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TECH REPORT

THE EFFECTS OF ANXIETY ON COMPUTER-ASSISTED LEARNING

Charles D. Spielberger

Technical Report 7

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The Effects of Anxiety on Computer-Assisted Learning[1]

Charles D. Spielberger

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During the past half-century, two very different approaches or orientations to the discovery of psychological laws have emerged. The first of these orientations is concerned with general psychological processes that are found in all behaving organisms. The second emphasizes the study of individual differences in behavior.

Psychologists who study general processes tend to use experimental methods in which they manipulate selected variables and rigorously control others. Such procedures permit them to test explicit hypotheses regarding the effects on behavior of specific changes in environmental conditions, and to formulate precise laws relating behavior to its antecedents. Psychologists who study individual differences are also interested in relationships between environmental factors and behavior, but their approach to psychological research does not usually involve experimental manipulation. These differential psychologists are concerned primarily with discovering correlations between already existing variations in behavior and a wide range of environmental circumstances, not just those that can be manipulated.

In his presidental address to the American Psychological Association, Cronbach (1957) discussed the divergence in goals and methods of psychologists

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mainly concerned with general processes and those primarily interested in individual differences. He believed this divergence was so fundamental and profound that he entitled his address, "The two disciplines of scientific psychology." In recent years, however, efforts have been made to combine and integrate these two approaches to scientific psychology. Such integrative efforts are perhaps most clearly reflected in studies which have investigated the influence of individual difference variables on the learning process.

Progress towards the unification of experimental and differential psychology in the learning area was assessed in a symposium on 'Learning and Individual Differences' held in 1965 at the University of Pittsburg (Gagne, 1967). The compelling conclusion that follows from reading the papers presented at the Pittsburg conference is that the integration of individual differences with learning theory is, as yet, minimal. In his comments on these papers, Melton suggested a strategy which might be effective in bringing about the needed integration. According to Melton: "What is necessary is that we frame our hypotheses about individual difference variables in terms of the process constructs of contemporary theories of learning and performance" (1967, p. 239).

The major goal in this chapter is to formulate hypotheses about the effects of individual differences in anxiety on the learning process. These hypotheses will be framed in terms of the learning constructs of a theory of emotionally based drive proposed by Spence (1958) and Taylor (1956), and tested in experiments on computer assisted instruction. The paper will be divided into five sections. In Section I, the fundamental nature of anxiety phenomena will be considered in historical perspective. In Section II, a trait-state conception of anxiety will be described. Spence-Taylor Drive Theory and the empirical evidence supporting it will be briefly reviewed in Section III. In Section IV, experiments on the relation between anxiety and performance in computer-assisted learning will be reported. Finally, in Section V, implications of research on anxiety and learning for the performance of school children in the classroom will be discussed.

I. Theory and Research on Anxiety

Anxiety is regarded as a principal causative agent for such diverse behavioral consequences as insomnia, debilitating psychological and psychosomatic symptoms, immoral and sinful acts, and even instances of creative self-expression.[2] Recognition of the importance of anxiety as a powerful influence in contemporary life is reflected in the following passage from *Time*:

> Anxiety seems to be the dominant fact--and is threatening to become the dominant cliché--of modern life. It shouts in the headlines, laughs nervously at cocktail parties, nags from advertisements, speaks suavely in the board room, whines from the stage, clatters from the Wall Street ticker, jokes with fake youthfulness on the golf course and whispers in privacy each day before the shaving mirror and the dressing table. Not merely the black statistics of murder, suicide, alcoholism and divorce betray anxiety (or that special form of anxiety which is guilt), but almost any innocent, everyday act: the limp or over-hearty handshake, the second pack of cigarettes or the third martini, the forgotten appointment, the stammer in mid-sentence, the wasted hour before the TV set, the spanked child, the new car unpaid for. (Time, March 31, 1961, p. 44)

The current interest in anxiety phenomena has many historical antecedents. For example, a conception of fear or anxiety may be found in ancient Egyptian hieroglyphics (Cohen, 1969). James Kritzeck of the Department of Oriental Studies at Princeton notes a central concern with anxiety phenomena in the work of the medieval Arab philosopher, Ali Ibn Hazm of Cordova. In a treatise entitled, "A philosophy of character and conduct," written in the 11th century A.D., Hazm states:

> I have constantly tried to single out one end in human actions which all men unanimously hold as good, and which they all seek. I have found only this: The aim of escaping anxiety. Not only have I discovered that all humanity considers this end good and desirable but also that no one is moved to act, or resolves to speak a single word, who does not hope by means to this action or word to release anxiety from his spirit. (Kritzeck, 1956, p. 573).

Whatever the historical forerunners, it was Freud who first attempted to explicate the meaning of anxiety within the context of psychological theory. He regarded anxiety as "something felt"--a fundamental, unpleasant emotional state or condition (Freud, 1924). This state, as Freud observed it in patients with anxiety neurosis, was characterized by "all that is covered by the word, nervousness, apprehension or anxious expectation, and efferent (physiological) discharge phenomena." Specific symptoms in anxiety states included heart palpitation, disturbances in respiration, sweating, tremor and shuddering, vertigo, and other physiological and behavioral manifestations. For Freud, anxiety was distinguishable from other unpleasant affective states such as anger or grief by its unique combination of phenomenological and physiological qualities. These gave to anxiety a special "character of unpleasure."

In his early theoretical formulations, Freud believed that anxiety resulted from the discharge of repressed somatic sexual tensions which he called libido. When libidinal energy was blocked from normal expression, it accumulated and was automatically transformed into anxiety or into symptoms that were anxiety equivalents. Freud (1936) subsequently modified this view in favor of a more general conception in which the functional utility of anxiety was emphasized. In his later theoretical conception, Freud regarded anxiety as a *signal* indicating the presence of a dangerous situation, and he differentiated between objective anxiety and neurotic anxiety largely on the basis of whether the source of the danger was from the external world or from the individual's own internal impulses.

For Freud, anxiety was the "fundamental phenomenon and the central problem of neurosis" (1936, p. 85), and understanding anxiety was considered by him to be "the most difficult task that has been set us," a task whose solution required "the introduction of the right abstract ideas, and their application to the raw material of observation so as to bring order and lucidity into it" (Freud, 1933, p.113). The complexity of this task and Freud's personal commitment to it are reflected in the fact that his theoretical views on the subject of anxiety evolved over a period of nearly 50 years, were continually modified, and were never regarded by him as complete.

Clinical studies of anxiety have appeared in the psychiatric literature with increasing regularity since 1894 at which time Freud first conceptualized anxiety neurosis as a discrete psychopathological syndrome to be distinguished from neurasthenia. Following Pavlov's discovery of experimental neurosis more than a half-century ago, there have been numerous experimental investigations of fear, frustration, and conflict in animals. In the past two decades, however, empirical research on anxiety has dramatically increased. During this period, more than 2,000 studies have been indexed under the heading "anxiety" in *Psychological Abstracts*, and over 3,000 studies have been indexed under "anxiety" or "anxiety-neurosis" in *Excerpta Medica* and *Index Medicus*. Inasmuch as there is surprisingly little overlap between the psychological and medical literature, it seems safe to estimate that over 4,000 articles or books on anxiety have been published since 1950.

While theory and research on anxiety have proliferated, this has not led to a consistent body of empirical findings, nor to convergence among theoretical interpretations. The distinguished scientists and clinicians who have made important contributions to the understanding of anxiety phenomena have, unfortunately, approached the problem of anxiety with their own unique theoretical perspectives and research objectives (Spielberger, 1966a). Consequently, despite the magnitude of the research effort, lack of agreement regarding the nature of anxiety, the particular stimulus conditions that arouse it, and the experiences that make individuals more or less vulnerable to it is still the rule rather than the exception. Indeed, our knowledge of anxiety today is not very different from what it was in 1950 when Hoch and Zubin introduced a symposium sponsored by the American Psychopathological Association with the following statement:

> Although it is widely recognized that anxiety is the most pervasive psychological phenomenon of our time and that it is the chief symptom in the neurosis and in the functional psychoses, there has been little or no agreement on its definition, and very little if any progress in its measurement (1950, p. v).

Given the prevailing interest in anxiety phenomena, and the extensive amount of empirical work that is being done, the need for a comprehensive theory of anxiety is obvious. In the next section, a trait-state conception of anxiety is proposed as a theoretical framework for classifying existing knowledge of anxiety phenomena and guiding future research.

II. State and Trait Anxiety

Research findings suggest that an adequate theory of anxiety must distinguish conceptually and operationally between anxiety as a transitory state and as a relatively stable personality trait. It is also apparent that a comprehensive theory of anxiety must differentiate between anxiety states, the stimulus conditions that evoke these states, and the defenses that serve to avoid or ameliorate them (Spielberger, 1966a). In this section, two different anxiety constructs, state anxiety (A-State) and trait anxiety (A-Trait), will be defined. A trait-state theory of anxiety will then be proposed in which the relationship between these concepts is clarified.

State Anxiety (A-State) may be conceptualized as a transitory emotional state or condition of the human organism that varies in intensity and fluctuates over time. This condition is characterized by subjective, consciously perceived feelings of tension and apprehension, and activation of the autonomic nervous system. Level of A-State intensity should be high in circumstances that are perceived by an individual to be threatening, irrespective of the objective danger; A-State intensity should be relatively low in objectively nonstressful situations, or under circumstances in which an existing danger is not perceived as threatening.

