THE EFFECTS OF ASSESSMENT CONTEXT ON STATE ANXIETY AND A NEUROPSYCHOLOGICAL MODEL OF ATTENTION

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This study investigated the effects of assessment context on state anxiety and attention according to the Mirsky (1996) model of attention. Context varied in the physical testing environment, demeanor of the assessor, and explanation of the purpose of testing. A relaxed condition (RC) and structured medical condition (SMC) distinction was made prior to data collection and the two contexts were designed to reflect contrasting practices of neuropsychologists. Elements of attention evaluated included Encoding (Digit Span), Focusing/Executing (Visual Search and Attention Test), Shifting (Wisconsin Card Sorting Test: Computerized Version 2), Sustaining, and Stabilizing (Continuous Performance Test-Identical Pairs). Eighty healthy adult females participated in the study. The findings suggest that the SMC caused higher levels of anxiety and lower valence than the RC, which in turn caused poorer sustained attention and superior shifting attention for this condition. Such interpretations are consistent with several theories on the effects of anxiety on attention. It should be noted, however, that differences observed in attention were limited to select measures. Factor analysis also indicates that the encode, shift, and sustain elements of attention were largely consistent with the factor solution proposed by Mirsky, while findings on the focus/execute and stabilize elements bring into question the construct validity of these aspects of the model. Findings from the study are considered relevant to those interested in attention theory and particularly researchers and clinicians involved in the administration of neuropsychological testing.

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To my loving parents, Marian and Larry, who taught me the value of dedication, integrity, and hard work, and the importance of pursuing my dreams.

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CHAPTER 1

INTRODUCTION

As early as the turn of the century, William James noted the effort necessary to maintain attention on that which has “caught the mental eye” (James, 1890). He pointed out that the construct received little notice from authors such as Locke, Hume, Hartley, Mill, and Spencer in their attempts to understand and explain intricacies of the human condition.

> These writers are bent on showing how the higher faculties of the mind are pure products of “experience,” and experience is supposed to be of something simply given. Attention, implying a degree of reactive spontaneity, would seem to break through the circle of pure receptivity which constitutes “experience,” and hence must not be spoken of under penalty of interfering with the smoothness of the tale (p. 402).

James did not contest the central importance of experience in psychology but asserted that a misunderstanding lay in the definition of the term. Whereas others believed that attention had little to do with experience, James argued that “experience is what I agree to attend to,” suggesting that attention is incorporated in the process of gaining experience and acts as the very foundation on which such experience is based. Therefore, according to James, the phenomenon of attention is quintessential to human perception, requiring investigation and understanding.

> Only those items which I [attend to] shape my mind - without selective interest, experience is an utter chaos. Interest alone gives accent and emphasis, light and shade, background and foreground - intelligible perspective, in a word. It varies in every creature, but without it the consciousness of every creature would be gray chaotic indiscriminateness, impossible for us even to conceive (pp. 402-403).

Despite James' argument, the construct received little consideration until the middle of the twentieth century.

Although attention was of interest to some in the early twentieth century (Parasuraman, 1984), the behaviorist movement facilitated substantial avoidance of the topic, discounting it as mentalistic (Moran, 1996). Later military efforts to improve the performance of lookouts and radar operators during World War II helped invigorate a new interest in attention research (Parasuraman, 1984). Information processing theories were developed to explain attention beginning in the 1950s (Cherry, 1953). Early and still well known laboratory studies on attention were completed by Broadbent (1958) and later by Treisman (1960) involving dichotic listening tasks. Greher (2000) provides a similar review of early literature on attention.

Additionally, substantial efforts have been directed over the years toward understanding the physiological correlates of attention. Mirsky (1996) explains that, according to Hughlings Jackson, the neurological basis of consciousness was located in the frontal lobe area. According to Mirsky (1996), Penfield and Jasper later indicated that such processes were located within the brain stem area. Understanding that both cortical and subcortical areas are involved in attention was facilitated by animal studies on electrical brain activity (Mirsky, 1996). The centrencephalic system was identified as the primary system by which information is coordinated from areas such as the spinal cord, brain stem, and thalamus, and distributed to appropriate locations within both hemispheres of the cortex. More recent research indicates that localization of attentional processes within the brain is also attributable to areas in the limbic system, and evolutionary development has allowed for differentiation across these neural areas according to the specific attentional process involved (Mirsky, 1996). Mirsky indicates that an attentional system facilitates the appropriate coordination of each of these specific processes.

