENDIX B

## Selected Experimental Materials

Print Your Name Here _____
(LAST) (FIRST)

Circle Your Sex: MALE FEMALE

Print Your Date of Birth _____
(MONTH) (DAY) (YEAR)

# NATIONAL INTELLIGENCE TEST

## Experimental Edition

Do not break the seal until you are told to do so.

DIRECTIONS: Circle the 1 if the statement does not describe your present feelings
Circle the 2 if the feeling is barely noticeable
Circle the 3 if the feeling is moderately strong
Circle the 4 if the feeling is strong
Circle the 5 if the feeling is very strong

| | | | | | |
|---|---|---|---|---|---|
| I do not feel very confident about my performance on this experiment . . . . . | 1 | 2 | 3 | 4 | 5 |
| I feel my heart beating fast . . . . . | 1 | 2 | 3 | 4 | 5 |
| I find myself thinking of how much brighter the other students are than I am . . . . . | 1 | 2 | 3 | 4 | 5 |
| I am so nervous that I may forget facts which I really know . . . . . | 1 | 2 | 3 | 4 | 5 |
| I am worrying a great deal about this experiment . . . | 1 | 2 | 3 | 4 | 5 |
| I am so tense that my stomach is upset . . . . . | 1 | 2 | 3 | 4 | 5 |
| Considering my state of mind, I feel I could have prepared myself better for this experiment . . . . . | 1 | 2 | 3 | 4 | 5 |
| I feel very panicky about participating in this experiment . | 1 | 2 | 3 | 4 | 5 |
| I am thinking of the consequences of performing poorly. . | 1 | 2 | 3 | 4 | 5 |
| I have an uneasy upset feeling. . . . . | 1 | 2 | 3 | 4 | 5 |

**DIRECTIONS: Circle the number which indicates how well you think you will perform on this experiment.**


**definitely will not do as well as I would like**

**definitely will do as well as I would like**

# Appendix C

## Analysis of Performance Using Worry and Emotionality Scores Separately

The analyses presented in Chapter IV were based on combined worry and emotionality scores. The scores were combined because they were highly correlated and because emotionality has been shown to exhibit patterns of variation similar to worry (Deffenbacher, 1978). From a theoretical perspective, however, worry would appear to be the more powerful of the two factors in its affect on attentional focus (Morris and Fulmer, 1977; Wine, 1971). Accordingly, the analyses reported in Chapter IV were also performed using the worry and emotionality scores separately. These analyses are summarized in Table C.1. As can be seen in the table the differences were not significant.

Table C.1

Multiple Correlation for Regression Models Predicting Task Performance from Stress Condition and State Anxiety (Worry, Emotionality, Worry and Emotionality)

| Dependent Variable | Multiple Correlations | | | |
|---|---|---|---|---|
| | | Anxiety Measure | | |
| | Regression Model[a] | WE23 | W23 | E23 |
| LC123567 (letters correct) | $\hat{Y} = A$ | .236 | .227 | .223 |
| | $\hat{Y} = A + S$ | .259 | .251 | .254 |
| | $\hat{Y} = A + S + (A \times S)$ | .328 | .293 | .344 |
| AC123567 (problems correct) | $\hat{Y} = A$ | .386 | .367 | .370 |
| | $\hat{Y} = A + S$ | .450 | .438 | .422 |
| | $\hat{Y} = A + S + (A \times S)$ | .531 | .501 | .517 |
| AO123567 (problems omitted) | $\hat{Y} = A$ | .291 | .272 | .283 |
| | $\hat{Y} = A + S$ | .347 | .334 | .330 |
| | $\hat{Y} = A + S + (A \times S)$ | .438 | .394 | .447 |

[a]A: anxiety measure (WE23, W23, E23)

S: stress condition (high, low)

b-weight coefficients are not shown

# REFERENCES

References


Alexander, F. Fundamentals of psychoanalysis. New York: Norton, 1963 (1948).