Trait Anxiety (A-Trait) refers to relatively stable individual differences in anxiety proneness, that is, to differences in the disposition to perceive a wide range of stimulus situations as dangerous or threatening, and in the tendency to respond to such threats with A-State reactions. Persons who are high in A-Trait tend to perceive a larger number of situations as more dangerous or threatening than persons who are low in A-Trait, and to respond to threatening situations with A-State elevations of greater intensity. A-Trait may also be regarded as reflecting individual differences in the frequency with which A-States have been manifested in the past, and in the probability that such states will be experienced in the future. Anxiety scales which require individuals to report how often they have experienced symptoms such as "worrying" or diarrhea would thus appear to be measures of A-Trait.

A major task for a trait-state theory of anxiety is to identify the characteristics of stressor stimuli that evoke differential levels of A-State in persons who differ in A-Trait. Atkinson (1964) suggests that a "fear of failure" motive is reflected in measures of A-Trait, and Sarason (1960) emphasizes the special significance for high A-Trait individuals of situations that arouse self-depreciating tendencies. On the basis of a review of the research findings obtained with various anxiety scales, Sarason concludes:

> ...the bulk of the available findings suggest that high anxious <u>S</u>s are affected more detrimentally by motivating conditions or failure reports than are <u>S</u>s lower in the anxiety score distribution...It is interesting to note that high anxious <u>S</u>s have been found to be more self-deprecatory, more self-preoccupied and generally less content with themselves than <u>S</u>s lower in the distribution of anxiety...it may well be that highly motivating or ego-involving instructions serve the function of arousing these self-oriented tendencies. (Sarason, 1960, p. 401-402).

Experimental investigations of anxiety phenomena have produced findings that are generally consistent with Atkinson's suggestion that fear of failure is a major characteristic of high A-Trait people, and with Sarason's conclusion that ego-involving instructions are more detrimental to the performance of high A-Trait individuals than persons with low A-Trait. In general, the experimental literature on anxiety appears to indicate that situations which pose direct or implied threats to self-esteem produce differential levels of A-State in persons who differ in A-Trait.

Although failure or ego-involving instructions evoke higher levels of A-State intensity in high A-Trait subjects than in low A-Trait subjects, whether or not a particular high A-Trait individual will show an elevation in A-State in a specific situation will depend upon the extent to which he perceives the situation as dangerous or threatening, and this will be greatly influenced by his aptitude and skills and by his past experience. For example, the requirement to perform on a difficult task may evoke high levels of A-State in most individuals with high A-Trait, but a high A-Trait person who has the requisite skills and experience to do well on a task is not likely to regard it as threatening. Conversely, a task or situation that most people would find nonthreatening might be regarded as extremely dangerous by a low A-Trait individual for whom it had special traumatic significance. Thus, while measures of A-Trait provide useful information regarding the probability that high levels of A-State will be aroused, the impact of any given situation can only be ascertained by taking actual measurements of A-State intensity in that situation.

There is some evidence that persons with high A-Trait do not perceive physical dangers as any more threatening than do low A-Trait individuals. It has been observed, for example, that while threat of electric shock produces significant increases in both self-report and physiological measures of A-State, the magnitude of increase in A-State intensity produced by shock-threat is unrelated to level of A-Trait as measured by the MAS (Katkin, 1965; Hodges & Spielberger, 1966).

In the Hodges-Spielberger study, Ss were also given a "Fear of Shock

Questionnaire" (FSQ) which was included among a group of tests administered two months prior to the experiment. The FSQ consisted of the single item, "How much concern or apprehension would you feel about participating in a psychology experiment in which you received electric shock?" Subjects responded by rating themselves or a five-point scale from "none" to "extreme." FSQ scores were positively and significantly correlated with changes in heart rate produced by threat of shock (r=.43), and with level of A-State intensity as measured by the AACL-Today (r=.49). In contrast, no correlations were found between the FSQ and MAS scores, nor between the FSQ and changes in heart rate. Thus, subjects who reported greater fear of shock showed greater increases in physiological and self-report measures of A-State intensity when threatened with shock than those who reported little or no fear of shock, but threat of shock failed to produce differential increases in these A-State measures for persons who differed in level of A-Trait.

<u>A Trait-State Theory of anxiety</u>

The conception of anxiety presented in Figure 1 assumes that the arousal of A-State involves a process or sequence of temporally ordered events. This process may be initiated by an external stimulus that is appraised by an individual as dangerous, such as the imminent threat of injury or death faced

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Insert Figure 1 about here

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by a soldier in combat. Or it may be aroused by situations that involve psychological stress, such as the threat to self-esteem that is encountered in performing on a competitive task.

Internal stimuli which cause an individual to anticipate danger may also evoke higher levels of A-State. For example, a student who suddenly recalls that he has not prepared for a test that will be administered during the next class period is likely to experience an increase in level of A-State intensity. As previously noted, situations or circumstances in which personal adequacy is evaluated are likely to be perceived as more threatening by high A-Trait individuals than by persons who are low in A-Trait. However, the appraisal of a particular stimulus or situation as threatening may be influenced more by idiosyncratic skills and past experience than by either the individual's level of A-Trait or the objective danger that is inherent in the situation.

Once a stimulus situation is appraised as threatening, Trait-State Anxiety Theory (Spielberger, Lushene & McAdoo, in press) posits that: (1) an A-State reaction will be evoked; (2) the <u>intensity</u> of the A-State reaction will be proportional to the amount of threat the situation poses for the individual; and (3) the <u>duration</u> of the reaction will depend upon the persistence of the evoking stimuli and the individual's previous experience in dealing with similar circumstances. The theory further assumes that through sensory and cognitive feedback mechanisms high levels of A-State intensity will be experienced as unpleasant, and will serve to initiate cognitive or motoric processes that have effectively reduced A-States in the past.

Stressful situations that are encountered frequently may lead an individual to develop effective coping responses that quickly alleviate or minimize the danger, thereby reducing immediately the intensity of the A-State reaction.

A person may also respond directly to situations that are appraised as threatening with defensive processes that serve to reduce the intensity of A-State reactions. Two important classes of stressor situations can be identified which appear to have different implications for the evocation of A-States in persons who differ in A-Trait:

1. Circumstances in which personal adequacy is evaluated appear to be more threatening to high A-Trait individuals than to persons with low A-Trait.

2. Situations that are characterized by physical danger are not interpreted as any more threatening by high A-Trait individuals than by those with low A-Trait.

Accordingly, differential elevations in A-State would be expected for persons who differ in A-Trait only under circumstances that are characterized by some degree of threat to self-esteem. In situations that involve physical danger, however, no difference in A-State elevation would be expected for Ss who differed in A-Trait unless, of course, personal adequacy was also threatened.[3]

With regard to the etiology of individual differences in A-Trait, it is assumed that residues of past experience dispose high A-Trait persons to appraise situations which involve some kind of personal evaluation as more threatening than do individuals who are low in A-Trait. We may speculate that childhood experiences influence the development of individual differences in A-Trait and that parent-child relationships centering around punishment are especially important in this regard. The fact that self-depreciating attitudes are aroused in high A-Trait persons under circumstances characterized by failure or ego-involving instructions suggests that excessive criticism and negative appraisals from parents may have undermined the self-confidence and adversely influenced the self-concept of these individuals.

In summary, the schematic diagram that is presented in Figure 1 provides a cross sectional analysis of anxiety phenomena. In this trait-state conception of anxiety, two different anxiety constructs, A-State and A-Trait, are posited and distinguished from the stimulus conditions which evoke A-States and the defenses that help individuals to avoid or reduce them. Thus, Figure 1 provides a conceptual frame of reference for classifying the major variables that should be considered in research on anxiety phenomena, and suggests some of the possible interrelationships among them. The classes of variables that we believe to be most significant in anxiety research are: (a) the characteristics of stimuli, both external and internal, that evoke A-States; (b) the nature of the cognitive processes that are involved in appraising various stimuli as dangerous or threatening; and (c) the defense mechanisms that are employed to avoid A-States, or to reduce the intensity of these states once they are experienced.

The State-Trait Anxiety Inventory

The State-Trait Anxiety Inventory (Spielberger & Gorsuch, 1966; Spielberger, Gorsuch & Lushene, 1969) was developed to provide reliable, relatively brief, self-report measures of both state and trait anxiety. Four important characteristics determined the test construction strategy for the STAI:

1. When the scale was given with instructions that required the subject to report his typical anxiety level ("Indicate how you generally feel"), each individual item was expected to correlate with other anxiety scales that were widely accepted as measures of individual differences in A-Trait, e.g., the Taylor Manifest Anxiety Scale and the IPAT Anxiety Scale. Each individual A-Trait item was also expected to be impervious to situational factors and relatively stable over time.

2. When the scale was given with instructions that required the subject to

report his present feelings ("Indicate how you feel <u>right now</u>"), each item was expected to reflect level of A-State intensity at that particular moment in time. Therefore, items were retained for the final scale only if they showed higher means in a <u>priori</u> stressful situations than in non-stressful or nonthreatening situations.

3. A third characteristic that was sought in the STAI was high reliability in the measurement of both A-Trait and A-State, but particularly for the latter.[4] In evaluating the effects of various stressor conditions on level of A-State, the major interest is most often in the differences obtained on two or more occasions of measurement. Difference scores between any two occasions contain the error components of both the initial and final scores. Therefore, if the components of the difference score are only moderately reliable, the resulting difference score will itself be low in reliability, and thus insensitive to changes in A-State.