Neural attentional systems are conceptualized from a brain-evolutionary point of view. Mirsky (1996) reviews MacLean's model of the triune brain. The brain of higher mammals can be divided into three levels, each of which represents an evolutionary advancement. The layers, from lowest to highest, include the reptilian (including basal ganglia and connections to the thalamus, tegmental, and pontine regions), paleomammalian (limbic system), and neomammalian (the forebrain area of higher mammals). The brain of reptiles primarily consists of the reptilian portion described above (hence its title) and limited portions of the paleo- and neomammalian levels. According to Mirsky (1996), the reptile brain is capable of attentional processes, and while the more highly developed portions of the brain augment attention the primitive reptilian/brain stem remains the central physical feature of such processes. As an example, Mirsky (1996) reviews observations made by Lipsett & Eimas that newborn children exhibit visual attention despite the fact that their limbic and forebrain regions are not yet fully myelinated.

Research involving attentional systems is complicated, however, by the convolutions of attentional measurement. Mialet, Pope, and Yurgelun-Todd (1996) write that “there is no pure measure of attention; one can only measure performance on a particular task that is presumed to require a high level of attention” (p. 1010). Morris (1996) argues that researchers must be careful in their assertions that we can reliably and validly assess measures as complex as attention for a variety of populations. The author points out that attention remains to be well defined and operationalized. Methods used to test attention are inherently confounded by the demands of other cognitive functions, suggesting that contemporary models and measures of attention lack adequate construct validity (Morris, 1996; O’Donnell, MacGregor, Dabrowski, Oestreicher, & Romero, 1994). The effects of this confusion are at least twofold. First, deciphering whether outcome on a particular measure of attention results from attentional functioning or another cognitive process is difficult. Second, a measure of “attention” according to one investigator may be, and often is, categorized by another as a measure of an alternative construct such as “memory,” “conceptual ability,” or “executive functioning.” Such deficiencies continue to complicate the efforts of researchers to further understand attentional processes. Despite the methodological limitations however, researchers continue their efforts and rely on the measures and models derived from their particular area of interest and expertise (Morris, 1996).

In the past, popular physiological measures of arousal and attention included such methods as galvanic skin response, pupillary dilation, and heart rate. More current methods used by psychophysiology researchers include event-related potentials (ERPs). ERPs are patterns of electrical brain activity that occur in response to environmental stimuli and vary depending on the complexity of stimulus demands. Electrodes are fixed or implanted within the brain in order to measure ERPs and brain activity is measured relative to time in response to such events as bells or flashes of light. ERPs are generally compared in terms of P300 is an ERP signal that researchers often associate with attention. Its designation “P” is based on the fact that it is a positive signal, while “300” is used because the signals occurs approximately 300 milliseconds after the presentation of an attention demanding stimulus amplitude (Beaumont, Kenealy, & Rogers, 1999).

Instead of relying on ERPs and P300, cognitive researchers rely on a different set of methods for assessing attention. Michael Posner, a cognitive researcher and theorist, remains one of the most well known investigators in attention and often uses visual orientation to stimuli to measure attentional systems. Alternatively, neuropsychologists measure attention through interactive administration of paper-and-pencil or computer-based tasks. These tasks are believed to require a great deal of auditory and/or visual attention, although simultaneous measurement of other constructs (e.g., visuomotor speed, short term memory, etc.) appears unavoidable, as pointed out by Morris (1996). Many of these measures are incorporated as subtests in scales of intelligence or comprehensive neuropsychological batteries, while others were developed as independent measures. In clinical settings, they have been found to be useful in identifying attentional problems or brain dysfunction, and include extensive normative data in order to help make differential diagnoses across demographic cohorts.