Alpert, R. and Haber, R. Anxiety in academic achievement situations. Journal of Abnormal and Social Psychology, 1960, 61, 207-215.

Atkinson, J.W. An introduction to motivation. New York: Van Nostrand Reinhold, 1964.

Borkowski, J.G. and Mann, T. Effects of anxiety and interference on short-term memory. Journal of Experimental Psychology, 1968, 78, 2, 352-354.

Brackbill, G. and Little, K. MMPI correlates of the Taylor manifest anxiety scale. Journal of Consulting Psychology, 1954, 18, 433-436.

Broadbent, D.E. Perception and communication. London: Pergamon Press, 1958.

Broadbent, D.E. and Heron, A. Effects of a subsidiary task on performance involving immediate memory by younger and older men. British Journal of Psychology, 1962, 53, 189-198.

Broverman, D., Klaiber, E. Vogel, W., and Kobayashi, Y. Short-term versus long-term effects of adrenal hormones on behaviors. Psychological Bulletin, 1974, 81, 10, 672-694.

Brown, J. Some tests of the decay theory of immediate memory. Quarterly Journal of Experimental Psychology, 1958, 10, 12-21.

Calvin, A.D., Koons, P.B., Bingham, J.F. and Fink, H.H. A further investigation of the relation between manifest anxiety and intelligence. Journal of Consulting Psychology, 1955, 19, 280-282.

Cattell, R. B. Anxiety and motivation: Theory and crucial experiments. In C.D. Spielberger (Ed.) Anxiety and behavior. New York: Academic Press, 1966.

Cherry, E.C. Some experiments on the recognition of speech with one and with two ears. Journal of the Acoustical Society of America, 1953, 25, 975-979.

Cherry, E.C. and Taylor, W.K. Some further experiments on the recognition of speech with one and two ears. Journal of the Acoustic Society of America, 1954, 26, 554-559.

Cohen, J. Multiple Regression As A General Data-Analytic System. Psychological Bulletin, 1968, 70, 6, 426-443.

Coleman, J.C. Abnormal psychology and modern life, (3rd Ed). Glenview, Illinois: Scott, Foresman, 1964.

Deffenbacher, J.L. Worry, emotionality, and task-generated interference in test anxiety: An empirical test of attentional theory. Journal of Educational Psychology, 1978, 70, 2, 248-254.

Doctor, R.M. and Altman, F. Worry and emotionality as components of test anxiety: replication and further data. Psychological Reports, 1969, 24, 563-568.

Dollard, J. and Miller, N.E. Personality and psychotherapy. New York: McGraw-Hill, 1950.

Doris, J. and Sarason, S. Test anxiety and blame assignment in a failure situation. Journal of Abnormal and Social Psychology, 1955, 50, 335-338.

Easterbrook, J.A. The effect of emotion on cue utilization and the organization of behavior. Psychological Review, 1959, 83-201.

Fenichel, O. The psychoanalytic theory of neurosis. New York: Norton, 1945.

Fischer, W.F. Theories of anxiety. New York: Harper and Row, 1970.

Frank, L.K. Projective mothods for the study of personality, Journal of Psychology, 1939, 8, 389-413.

Freud, S. The problem of anxiety. New York: Norton, 1936. (Original publication in German, 1923).

Ganzer, V.J. Effects of audience presence and test anxiety on learning and retention in a serial learning situation. Journal of Personality and Social Psychology, 1968, 8, 194-199.

Gaudry, E. and Spielberger, C.D. Anxiety and educational achievement. Sydney: John Wiley and Sons, 1971.

Harleston, B.W. Test anxiety and performance in problem-solving situations. Journal of Personality, 1962, 50, 4, 557-573.

Hodges, W.F. and Spielberger, C.D. Digit-span: An indicant of trait or state anxiety? Journal of Consulting and Clinical Psychology, 1969, 33, 430-434.

Hull, C.L. Principles of behavior. New York: Appleton, 1943.