4. To maximize its usefulness in psychological research, a fourth characteristic that was desired in the STAI A-State scale was ease and brevity of administration. In the investigation of the effects of emotional states on performance, a long involved test would be unsuitable for many experimental tasks in which taking the test might interfere with performance on the task. Furthermore, a long test would be less sensitive to rapid fluctuation in A-State.

The A-State scale that was developed on the basis of these criteria consists of 20 statements that ask people to describe how they feel at a particular moment in time; subjects respond to each scale item (e.g., "I feel tense") by rating themselves on the following four-point scale: (1) "Not at all; (2) Somewhat; (3) Moderately so; (4) Very much so." The A-Trait scale consists of 20 statements that ask people to describe how they generally feel; subjects respond to each scale item (e.g., "I lack self confidence") by checking one of the following: (1) Almost never; (2) Sometimes; (3) Often, (4) Almost always. The State-Trait Anxiety Inventory is comprised of these two self-report scales. Item selection procedures and the item validation process for the STAI are described in detail by Spielberger and Gorsuch (1966) and by Spielberger, Gorsuch and Lushene (1969a).

The STAI A-State scale evaluates subjective feelings of tension, nervousness, worry and apprehension. In developing this scale, it was discovered that such feelings were highly correlated with the absence of feelings of calmness, security, contentedness and the like. Therefore, items such as "I feel calm" and "I feel content" were included to produce a balanced A-State scale: half of the items pertain to the presence of feelings of apprehension, worry or tension, and the remaining items reflect the absence of such states. Thus, the STAI A-State scale defines a continuum of increasing levels of A-State intensity, with low scores indicating states of calmness and serenity, intermediate scores indicating moderate levels of tension and apprehensiveness, and high scores reflecting states of intense apprehension and fearfulness that approach panic.

It has been demonstrated that scores on the STAI A-State scale increase in response to various kinds of stress and decrease as a result of relaxation training (Spielberger, et al., 1969). Further evidence bearing on the construct validity of the STAI A-State scale may be found in recent studies by Hodges (1967) and Taylor, Wheeler, and Altman (1968), and in the experiments that are reported in Section IV below. The relationship between anxiety and learning is considered in the next section.

III. Anxiety and Learning

Over the past two decades, much of the research on the effects of individual differences in anxiety on the learning process has been guided by a theory of emotionally-based drive formulated by Spence (1958) and Taylor (1956). A detailed statement of the current status and empirical evidence supporting Drive Theory was recently published by Spence and Spence (1966). The theory proceeds from Hull's (1943) basic assumption that excitatory potential, E, which determines the strength of a given response, R, is a multiplicative function of total effective drive state, D, and habit strength, H. Thus:

$$R = f(E) = f(D \times H)$$

Total effective drive state, D, results from the summation of all individual need states existent in a person at a given period of time, irrespective of their source. The number and strength of the specific habits that are elicited in any situation is determined by an individual's previous experience in the same, or in similar situations. All habit tendencies that are evoked in a subject by a particular situation are multiplied by D. Predictions from Hullian theory regarding the effects of variations in D on performance have been succinctly stated by Taylor:[5]

> The implication of varying drive level in any situation in which a single habit is evoked is clear: the higher the drive, the greater the value of E and hence of response strength. Thus in simple noncompetitional experimental arrangements involving only a single habit tendency the performance level of high-drive Ss should be greater that that for low-drive groups. Higher drive levels should not, however, always lead to superior performance (i.e., greater probability of the appearance of the correct response). In situations in which a number of competing response tendencies are evoked, only one of which is correct, the relative performance of high and low drive groups will depend upon the number and comparative strengths of the various response tendencies. (Taylor, 1956, p. 304).

Drive Theory proper begins with the assumptions that noxious or aversive stimuli arouse a hypothetical emotional response, r_e, and that drive level, D, is a function of the strength of r_e. The Taylor (1953) Manifest Anxiety Scale (MAS) was developed as an operational measure of individual differences in r_e. It was orginally assumed that scores on the MAS were positively related to characteristic differences among people in r_e and, therefore, reflected consistent individual differences in D. The construct validity of the MAS as an index of D has been repeatedly demonstrated in classical conditioning experiments in which the UCS is typically a noxious stimulus (Spence, 1964).

But verbal learning and concept attainment tasks do not generally involve noxious stimulation, at least in a physical sense. Evidence bearing on whether persons with high anxiety (HA) as measured by the MAS have higher D than low anxiety (LA) subjects when performing on such tasks is inconclusive. This led Spence to propose two alternative hypotheses concerning the relation between MAS scores and D: (a) The "Chronic Hypothesis" posits that HA Ss are more emotional than LA Ss and this causes them to manifest higher D in all situations, whethe. stressful or not. (b) The "Reactive Hypothesis" posits that HA Ss are more emotionally responsive than LA Ss which causes them to react with higher D to situations involving some form of stress.

Investigations of learning under neutral and stressful experimental conditions provide strong empirical support for the Reactive Hypothesis (e.g., Nicholson, 1958; Sarason, 1960; Spence & Spence, 1966; Spielberger & Smith, 1966). In these studies, differences in the performance of Ss who differed in anxiety as measured by the MAS were obtained only when the experimental conditions involved some form of psychological stress. The kinds of psychological stress that were especially effective in producing performance differences which could be attributed to drive level were ego-involving instructions (e.g., Ss were told they were performing on an intelligence test) and failure instructions (e.g., Ss were told they were doing poorly on an experimental task).

Spence's Reactive Hypothesis may be interpreted in terms of Trait-State Anxiety Theory, as measured by instruments such as the MAS, the IPAT Anxiety

Scale, or the STAI A-Trait scale, tend to perceive situations that involve psychological stress as more threatening than do low A-Trait individuals. On the further assumption that A-State and drive level (D) are positively related, high A-Trait individuals would be expected to have higher D only in situations involving psychological stress.

According to Drive Theory, the effects on performance in a learning task of individual differences in D depend upon the relative strengths of the correct and competing response tendencies that are evoked in the task. On simple tasks, in which there is a single dominant response tendency, or in which correct response tendencies are stronger than competing responses, it would be expected that high D associated with high levels of A-State intensity would facilitate performance. On complex or difficult tasks, in which competing error tendencies were numerous and/or stronger than correct response tendencies, high D associated with high A-State intensity would be expected to interfere with performance. These predictions are tested in the experiments on computer-assisted learning reported in the next section.

IV. Effects of Anxiety on Computer-Assisted Learning

Most studies concerning the effects of anxiety on learning have originated either in artificial laboratory settings or realistic but poorly controlled natural settings. Computer-Assisted Instruction (CAI) systems provide a convenient natural setting in which it is possible to evaluate the learning process under carefully controlled conditions with materials that are relevant to the real-life needs of the subject. In the studies reported below, the effects of anxiety on the learning process were investigated in a CAI setting.

Study I: The Effects of A-State on Computer Assisted Learning

This study investigated the relationship between A-State and performance for college students who learned difficult and easy mathematics concepts by computer-assisted instruction (O'Neil, Spielberger & Hansen, 1969). According to Spence-Taylor Drive Theory, it would be expected that the performance of high A-State students would be inferior to that of low A-State students on tasks in which competing error tendencies were stronger than correct responses, and superior on tasks in which correct responses were dominant relative to incorrect response tendencies. With regard to the expected relationship between A-State and performance in the present study, it was hypothesized that students who were high in A-State would make more errors than low A-State students on the difficult CAI task, and that this relationship would be reversed on the easy task. A unique feature of this study was that A-State measures were obtained while the students performed on the learning tasks.

The subjects (Ss) were undergraduate students enrolled in the introductory psychology course at Florida State University. The A-State scale of the STAI (Spielberger, et al., 1969) provided a self-report measure of the phenomenological aspects of A-State. Measures of systolic blood pressure (SBP) were obtained as indicants of the physiological component of A-State. SBP was measured by means of a desk model Baumanometer. A CAI typewriter terminal controlled by an IBM 1440 System (IBM, 1965) presented the learning materials and recorded the students' responses. The CAI program was written in a linear format using COURSEWRITER I (IBM, 1965), an author programmer language. The CAI program was composed of two main parts: a Difficult Section, which required Ss to prove the mathematical field properties of complex numbers, and an Easy Section, which consisted of problems about compound fractions. The programming logic required the S to solve each succeeding problem correctly before he could attempt the next one. The learning materials are described in detail by O'Neil, Spielberger and Hansen (1969).

Two experimenters (Es) supervised as many as eight Ss at the same time. The Ss were seated at CAI terminals located in a sound-deadened, air-conditioned room which the Es entered only to read instructions, administer the anxiety scales and take blood pressure. The experimental procedures were the same for all students and were divided into four main periods: Pre-task, the Difficult and Easy Performance Periods, and Post-task. During the performance periods, each S first progressed through the difficult learning materials and then the easy materials. At the end of each period, SBP was taken and the STAI A-State scale was administered. The possibility of systematic experimenter bias was minimized by insuring that neither E took a complete series of A-State measures for any given S. A brief four-item A-State scale was also presented during the task by the computer, and Ss were instructed to respond to it according to how they felt while working on the task.