Relevance of Attention

Motivation for understanding the processes, elements, and neural components of well functioning attention inspire much of the research in this field. There are also motivations for understanding attention provoked largely by observations of disordered attention across a variety of psychological dysfunctions. Mirsky, Anthony, Duncan, Ahearn, and Kellam (1991) review data relevant to such observations, including findings that estimates of disordered attention in school children range between 5% and 30%. In addition to psychiatric disorders such as Attention-Deficit/Hyperactivity Disorder, schizophrenia, and autism, attention is known to be related to a number of physiological conditions. This includes familial and genetic disorders such as epilepsy, phenylketonuria, and uremia. Environmentally related disorders include malnutrition, lead intoxication, fetal alcohol syndrome, parasitic infections, and lack of intellectual stimulation. Finally, head injury, brain infections, tumors, sleep and breathing disorders, and eating disorders are also associated with attention problems (Mirsky & Duncan, 2000). Other conditions include frontal and right posterior cerebral lesions, AIDS-related dementia, anxiety disorders, and affective disorders (Mirsky et al., 1991). Mirsky and his colleagues point out that disorders of attention and concentration are readily listed amongst polythetic criteria necessary for making a variety of psychiatric diagnoses (DSM – IV, APA, 1994) and life time prevalence rates of impaired attention are estimated between 10% and 15%. Despite its relevance to evaluating overall cognitive functioning, much less focus is given to the impacts of disordered attention in neuropsychological assessment when compared to other cognitive processes (Mirsky et al., 1991).

Theories of Attention

Cognitive Theories of Attention

Mirsky (1996) offers a comprehensive review of the prominent theories of attention, discussed below. Posner and Peterson presented a model of attention that conceptualized attention as having three separate components constituting an attentional system. The components included orienting to sensory events, detecting signals for focal processing, and maintaining vigilance. The authors operationalize orienting based on the changing eye position to attend to stimuli in varied locations. Posner and Peterson argue that neural areas associated with the process of orienting include the parietal lobe and dorsal visual pathway projections to V1. Signal detection involves reporting the presence of a target event and is considered to occur in the anterior cingulate gyrus and supplementary motor cortex. Alerting (or vigilance) is defined as situations requiring preparation for the processing of target events (typically visual events). The norepinephrine system originates at the locus ceruleus, innervates the right parietal area, and is argued to be the primary physiological substrate of vigilance. Posner and Peterson point out that this systemic approach toward attention is necessary to overcome the inadequacies of previous vague conceptualizations, and furthermore allow for improved levels of analysis by connecting distinct cognitive and physiological mechanisms.

Based on a review of literature, Pribram and McGuiness assert that attention involves three separate systems including those of arousal, activation, and effort in the control of processing. The arousal system is associated with reticular, brain stem, and amygdala functioning and phasic monitoring of input stimuli. It is viewed as the most primitive aspect of attention, facilitating orienting to stimuli. Activation is associated with the basal ganglia and tonic processing in responsive readiness to stimuli. Effort in the control of processing is associated with the hippocampus and involves coordination of the other two primary attentional processes. Mirsky (1996) points out, however, that the basis of the Pribram and McGuiness model lies in animal research, and updated modifications are needed due to the many advances in understanding of neural processes since its inception in 1975.

Geschwind is credited with being the first to develop a theory of attention related to the experience of unilateral spatial neglect, resulting from damage to the right parietal region (Mirsky, 1996). Mesulam used the experience of neglect to help develop his theory of attention, which is similar in many ways to those already discussed and suggests that two primary systems control attention. The first of these is described as an underlying "pacemaker" for attention that dictates attentional tone, capacity, and vigilance, and is associated with reticular functioning and the reticular system's interactions with the brainstem, thalamus, and cortex. Higher level, goal-directed vector attention then functions through use of the foundational attentional tone and is associated with rostral areas of the neocortex. All attentional behaviors involve varying interactions of these two systems depending upon task demand. States of confusion result from damage to attentional tone, which in turn influences goal directed vector attention. Neglect represents a more discrete disorder of vector attention.

Shiffrin and Schneider argue for a related model of attention involving a distinction between automatic and controlled information processing. The authors assert that automatic processing involves responding without demanding attention or awareness through activation of long-term memory of a learned response. Controlled processing instead necessitates awareness, attention, and conscious control by the individual. Behavioral research involving responses to varied stimuli supports the process of controlled search, while responses to repeated presentation of certain stimuli over several trials supports the existence of automatic detection (Mirsky, 1996).