Iacino, L. and Cook, P. Threat of shock, state anxiety, and the Holtzman inkblock technique. Journal of Personality Assessment, 1974, 38, 5, 450-458.

Izard, C.E. and Tomkins, S.S. Affect and bahavior: Anxiety as a negative affect. In C.D. Spielberger (Ed). Anxiety and behavior. New York: Academic Press, 1966.

James, W. The principles of psychology. New York: H. Holt, 1890.

Jessor, R. and Hammond, K.R. Construct validity and the Taylor anxiety scale. Psychological Bulletin, 1957, 54, 161-170.

Kahneman, D. Attention and effort. Englewood Cliff, New Jersey: Prentice-Hall, 1973.

Keele, S.W. Attention demands of memory retrieval. Journal of Experimental Psychology, 1972, 93, 2, 245-248.

Kendall, P.C. Anxiety: States, traits-situations? Journal of Consulting and Clinical Psychology, 1978, 46, 2, 280-287.

Kerrick, J.S. Some correlates of the Taylor manifest anxiety scale. Journal of Abnormal and Social Psychology, 1955, 50, 75-77.

Leherissey, B., O'Neil, H., Heinrich, D., and Hansen, D. Effect of anxiety, response mode, subject matter familiarity and learning times on achievement in computer-assisted learning. Proceedings, 79th Annual Convention, APA, 1971.

Levitt, E.E. The psychology of anxiety. Indianapolis: Bobbs-Merrill, 1967.

Lewis, J.L. Semantic processing of an unattended message using dichotic listening. Journal of Experimental Psychology, 1970, 85, 225-228.

Liebert, R.M. and Morris, L.W. Cognitive and emotional components of test anxiety: A distinction and some initial data. Psychological Reports, 1967, 20, 975-978.

Lunneborg, P.W. Relations among social desirability, achievement, and anxiety measures in children. Child Development, 1964, 35, 169-182.

Mackworth, N.H. Researches on the measurement of human performance. In H.W. Sinaiko (Ed.), Selected papers on human factors in the design and use of control systems. New York: Dover, 1961.

Mandler, G. and Sarason, S.B. A study of anxiety and learning. Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

Mandler, G. and Watson, D.L. Anxiety and the interruption of behavior. In C.D. Spielberger (Ed.), Anxiety and Behavior. New York: Academic Press, 1966.

Marlett, N.J. and Watson, D. Test anxiety and immediate or delayed feedback in a test-like avoidance task. Journal of Personality and Social Psychology, 1968, 8, 200-203.

McClelland, D.C., Atkinson, J.W., Clark, R.A., and Lowell, E.L. The achievement motive. New York: Appleton-Century-Crofts, 1953.

McClelland, D.C., Clark, R.A., Roby, T. and Atkinson, J.W. The projective expression of needs: IV. The effect of need for achievement on thematic apperception. Journal of Experimental Psychology, 1949, 39, 242-255.

Meunier, C. and Rule, B.G. Anxiety, confidence, and conformity. Journal of Personality, 1967, 35, 498-504.

Miller, G.A. The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychological Review, 1956, 63, 81-97.

Moldawsky, S. and Moldawsky, P.C. Digit span as an anxiety indicator. Journal of Consulting Psychology, 1952, 16, 115-118.

Moray, N. Attention in dichotic listening: affective cues and the influence of instructions. Quarterly Journal of Experimental Psychology, 1959, 11, 56-60.

Morris, L.W. and Fulmer, R.S. Test anxiety (Worry and Emotionality) changes during academic testing as a function of feedback and test importance. Journal of Educational Psychology, 1976, 68, 6, 817-824.

Morris, L.W. and Liebert, R.M. Relationship of cognitive and emotional components of test anxiety to physiological arousal and academic performance. Journal of Consulting and Clinical Psychology, 1970, 35, 3, 332-337.

Mowbray, G.H. Simultaneous vision and audition: The comprehension of prose passages with varying levels of difficulty. Journal of Experimental Psychology. 1953, 46, 365-372.