Results: The mean STAI A-State scores for the Pre-task Period, the two performance periods, and the Post-task period are presented in Figure 2. It may be noted that A-State scores increased from the Pre-task period to the Difficult task period, decreased in the Easy task period, and showed no change

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Insert Figure 2 about here

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from the Easy task period to the Post-task period. In a two-factor analysis of variance with repeated measures, only the Periods main effect was statistically significant. Individual *t* tests revealed that A-State scores were significantly higher in the Difficult Task period than in any of the other periods. There were no differences in the A-State scores of men and women.

The mean SBP values, corresponding to the periods for which STAI A-State measures were available, are presented in Figure 3. It may be noted that SBP increased during the Difficult task period, decreased during the Easy task period and showed little change from the Easy task period to the Post-

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Insert Figure 3 about here

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task period. In the analysis of variance for these data, the main effects for Sex and Periods were statistically significant, indicating that: (a) SBP for males was considerably higher than for females: and (b) SBP showed changes over task periods similar to those obtained for the STAI A-State Scores. For both men and women, SBP measures taken immediately after *Ss* performed on the Difficult task were significantly higher than in any other period.

In the analysis of the error data for the Difficult and the Easy CAI tasks, each task was divided into two sections. For the Difficult Task, the first section consisted of five proof statements, Diff/(1-5), and the second section consisted of the remaining twelve proof statements, Diff/(6-17). Similarly, for the Easy task, the two sections corresponded to the first five items, Easy/(1-5), and the remaining eleven items, Easy/(6-16). Brief A-State scales had been given by the computer between the two sections of each task.

The mean number of errors per problem for the first and second sections of the Difficult and Easy tasks are presented in Figure 4. It may be noted that the Diff/(1-5) section produced the most errors, the Diff/(6-17) section

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Insert Figure 4 about here

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produced an intermediate number of errors, and that errors fell almost to zero in both sections of the Easy task. These data were evaluated in an analysis of variance in which the significant F ratio for Tasks indicated that errors declined across the four periods. There were no differences in mean number of errors for men and women.

No significant sex differences were found for either STAI A-State scores or errors. Therefore, in the evaluation of the relationship between A-State and errors, the data for men and women were combined. But separate analyses were carried out for the Difficult and Easy tasks because there were significant differences between them in mean number of errors. For these analyses, the Ss were divided at the median STAI A-State score obtained during each task. Subjects whose scores were above the median were designated the High A-State group; those below the median were designated the Low A-State group.

The number of errors made by the High and Low A-State groups on the two sections of the Difficult Task is indicated in Figure 5. High A-State Ss made nearly twice as many errors as the low A-State Ss on the Diff/(1-5) section, and they made fewer errors than low A-State Ss on the Diff/(6-17) section. An analysis of variance for these data yielded a significant A-State by Tasks interaction and a main effect of Tasks.

Insert Figure 5 about here

There were very few errors on the Easy task and no statistically significant F ratios were obtained in the analysis of the error for this task.

To sum up, state anxiety increased when Ss worked on difficult CAI materials and decreased while Ss performed on easy CAI materials. This pattern of change in A-State was observed for the 20-item STAI A-State scales, for the brief A-State scales embedded in the learning materials, and for the SBP measures. While there were no differences in the STAI A-State scores for men and women, the SBP scores for males were significantly higher than for females. It is known that SBP is dependent upon physical characteristics such as height, weight and body build (Gregg, 1961). Since the males, on the average, were taller, heavier and more muscular than the females, higher levels of SBP would be expected on the basis of these physical differences.

In Figure 5, it may be noted that the high A-State students made more errors than low A-State students on Diff/(1-5) whereas low A-State students made more errors than high A-State students on Diff/(6-17). On the assumption that A-State reflects drive level (D), the finding that performance on the CAI task was an interactive function of level of A-State and Task Difficulty is consistent with the prediction from Drive Theory that the effects of anxiety on learning will depend upon the relative strength of correct responses and competing error tendencies (Spence & Spence, 1966). In the present study, A-State apparently influenced performance by: (a) activating error tendencies on the initial section of the Difficult CAI task, for which error rate was relatively high; and (b) enhancing the production of correct responses on the second section of the Difficult task, for which error rate was relatively low.

In contrast to the interactive relationship obtained between A-State and errors on the Difficult CAI task, no relationship was found between A-Trait and errors in this study. It should be noted, however, that in the statistical analysis of error rate as a function of A-Trait, Ss were divided at the median of the A-Trait score distribution, rather than selected on the basis of extreme A-Trait scores as is customary in research on anxiety and learning. Thus, for high and low A-Trait students, the differences in A-State (and the corresponding difference in D) may not have been large enough to produce the expected differences in performance.

Study II: State and Trait Anxiety and Computer Assisted Learning

In this study,[6] subjects were selected on the basis of extreme scores on the STAI A-Trait scale and the order of presentation of the Difficult and Easy CAI tasks was counterbalanced. In addition, an IBM 1500 CAI system was employed which made it possible to evaluate the generality of the findings obtained in Study I with an IBM 1440 system. It was hypothesized that high A-Trait (HA) students would respond to the CAI tasks with higher levels of A-State than low A-Trait (LA) students, and that students who responded to the learning tasks with high A-State would make more errors on the more difficult CAI materials and fewer errors on the easy CAI materials than low A-State students.

The A-State and A-Trait Scales of the STAI (Spielberger, et al., 1969) were administered to approximately 1100 introductory psychology students. From this population, 80 males whose scores were in the upper and lower twenty percent of the A-Trait distribution for the class were invited to participate in an experiment on computer-assisted learning. Of the 44 Ss who were selected from this group, 22 had high A-Trait scores and 22 had low A-Trait scores; these Ss were respectively designated the HA and LA groups. The CAI mathematics program used in the previous study (O'Neil et al., 1969) was adapted for the present experiment by recoding the same learning materials in Coursewriter II (IBM, 1967).

The learning materials were presented by an IBM 1500 CAI System (IBM, 1967). The terminals of this system consist of a cathode-ray tube, a light pen, and a keyboard. For each problem, the S selected the response he believed to be correct from multiple choices presented on the screen of the cathode-ray tube. He did this by pressing the light pen against a box that corresponded to the answer he considered correct. If the response was correct, the next problem was immediately presented; if the response was incorrect, the same problem was presented again. Since the display on the screen of the cathode-ray tube was removed after each response, information from previous responses was not available to the subject. Thus, there was a greater memory load with the IBM 1500 system used in Study II than with the CAI typewriter terminal used with the 1440 system in Study I, and this produced a larger number of errors.

The CAI system also presented the STAI A-State scales during the learning tasks and recorded the student's responses. Seven measures of A-State were obtained. Except for the pre-task A-State scale, which was given with standard instructions ("indicate how you feel right now"), Ss were asked to respond to the A-State scales by indicating how they felt while performing on each preceding section of the learning task. The administrations of the A-State scales were programmed so that the order of item presentation on different occasions was random.

The experimental procedures in Study II were divided into three periods: (a) the Pre-task period, in which the students learned how to operate the CAI terminals; (b) the Performance period in which the computer presented the learning materials; and (c) the Post-task period in which students were interviewed and debriefed. These procedures were essentially the same as in Study I, except that blood pressure was not taken and the Easy and Difficult CAI tasks were presented in counterbalanced order. Each subject was assigned either to the D/E order, in which he progressed through the Difficult task first and then the Easy task, or the E/D order in which the Easy task was followed by the Difficult task.

Results: The mean STAI A-State scores for HA and LA Ss on each of the three sections of the Difficult and Easy tasks are shown in Figure 6. The data as presented have been collapsed over task order since level of A-State

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Insert Figure 6 about here

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was approximately the same during the Difficult task irrespective of whether it was given first or preceded by the Easy task, and A-State intensity in the Easy task was approximately the same when it was given either first or second. It may be noted in Figure 6 that: (a) HA Ss responded with higher levels of A-State than the LA Ss throughout the experiment; and (b) Level of A-State intensity increased from the Pre-task measure to Diff/A, decreased somewhat during Diff/B and Diff/C, and was relatively low in all three sections of the Easy task.

Although there was a greater difference in A-State for the HA and LA Ss in the Difficult task than in the Easy task, the F ratio for the A-Trait by Task Difficulty interaction was not statistically significant. The main effects of A-Trait and Periods were significant, however, and further analysis of the Periods effect indicated that A-State was significantly higher in the Difficult CAI task than in the Easy task. Thus, A-State scores varied as a function of both A-Trait and task difficulty, but not as a function of task order, and higher levels of A-State were associated with the more difficult task.

Since there were so few errors on the Easy CAI task, the relationship between A-State and errors was investigated only for the three sections of the Difficult task. In this analysis, the students were divided at the STAI A-State median obtained during Diff/A, which was 13. The mean number of errors per problem made by high and low A-State students on the three sections of the difficult task are presented in Figure 7A. It may be noted that high A-State students made more than twice as many errors on Diff/A than low A-State students,

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Insert Figure 7 about here

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whereas there was relatively little difference in the error rate for high and low A-State students on Diff/B and Diff/C.

The analysis of variance for these data yielded a significant A-State by Periods interaction similar to that obtained for these same variables in Study I. The data for Study I, in which Diff/B and Diff/C were combined, are shown in Figure 7B. In both studies, high A-State Ss made more errors on the CAI materials presented earlier in the task than on the materials presented later in the task. In contrast, there was relatively little difference in the error rate for low A-State Ss on materials presented earlier and later in the learning task. A comparison of the results presented in Figures 7A and 7B also reveals that the same learning materials produced more errors when presented with the IBM 1500 CAI system in Study II than with the IBM 1440 system that presented the learning materials in Study I.