A Neuropsychological Model of Attention

In an attempt to develop a neuropsychologically based model of attention, Mirsky and his colleagues relied on essential concepts first described within the cognitive psychology realm, including the notions that attention is not a unitary phenomenon, is an exhaustible resource, and that a distinction can be made between automatic and controlled processing (Mirsky et al., 1991). Zubin's division of attention into the elements of focus, sustain, and shift (Mirsky et al., 1991) was also a founding concept of Mirsky's model. Mirsky (1996) defines attention as "a highly articulated form of consciousness that has been shaped and modified by learning and experience" (p. 71) and describes his model as evolutionary-developmental.

In his original work on the topic, Mirsky (1987) tested Zubin's three factor model of attention by administering a battery of eight commonly used cognitive tests believed to assess, in addition to other cognitive functions, attention. Later research by Mirsky et al. (1991) used a normal adult sample as well as individuals suffering from diagnosed psychiatric and/or neurological disorders. A similar battery was administered to a large group of undiagnosed school children. Tests of focusing included the Stroop Color and Word Test (Stroop, 1935; cited in Mirsky, 1991), the Talland Letter Cancellation Test (Talland, 1965; cited in Mirsky, 1991), the Trail Making Test (Parts A and B) of the Halstead Reitan Neuropsychological Battery (Reitan & Wolfson, 1993), and subtests of the Wechsler Adult Intelligence Scale®-Revised (WAIS-R®) (Psychological Corporation, San Antonio, TX, www.psychcorp.com), including the Digit Symbol, Digit Span, and Arithmetic subtests. The Continuous Performance Test (CPT; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956; cited in Mirsky, 1991) and the Wisconsin Card Sorting Test™ (WCST™) (Psychological Assessment Resources, Lutz, FL, www.parinc.com) were also included.

Principal components analyses (PCA) largely conformed to the original model proposed, with the exception of one additional factor. The labels are consistent with the requirements of the measures used and with Zubin's originally suggested elements of focus, sustain, and shift. It should also be noted that the findings of the PCA performed with adults was virtually identical to that found in children, indicating that the model proposed is consistent in both adults and children and an accurate reflection of the elements of human attention. Research conducted by a variety of investigators have largely confirmed the model's accuracy and are reviewed by Mirsky et al. (1991). Rogers (1996) found that data from many of the same measures best fit the four-factor model when submitted to a confirmatory factor analysis (CFA). However, Strauss, Thompson, Adams, Redline, and Burant (2000) found otherwise after conducting their own CFA.

Given the disparity in these analyses, the Mirsky et. al model is still viewed as one requiring further study.

Based on the findings from the earlier PCA, a neuropsychologically based theory of attention is presented (Mirsky, 1987; Mirsky et. al, 1991). First, the element of “focus” is described as the process of focusing on a particular task while simultaneously screening out potential distracters. Mirsky explains that tests consistent with the process of focusing are invariably time dependent, hence the use of the term “focus/execute.” These tests include the Digit Symbol test, the Stroop Color and Word Test, the Talland Letter Cancellation Test, and the Trail Making Test (Parts A and B). More recent factor analyses suggest that the Visual Search and Attention Test (Trenerry, Crosson, DeBoe, & Leber, 1990) is another measure of this factor (O’Donnel et. al, 1994). The attentional process of vigilance, or maintaining attention to a particular task is known as “sustain.” Sustain allows for a readiness to respond to target stimuli, as well as inhibiting response to distracters and is defined by CPT correct responses, commission errors, and reaction time. Attentional “shift” allows for the shifting of attention from one task to the next and can be assessed by the WCST categories, percentile correct, and sorting errors. The fourth factor originally described by Mirsky et al. (1991) is known as “encoding” and describes the capacity to hold a particular piece of information in one’s mind and manipulate it in some way. Encoding corresponds with Digit Span and Arithmetic subtests, as included in the WAIS-R. A fifth factor mentioned by Mirsky (1996) and Mirsky and Duncan (2000) has been identified in more recent studies. “Stability” involves the consistency of accurate responses to stimuli. This factor is consistent with variance in CPT reaction time to correctly identified targets, although there appears to be less relative confidence in the existence of this element.