Mowrer, O.H. A stimulus-response analysis of anxiety and its role as a reinforcing agent. Psychological Review. 1939, 46, 553-565.

Murdock, B.B. Effects of a subsidiary task on short-term memory. British Journal of Psychology, 1965, 56, 413-419.

Murray, J.B. Renewed interest in attention. Psychological Reports, 1974, 34, 155-166.

Neale, J.M. and Katahn, M. Anxiety, choice and stimulus uncertainty. Journal of Personality, 1968, 36, 235-245.

Neisser, V. Cognitive psychology. New York: Appleton-Century-Crofts, 1967.

Ninio, A. and Kahneman, D. Reaction time in focused and in divided attention. Journal of Experimental Psychology, 1973. Cited in D. Kahneman, 1973, op. cit.

Norman, D.A. Memory and attention: An introduction to human information processing. New York: John Wiley & Sons, 1969.

Posner, M.I. and Boies, S.J. Components of attention. Psychological Review, 1971, 78, 5, 391-408.

Post, A.L., Wittmaier, B.C., and Radin, M.E. Self-disclosure as a function of state and trait anxiety. Journal of Consulting and Clinical Psychology, 1978, 46, 1, 12-19.

Richardson, F.C., O'Neil, H.F., and Grant, R.D., Development and evaluation of an automated test-anxiety reduction program for a computer-based learning environment. In J.E. Sieber, H.F. O'Neil, and S. Tobias, 1977.

Salzman, L. The obsessive personality. New York: Jason Aronson, Inc., 1973.

Sandison, P.C. and Burgess, I.S. The effects of anxiety level upon short-term memory. Journal of Behavioural Science, 1971, 1, 3, 117-120.

Sarason, I.G. Empirical findings and theoretical problems in the use of anxiety scales. Psychological Bulletin, 1960, 57, 5, 403-415.

Sarason, I.G. Experimental approaches to test anxiety: Attention and the uses of information. In. C.D. Spielberger, 1972, op cit.

Sarason, I.G. and Ganzer, V.J. Anxiety, reinforcement, and experimental instructions in a free verbalization situation. Journal of Abnormal and Social Psychology, 1962, 65, 300-307.

Sarason, I.G. and Ganzer, V.J. Effects of test anxiety and reinforcement history on verbal behavior. Journal of Abnormal and Social Psychology, 1963, 67, 513-519.

Sarason, I.G. and Koenig, K.P. The relationship of test anxiety and hostility to description of self and parents. Journal of Personality and Social Psychology, 1965, 2, 617-621.

Sarason, I.G. and Stoops, R. Test anxiety and the passage of time. Journal of Consulting and Clinical Psychology, 1978, 46, 1, 102-109.

Sarason, S.B., Davidson, K.S., Lighthall, F.F., Waite, R.R. and Ruebush, B.K. Anxiety in elementary school children. New York: Wiley & Sons, 1960.

Sarason, S.B. and Gordon, E.M. The test anxiety questionnaire: scoring norms. Journal of Abnormal and Social Psychology, 1953, 48, 447-448.

Sarason, S.B., Mandler, G. and Craighill, P.G. The effect of differential instructions on anxiety and learning. Journal of Abnormal and Social Psychology, 1952, 47, 561-565.

Schachter, S. A cognitive-physiological view of emotion. In Q Klineberg and R. Christie (Eds.) Perspectives in social psychology, 1964.

Schlesinger, A.J., Jr. The vital center. New York: Houghton-Mifflin, 1948. Quoted in E.E. Levitt, 1967.

Sieber, J.E., Kameya, L.I., and Paulson, F.L. Effect of memory support on the problem-solving ability of test-anxious children. Journal of Educational Psychology, 1970, 61, 2, 159-168.

Sieber, J.E., O'Neil, H.F., and Tobias, S. Anxiety, Learning, and Instruction. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Spence, J.T. and Spence, K.W. The motivational components of manifest anxiety: Drive and drive stimuli. In C.D. Spielberger, 1966.