Although high A-Trait students in Study II had higher A-State scores throughout the experiment, no relationship was found between A-Trait and errors. This was unexpected because A-State scores and errors were related, and A-Trait scores were moderately correlated with A-State. In order to clarify the relationship between A-Trait and errors, the simultaneous influence of A-Trait and A-State on performance was evaluated. For this analysis, the HA and LA groups were divided into high and low A-State sub-groups on the basis of whether a student's score was above or below the A-State median obtained in Diff/A. Approximately 25% of the high A-Trait students had low

A-State scores during Diff/A and a comparable percentage of low A-Trait students had high A-State scores.

The error data for HA and LA students whose A-State scores were consistent with their A-Trait scores are presented in Figure 8A; the data for the HA and LA students whose A-State scores were inconsistent with their

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Insert Figure 8 about here

A-Trait scores are presented in Figure 8B. It maybe noted that the data in Figure 8A are generally quite consistent with the findings in the previous experiment (See Figure 7B); the HA/high A-State students made more errors on materials presented at the beginning of the CAI task and fewer errors on materials presented later in the task than did LA/low A-State students. Thus, when A-State level was consistent with A-Trait scores, the familiar A-Trait by task difficulty interaction was noted.

Perhaps the most interesting findings in Study II are the error rates presented in Figure 8B for students whose A-State scores were inconsistent with their A-Trait scores. The error rate for LA students with high A-State scores was over four times as great as the error rate for the HA/Low A-State students on Diff/A, and remained high on Diff/B and Diff/C. In contrast, the HA/Low-A-State Ss made fewer errors than any other group.

In an effort to clarify the data presented in Figure 8B, measures of intellectual aptitude were obtained from university records. For those students who participated in Study II for whom aptitude scores were available, the median

CEEB SAT (College Board) score for the LA/High A-State students was just over 800, in contrast to median SAT scores of 1050 to 1100 for students in the other three groups. Thus, the low A-Trait students who experienced high levels of A-State intensity while performing on the difficult CAI task were much lower in intellectual ability than their peers.

To sum up, in the computer-assisted learning studies reported in this paper, higher levels of state anxiety were observed for students who worked on difficult CAI mathematics materials whereas level of A-State intensity for these same students was relatively low while they worked on easy materials. On the more difficult materials, overall error rate was high and students with high A-State scores showed impaired performance relative to low A-State students. In contrast, high A-State students made fewer errors than low A-State students on CAI materials for which there was a relatively low overall error rate. Thus, task difficulty influenced level of A-State intensity, and individual differences in A-State either impaired or facilitated performance, depending upon the overall error rate produced by the task. In general, these findings are consistent with Spence-Taylor Drive Theory and Trait-State Anxiety Theory (Spielberger, Lushene & McAdoo, in press).

Although STAI A-Trait scores were relatively good predictors of level of A-State intensity, individual differences in A-Trait were unrelated to performance. For students whose A-Trait and A-State scores were consistent, however, high A-State was associated with poorer performance on the more difficult part of the CAI learning task, and with better performance on the easier CAI learning materials. For students whose A-Trait and A-State scores were inconsistent, high levels of A-State intensity were especially detrimental to the performance of the LA/High A-State students, as may be noted in Figure 8B. These students have infrequently experienced anxiety states in the past and we may speculate that they have not learned to cope effectively with such states when they occur. In contrast, the HA/High A-State students made more errors on the first section of the difficult task, but the performance of these students was ultimately superior to that of LA students. This finding suggests that HA students have had more experience than LA students in adjusting to anxiety states in the past and are therefore better able to cope with such states when they occur.

V. Implications of Research on Anxiety and Learning for the Classroom Teacher

What implications do the research findings on anxiety and learning have for the classroom teacher? To begin with, it is important for teachers to recognize that students respond emotionally to learning situations and that emotional reactions may either facilitate or impair performance (Spielberger, 1966b). Emotional reactions such as anxiety are likely to be more intense for difficult learning tasks than for easy tasks, particularly where there is an evaluation of the student's performance which may have some bearing on his future success. Since the evaluation of achievement is an essential activity in most educational settings, it would seem important for teachers to understand the nature of anxiety and how it influences learning and behavior.

Because anxiety is an unpleasant emotional state that often interferes with constructive behavior, some educators contend that there is no place for anxiety in the classroom. It is true that high levels of A-State may impair performance, particularly at the beginning of a difficult learning task, as was the case in our studies of computer-assisted instruction. However, a moderate amount of A-State may actually facilitate learning by helping a student to be more alert, and motivating him to try harder and persist in his efforts. In working with children in the classroom, teachers can help students to recognize that it is normal to be concerned about how well one will do on a difficult task. It is especially important for the teacher to be available to students as they begin to work on a new learning task because fear of failure and anxiety (A-State) reactions are likely to be greatest at such times.

It is essential for the classroom teacher to realize that the emotional reactions of all students to a given learning task will not be the same. Anxiety reactions will depend upon the amount of personal threat that a specific task poses for a particular student. Because of fear of failure, some students (those with high A-Trait) react to most learning situations as personally threatening. But whether or not a specific learning task or classroom setting will be regarded as threatening by a particular child will be determined by a host of factors. Among the most important are individual differences in intelligence, aptitude, or learning ability, and past-experience in similar circumstances. The personality characteristics of the teacher may also be a critical factor for certain children, particularly those who are introverted, shy and highly dependent upon adults for guidance and direction.

Knowledge of the role of individual differences in learning will assist teachers to be more sensitive to the needs of individual students. Students who are high in anxiety proneness (A-Trait) will need more help in the beginning of a difficult learning task, but may do quite well after they have attained a degree of mastery of the task. While students with low A-Trait may have less difficulty at the beginning of a learning task because they experience less intense levels of A-State, a low A-Trait student who lacks the ability to do well on the task may be overwhelmed with anxiety if it is important for him to succeed. However, once a low A-Trait student has achieved a certain degree of mastery of a task, he may require continual challenge in order not to lose interest in his work.

It is particularly important for teachers to be aware of the abilities and the limitations of their students. When a child works on a difficult learning task for which he has little aptitude, the failure he experiences is likely to induce high levels of state anxiety which will interfere with his efforts to master the task. Paradoxically, the student who is not highly disposed to experience anxiety will have the greatest difficulty in situations that are perceived by him as threatening. Since he has less experience in coping with anxiety, he is more likely to find it extermely unpleasant and disruptive when it occurs.

While it is not possible to avoid anxiety in the classroom, anxiety need not be detrimental to learning. The relationship between anxiety and learning is exceedingly complex, and a great deal of research will be required in order to ascertain how best to help students cope more effectively with anxiety. This knowledge can be more readily obtained if psychologists and educational researchers collaborate with classroom teachers in seeking it.

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Time, March 31, 1961, p. 4.

Footnotes

1. The research on anxiety and computer-assisted learning reported in this chapter was carried out in collaboration with Dr. Duncan N. Hansen and Dr. Harold F. O'Neil whose contributions to this paper are gratefully acknowledged.

2. Sections I and III of this chapter have been adapted from C. D. Spielberger (Ed.) Anxiety and Behavior. Section II is based in part on materials presented in a chapter (Spielberger, Lushene, & McAdoo, in press) that will appear in R. B. Cattell (Ed.) Handbook of Modern Personality Theory, Chicago: Aldine, 1969.

3. In many psychological experiments, threats of physical harm are confounded with threats to self-esteem. A subject may be told, for example, that he will receive an electric shock if he does poorly on a task, or if his performance falls below a certain standard.

4. Since level of A-State should reflect transitory conditions that exist at the time of testing, the test-retest reliability of A-State measures would be expected to be relatively low. Consistent with this expectation, test-retest correlations for college students retested on the STAI A-State scale after periods of one hour, 20 days, and 104 days ranged from .16 to .54, with a median *r* of only .32. In contrast, the alpha reliability of the STAI A-State scale for college students varies between .80 and .93. Given the transitory nature of personality states, measures of internal consistency such as alpha would seem to provide a more meaningful index of reliability than test-retest correlations.

5. Taylor also notes that in tasks involving a number of competing response

tendencies predictions concerning the performance of HA and LA subjects may require consideration of the Hullian concepts of oscillatory inhibition (O) and response threshold (L). While these concepts have been occasionally called upon to account for experimental findings in tests of Drive Theory utilizing complex learning tasks, such explanations have generally been post hoc. Since neither O nor L have been given operational meaning in investigations of human learning guided by Drive Theory, these concepts will not be further considered here.

6. Study II is described in greater detail in an unpublished paper presented in February, 1969, by O'Neil, Hansen and Spielberger at the American Educational Research Association Meetings in Los Angeles.