Also presented in Mirsky et al’s (1991) model are assertions of neural localization of attentional processes. Data collected in order to make such arguments include both animal and human subjects, involving methods such as aluminum cream lesions, electrical stimulation, cortical resections, cerebral blood flow imaging, cortical lesions, and seizures. According to the model, “sustain” is dependent upon rostral midbrain structures, involving more specifically the tectum, mesopontine reticular formation and midline and reticular thalamic nuclei. Mirsky points out that these are the basic neural structures that are believed to constitute the earliest phylogenetically developed attentional processing center within the mammalian brain, as discussed earlier. “Focusing” is believed to be processed in the superior temporal cortex, the inferior parietal cortex, and structures of the corpus striatum, while “execution” is also likely processed in the latter of these two regions. “Encoding” involves the hippocampus and amygdyla, and “shift” the anterior cingulate gyrus of the prefrontal cortex. As a whole, the model encompasses a variety of cortical and subcortical structures. The author estimates that “stabilize” involves brain stem structures as well as midline-thalamic structures (Mirsky, 1996), although more recent discussions suggest that “stabilize” likely involves similar attention systems as the other four elements but cannot yet reliably be localized (Mirsky & Duncan, 2000).

There are similarities amongst the models discussed earlier and the neuropsychological model presented, as pointed out by Mirsky (1996). For example, Pribram and McGuinness's constructs of arousal and activation coincide with the Mirsky model's construct of sustain. There are also clearly points of overlap in the arguments made in both models on the physiological correlates of attentional processing, including the amygdala, frontal cortex, and basal ganglia. However, Mirsky (1996) explains that his own theory of attention is discernible from that of Pribram and McGuinness because it is based on neuropsychological data as opposed to animal research, and is more concerned with the "clinical neurobehavioral issues." In comparing his model to the Posner-Peterson model, Mirsky (1996) points out that there are again similarities in the physiological structures implicated, such as the prefrontal cortex, parietal cortex, and structures of the brain stem. He also asserts that the focus/execute and sustain elements of his model correspond with the orient/detect and maintaining vigilance elements of the Posner-Peterson model. However, Posner and Peterson attribute shift behaviors to the superior colliculus and adjacent structures and Mirsky argues this is the case because their model focuses specifically on shifts in eye movement. Differentially, the Mirsky model conceptualizes shift as the shifting of set in concepts and abstract thinking, as measured through administration of the WCST.

At this point, it may be helpful to explain why Mirsky's model is considered neuropsychological in nature. The study of neuropsychology is traditionally viewed as one focused on findings in human beings, though neuropsychologists remain abreast of the findings in animal research which allows for the manipulation of neural structures. Neuropsychological tests are developed with the intention of making functional and anatomical distinctions between "normal" individuals and those with neurological disorders (Halperin, 1996). In the development of his model, Mirsky and his colleagues use a battery of well normed neuropsychological tests and distinguish between separate elements of attention based on PCA of test performance. Yet, as pointed out in a more general discussion of cognitive testing by Morris (1996), it remains difficult if not impossible to develop a test that isolates one element of attention from another, and most attentional measures likely tap into all elements of this construct as well as whole other cognitive functions (Halperin, 1996). Nonetheless, Halperin concedes that Mirsky's use of sound measures and PCA allow for some of the best possible conclusions made from a neuropsychological perspective.

While other models of attention have been proposed that indicate neural localization of particular functions, Mirsky et al. (1991) argue that theirs is differentiated by the specificity of associations proposed between particular functions and particular regions. It should be noted, however, that the authors do not consider this organization absolute as Mirsky (2000, October) readily describes it as a work in progress. Such a model allows researchers the opportunity to better understand how specific elements of attention relate to the many disorders mentioned which appear to have an attentional component, and helps clinicians to make differential diagnoses and aid in the process of treatment planning.

Anxiety

Continuum of Perceived Imminent Threat

Anxiety and worry are sometimes described as proximal constructs on a continuum of perceived threat imminence, while anticipatory anxiety exists toward the middle of the spectrum, and fear and panic exist on the more severe end (Craske, 1999). According to Craske, emotion theorists conceptualize fear and panic, as well as sadness, excitement and anger as emotions in that they represent hardwired biological processes. Anxiety is alternatively viewed as a cognitive association between hardwired basic emotions and particular environmental experiences, therefore representing a higher level of cognitive processing. Anxiety and worry, then, are the cognitive experiences of preparation for perceived imminent threat.