Spence, K.W. Anxiety (drive) level and performance in eyelid conditioning. Psychological Bulletin, 1964, 61, 129-139.

Spence, K.W. A theory of emotionally based drive (D) and its relation to performance in simple learning situations. American Psychologist, 1958, 13, 131-141.

Sperling, G. Successive approximations to a model for short-term memory. In A.F. Sanders (Ed.) Attention and performance. Amsterdam: North-Holland Publishing Co., 1967.

Spielberger, C.D. Anxiety and behavior. New York: Academic Press, 1966.

Spielberger, C.D. Anxiety as an emotional state. In C.D. Spielberger, 1972, op cit.

Spielberger, C.D. Anxiety: Current trends in theory and research. New York: Academic Press, 1972.

Spielberger, C.D. Complex learning and academic achievement. In C.D. Spielberger, 1966 (a), op cit.

Spielberger, C.D. The effects of manifest anxiety on the academic achievement of college students. Mental Hygiene, 1962, 46, 420-426.

Spielberger, C.D. Theory and research on anxiety. In C.D. Spielberger, 1966 (b), op cit.

Spielberger, C.D., Edwards, C.D., Montouri, J., and Lushene, R. Manual for the children's state-trait anxiety inventory. Palo Alto, California: Consulting Psychologists Press, 1973.

Spielberger, C.D., Gorsuch, R., and Lushene, R. Manual for the state-trait anxiety inventory. Palo Alto, California: Consulting Psychologists Press, 1970.

Spielberger, C.D. and Katzenmeyer, W.G. Manifest anxiety, intelligence, and college grades. Journal of Consulting Psychology, 1959, 23, 278.

Stroop, J.R. Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 1935, 18, 643-662.

Taylor, J.A. A personality scale of manifest anxiety. Journal of Abnormal and Social Psychology, 1953, 48, 285-290.

Taylor, J.A. Drive theory and manifest anxiety. Psychological Bulletin, 1956, 53, 4, 303-320.

Taylor, J.A. The relationship of anxiety to the conditioned eyelid response. Journal of Experimental Anxiety, 1951, 41, 81-92.

Tobias, S. A model for research on the effect of anxiety on instruction. In J.E. Sieber, H.F. O'Neil, and S. Tobias, 1977, op cit.

Trapp, E.P. and Kausler, P.H. Test anxiety level and goal-setting behavior. Journal of Consulting Psychology, 1958, 22, 31-34.

Triesman, A. Verbal cues, language and meaning in selective attention. American Journal of Psychology, 1964, 77, 215-216.

Uno, T. and Grings, W. Autonomic components of orienting behavior. Psychophysiology, 1965, 1, 311-321.

Vygotsky, L.S. Thought and language. Cambridge, Mass.: The MIT Press, 1962. (Originally published in Russian: Soc.-econom. izd., Moscow-Leningrad, 1934.)

Walker, B.S. and Orr, F.E. Anxiety and the next-in-line effect. Journal of Educational Psychology, 1976, 68, 775-778.

Walker, R.E. and Spence, J.T. Relationship between digit span and anxiety. Journal of Consulting Psychology, 1964, 28, 3, 220-223.

Watkins, M.J. Concept and Measurement of Primary Memory. Psychological Bulletin, 1974, 81, 10, 695-711.

Wine, J. Cognitive-attentional approaches to test anxiety modification. Paper presented as part of a symposium entitled "Anxiety and Instruction" at the annual conference of the American Psychological Association, Montreal, August, 1973.

Wine, J.D. Investigations of an attentional interpretation of test anxiety. Doctoral Dissertaion. University of Waterloo, 1970.

Wine, J.D. Test anxiety and direction of attention. Psychological Bulletin, 1971, 76, 2, 92-104.

Zubrzycki, C.R. and Borkowski, J.G. Effects of anxiety on storage and retrieval processes in short-term memory. Psychological Reports, 1973, 33, 315-320.