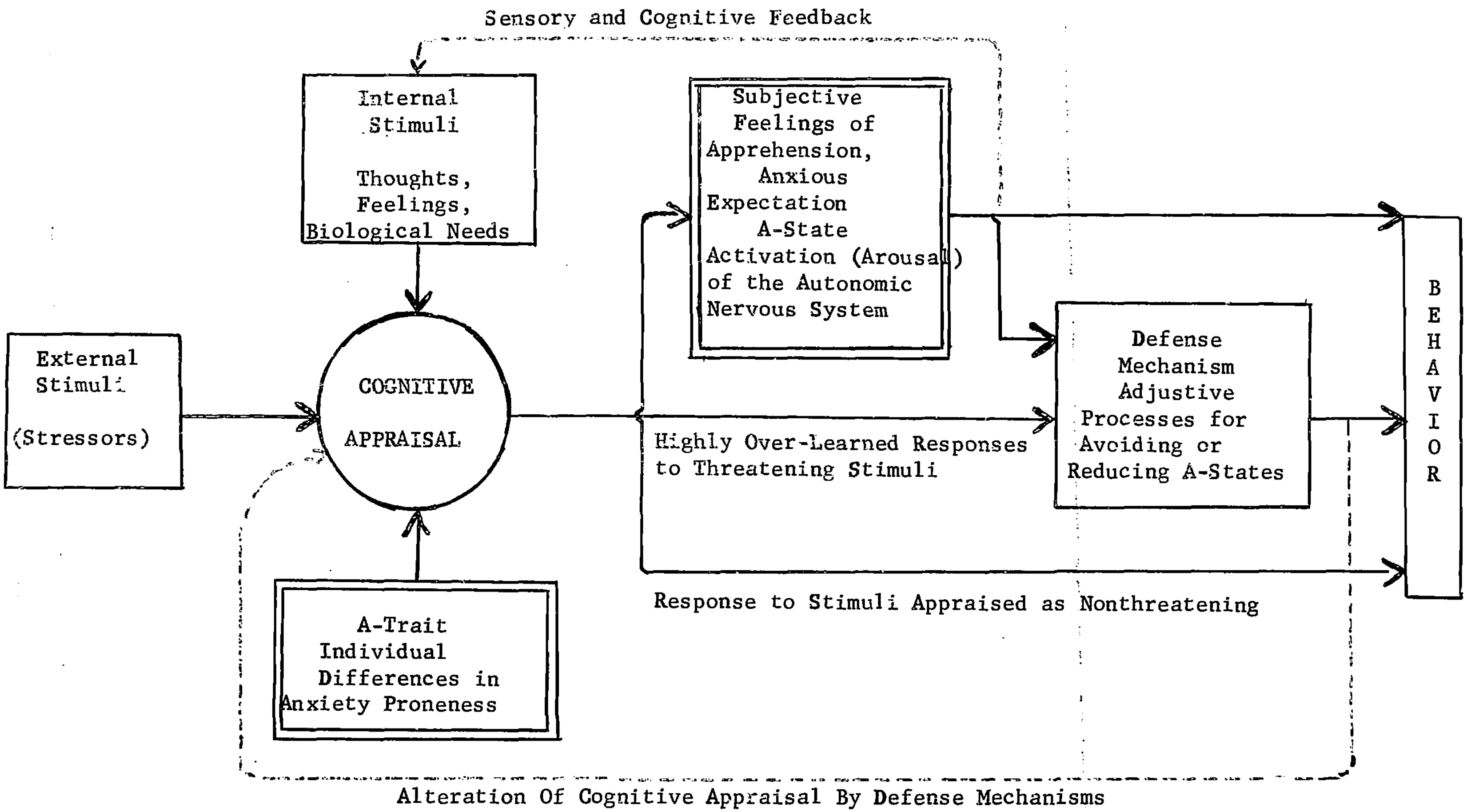


Figure 1. A Trait-State conception of anxiety. Reprinted with permission from Anxiety And Behavior, C. D. Spielberger, Editor, p. 17 © by Academic Press, Inc.