Craske postulated that the response systems of fear include self-report, behavioral, and physiological (Craske, 1999). Self-report involves verbal appraisal of one's experience, including inaccurate or catastrophizing beliefs and recognition of internal physiological sensations. The behavioral system involves avoidance as well as performance deficits. The physiological reaction involves arousal via activation of the autonomic nervous system. According to Craske, these methods of anxiety response can also function as stimuli in a negative feedback loop, thereby facilitating downward spirals of anxiety experienced by those suffering from such difficulties as panic disorder.

Behavioral Inhibition System and Approach/Avoidance

One of the most noted theories on anxiety involves Gray's (1982) description of the Behavioral Inhibition System (BIS). While several other models exist, a comprehensive review of these models is beyond the scope of the present study and interested readers are directed to Craske's (1999) text for such information. Gray explores what he characterizes as the psychologically-oriented aspects of the mind and its involvement in anxiety, as well as the relationship between anxiety and the brain (physiologically-oriented). Gray’s model is based largely on the effects of anti-anxiety medications and the systems they are likely to affect which are logically involved in the existence of anxiety given that they are also involved in its treatment.

The experience of anxiety is subsumed within the BIS, a theoretical ‘psychological component’ involved in classical conditioning necessary for the experience of anxiety, as the mind must learn to distinguish much of that which is threatening. Within the BIS, worry is conceived of as a preparatory method for contending with potential threat and moderating the consequences of such threat. The BIS responds to inputs of secondary punishing stimuli (according to Gray, emotion theorists characterize this as fear), as well as secondary frustrative stimuli (signals of non-reward, also known as conditioned frustration), innate fear stimuli, and novel stimuli. Outputs of the BIS function to inhibit ongoing behaviors, increase maximum possible analysis of current stimuli in the environment with particular attention to novel stimuli, as well as increase overall arousal and thereby intensify behaviors that follow. Gray also describes passive avoidance and extinction as specific output behaviors. The author focuses on findings that the septo-hippocampal region of the limbic system is most closely associated with BIS activity.

In addition to the BIS, Gray (1982) discusses briefly two other systems: fight-flight, and approach. The fight-flight system responds to unconditioned punishment and non-reward, while responses of this system involve unconditioned escape and defensive aggression. It should be noted that classification of fear outside of the fight-flight system and instead in the BIS is contrary to many other theories, including those cited earlier on the definition of constructs such as fear, anxiety, and worry (Craske, 1999). In addition to the fight-flight system, Gray discusses the system of approach toward appetitive stimuli, which he later elaborates and terms the Behavioral Activation System (BAS; Gray, 1982; cited in Sutton & Davidson, 1997). BAS inputs include conditioned stimuli for reward and non-punishment, while responses include approach learning, active avoidance, skilled escape, and predatory aggression. While Gray argues for the involvement of the limbic system, there are also data to indicate the presence of cortical associations with emotional experience. Left prefrontal activation, as measured through electroencephalogram (EEG), was found to coincide with appetitive behaviors (BAS), while right prefrontal activation was found to be associated with self-reported inhibitory or withdrawal behaviors (BIS; Sutton & Davidson, 1997). These data suggest that the left anterior cortex is associated with the experience of positive affect and right anterior cortex is associated with the experience of negative affect. More recent research suggests that depression and anxiety (both of which typically fall under the construct of negative affect) are differentiated neuropsychologically based on relative increase in right posterior activity in anxiety and relative decreased activity in this area with depression (Keller, Nitschke, Bhargava, Deldin, Gergen, Miller, & Heller, 2000).