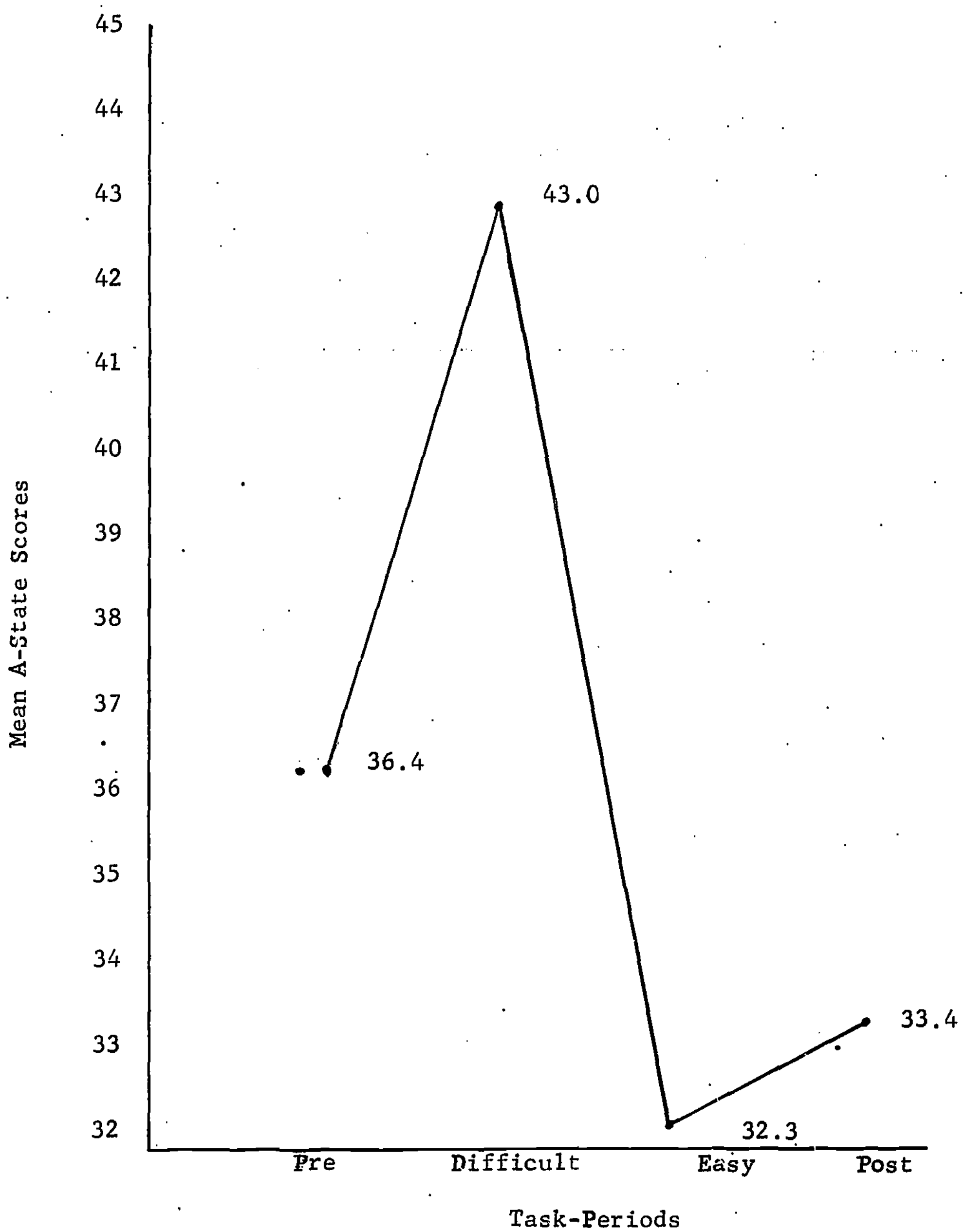


Figure 2

Mean STAI A-State Scores across
Task Periods

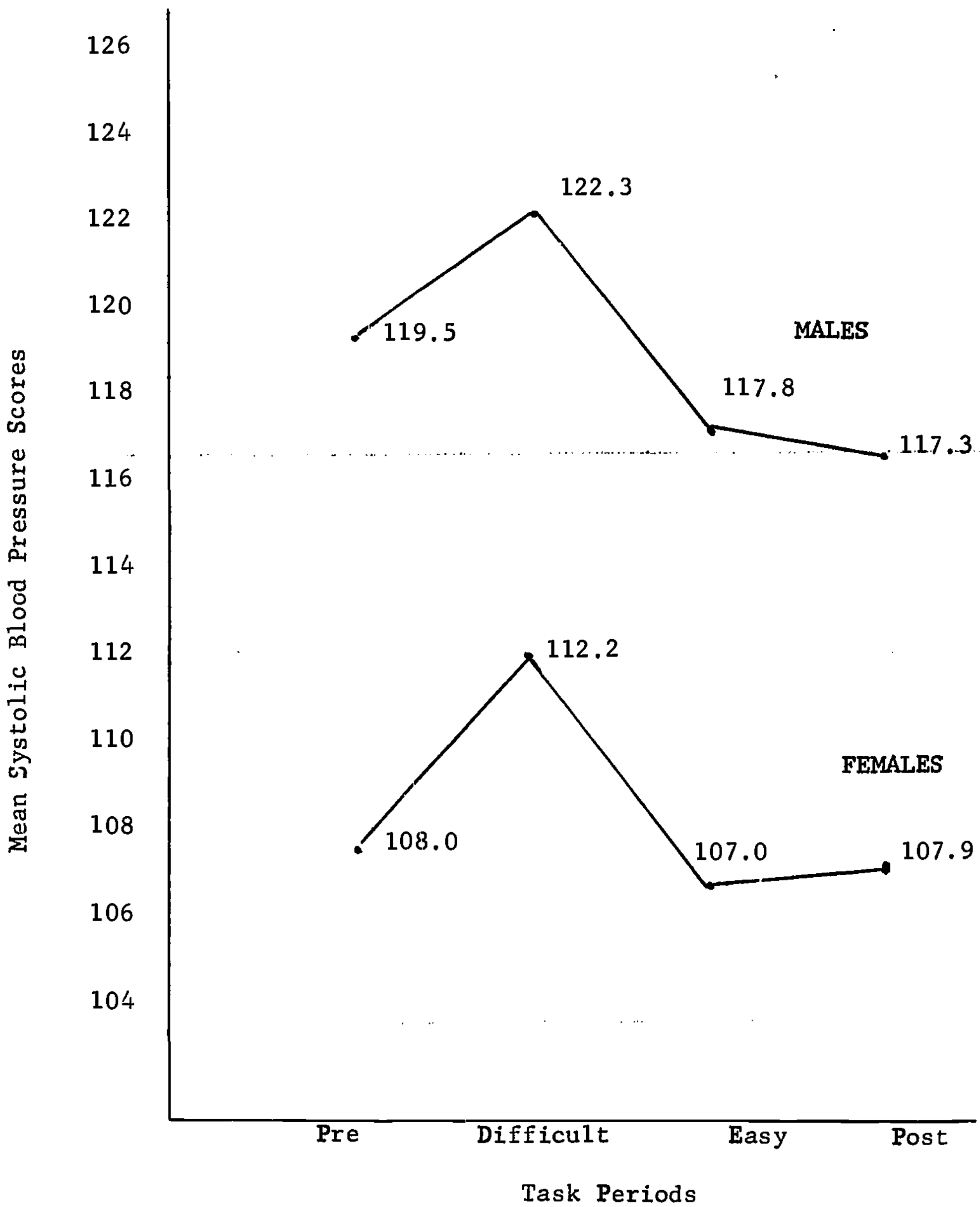


Figure 3

Mean Systolic Blood Pressure for
Males and Females across Task Periods

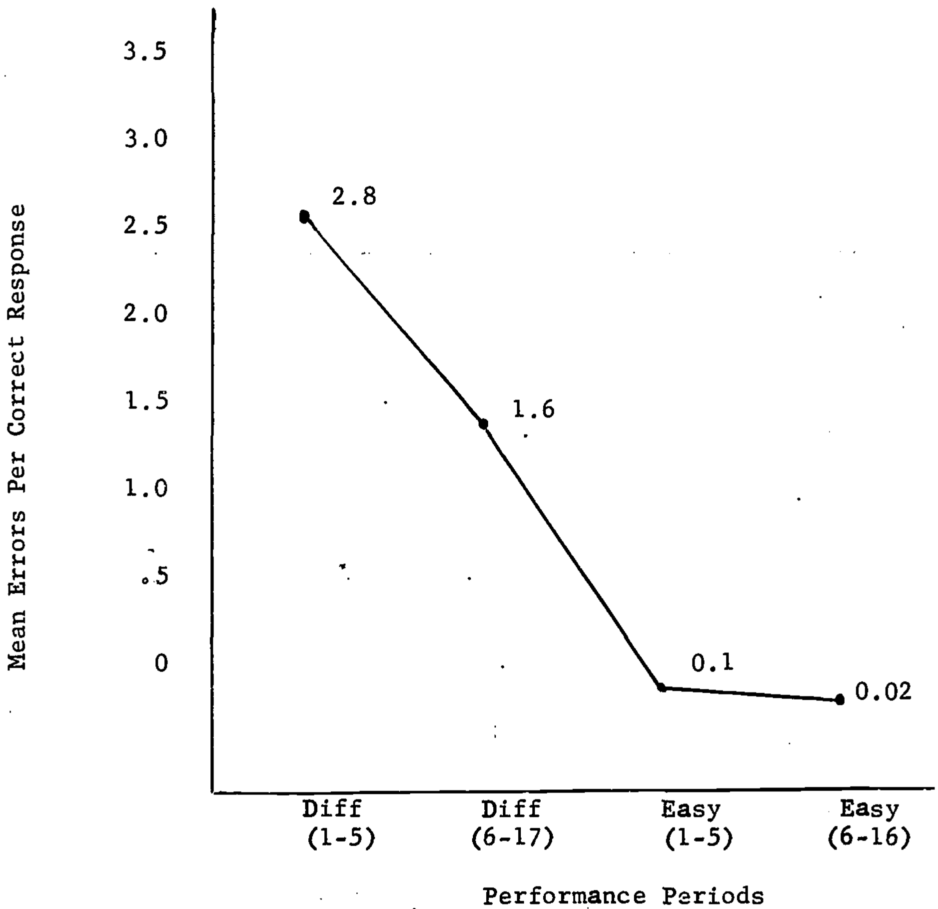


Figure 4

Mean Errors per Correct Response for the two sections of the Difficult and Easy Task

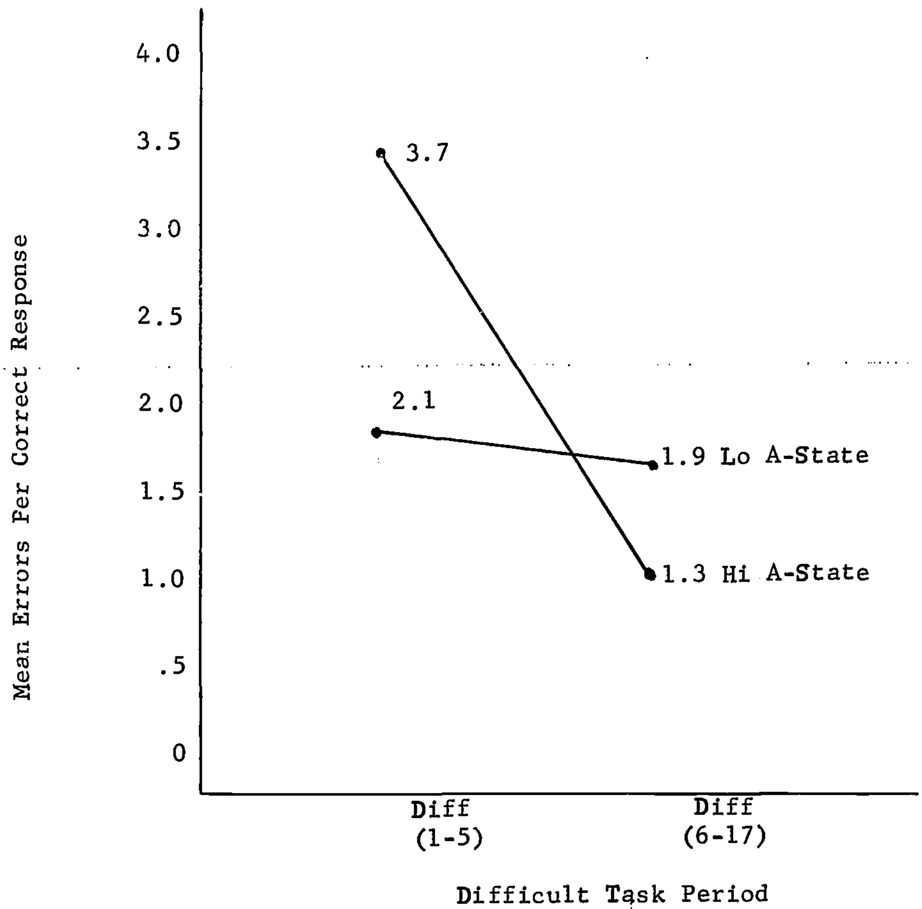
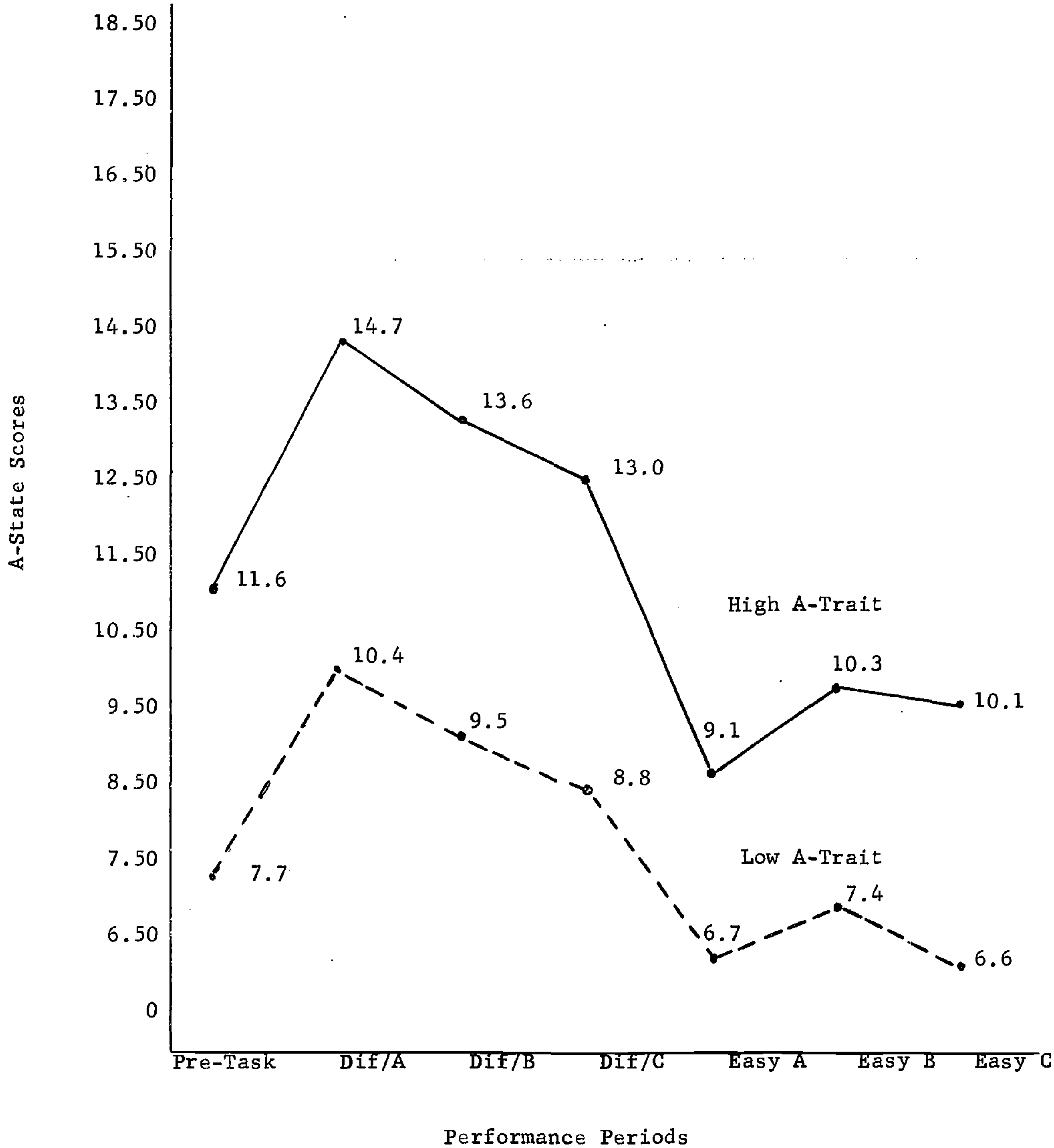


Figure 5

Mean Errors per Correct Response for High A-State and Low A-State Subjects for the two sections of the Difficult Task



A-State Scores
18.50
17.50
16.50
15.50
14.50
13.50
12.50
11.50
10.50
9.50
8.50
7.50
6.50
0
14.7
13.6
13.0
11.6
High A-Trait
10.3
10.1
9.1
10.4
9.5
8.8
7.7
Low A-Trait
7.4
6.7
6.6
Pre-Task
Dif/A
Dif/B
Dif/C
Easy A
Easy B
Easy C
Performance Periods

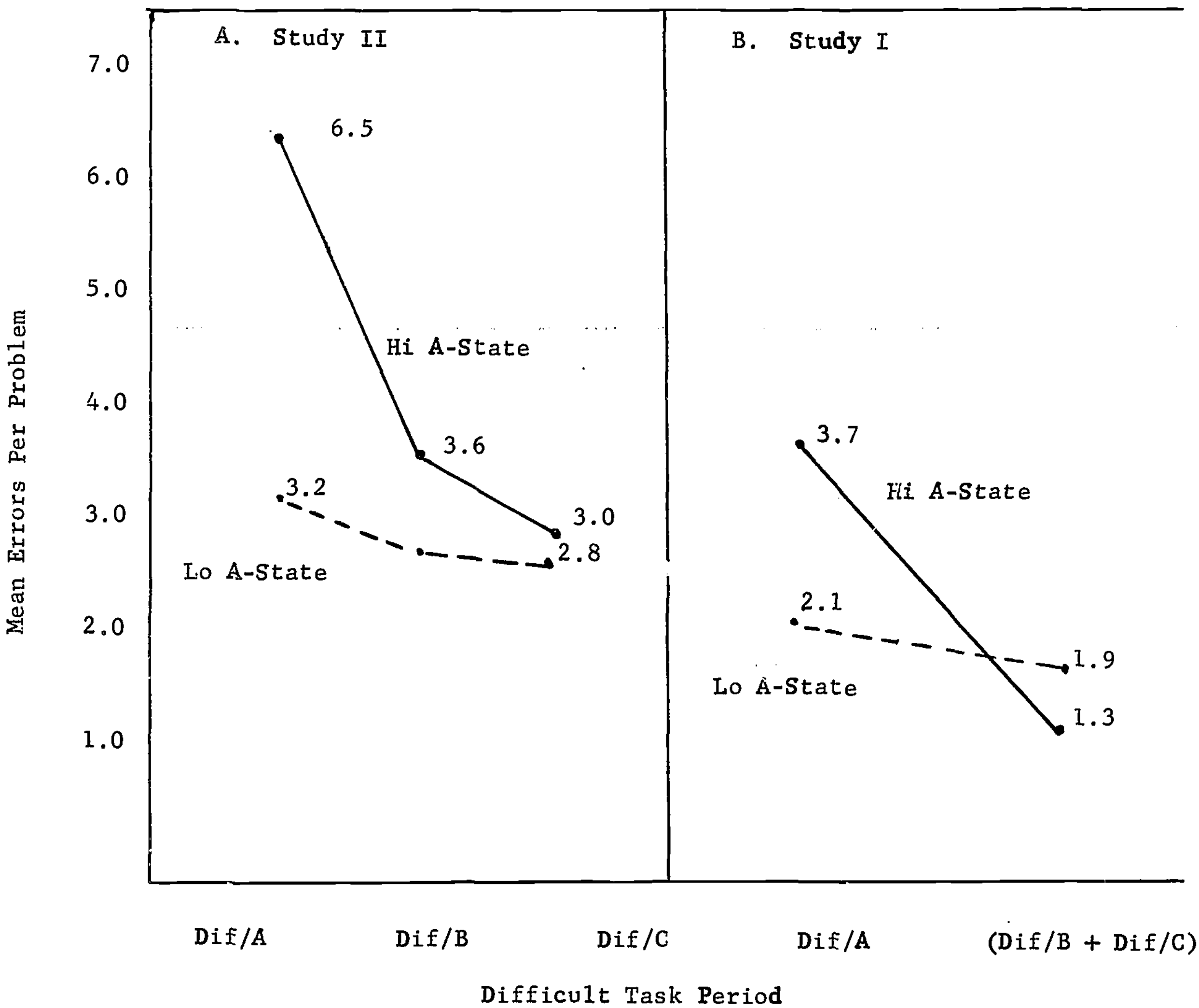


Figure 7

Mean Errors Per Problem for High A-State and Low A-State
Ss on the Difficult CAI Task

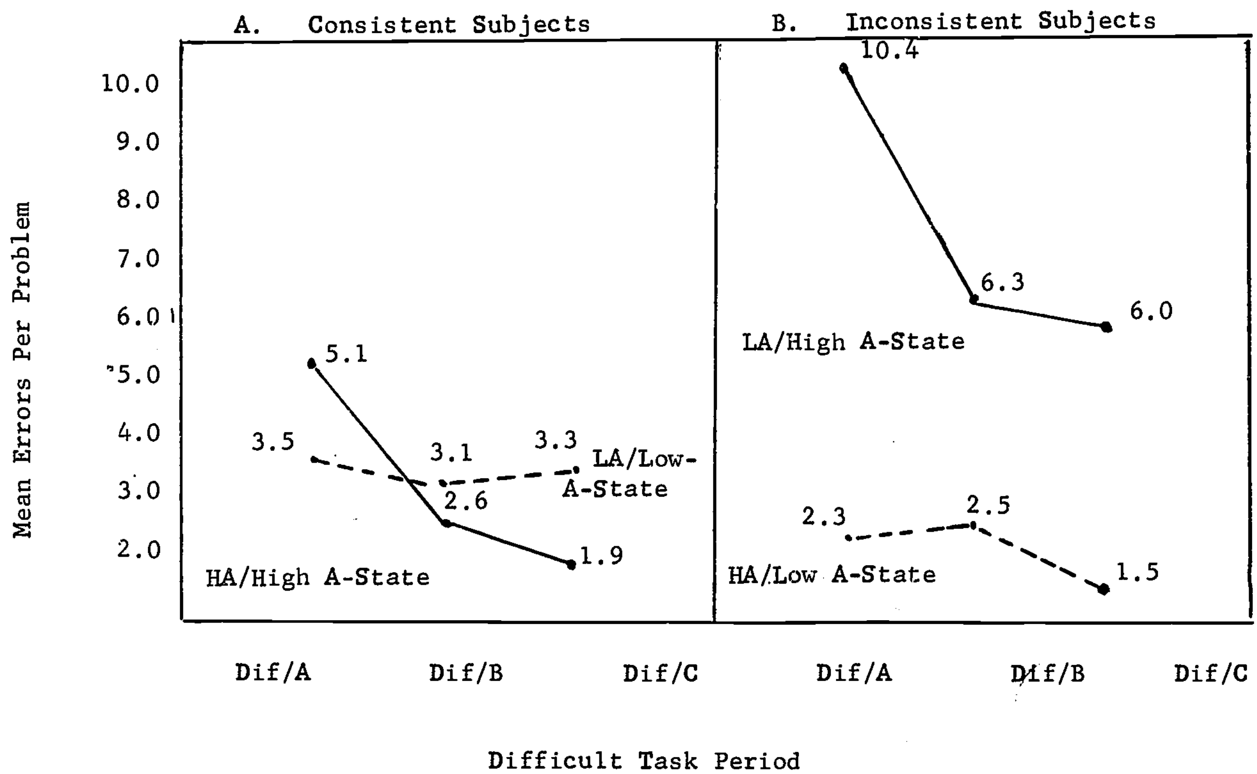


Figure 8

Mean Errors Per Problem for Ss in the Difficult Task Period Classified According to A-Trait & A-State Level