Several authors have come to characterize these behavioral systems using the terms mentioned or alternative ones, such as approach and avoidance. Approach involves responses to incentives requiring organization and implementation of behaviors intended to attain appetitive stimuli. Avoidance involves responses to incentives requiring organization and implementation of behaviors intended to withdraw from aversive stimuli

(Sutton & Davidson, 1997). Lang, Bradley, and Cuthbert (1997) offer a brief review of theory development regarding these motivational systems. Other terms used to describe the systems have included preservative vs. protective, aversive vs. attractive, and there appears to be agreement that the constructs of response involve the valence of motivation: either positive, consummatory, approach, and attachment behaviors, or negative, defensive, escape, and avoidance. In addition to the dimension of valence, level of arousal is associated neurologically and metabolically with activation of the motivational systems controlling behavioral approach to appetitive/pleasant stimuli, or withdrawal from aversive/unpleasant stimuli (Sutton & Davidson, 1997; Lang 1995). Per this explanation of emotion, Lang (1995) describes emotion as “motivationally tuned states of readiness” or “dispositions to action.” Craske (1999) cites theorists who conceptualize emotion similarly (according to valence and arousal) but using a three dimension model, including control as the third factor. Craske references researchers who argue that fear involves low valence, high arousal, and low control.

State-Trait Anxiety Distinction

An additional consideration to take into account is theorists’ distinction between state dependent anxiety and an individual’s personal predisposition to such experience, or trait anxiety (Speilberger, 1983). While trait anxiety is defined as a stable degree of anxiety proneness, state anxiety is considered a subjective experience of momentary apprehension in response to immediate threat coupled with a heightened level of arousal. Literature indicates that state and trait anxiety are highly correlated (Spielberger, 1983). Eysenck (1982) provides a helpful model to explain the dynamics of the strong interrelationship of these constructs, specifying that degree of state anxiety is a function of both trait anxiety and environmental stress. A sizeable literature is consistent with this conceptualization of anxiety which has gained great popularity since its inception amongst both researchers and clinicians and may be considered in tandem, not opposed to, theoretical frameworks described above (Eysenck, 1982; Speilberger, 1983).

Effects of Anxiety on Cognitive Performance

Threat-Relevant Attentional Bias

Research thus far indicates that individuals experiencing feelings of anxiety exhibit an attentional bias toward threat-relevant stimuli, eliciting interference of cognitive processes extraneous to such threat (Craske, 1999). Craske offers a comprehensive review of this literature, including studies amongst clinical populations indicating attentional biases for specific types of information depending upon anxiety disorder diagnosis (e.g., socially anxious people exhibiting the greatest amount of interference from words linked to social and physical threat). In such cases, attentional systems are heightened by activation of the toward threat-relevant rather than task-relevant information.

Cognitive Interference Along the Perceived Imminent Threat Continuum

While an extensive literature exists on the occurrence of decreased levels of task-relevant attention, researchers continue to develop constructive conceptualizations and theoretical models in an effort to explain this phenomenon. The models of anxiety discussed earlier are helpful in explaining how the experience of imminent threat (from anxiety/worry, to anticipatory anxiety, to fear/panic) influences cognitive processing

(Craske, 1999). Response (verbal, behavioral, or physiological) is dependent upon the level of threat imminence experienced and the types of responses elicited are associated with varying degrees of cognitive interference. Anxiety typically elicits verbal/self-report and involves the experience of limited arousal for cognitive processes employed in preparation for threat. Anticipatory anxiety involves a behavioral response coupled with a greater degree of autonomic arousal. Increased interference of cognitive processes occurs in order to plan and prepare for threat due to recruitment of the fight-flight system. Finally, cognitive processes are greatly limited when experiencing fear and panic as a result of the high level of arousal and intensity of the fight-flight response. Verbal, behavioral, and physiological responses are all incorporated when fear/panic are involved. Craske (1999) points out that true fear and panic are unlikely to occur even in the most extreme of laboratory settings due to the presence of recognizable safety factors.

Worry and Attentional Interference Theory

Eysenck and Calvo (1992) describe in brief detail the specifics of the worry and attentional interference theory, which is closely related to the previous theory described. The theory purports that worry reduces cognitive resources and interferes with attentional focus on task-relevant stimuli, thereby reducing cognitive capacity for task-relevant performance. The theory therefore suggests that higher degrees of worry are associated with higher degrees of interference and a lower degree of performance via the interaction of environmental stress and trait anxiety on processing activities (Eysenck, 1982). It also suggests that worry is likely to cause greater detriment when completing more difficult tasks, as task difficulty is associated with attentional demands. Eysenck and Calvo (1992) provide a healthy review of literature corroborating this theory. However, the authors also argue that the theory is deficient in at least two primary ways. First, that it conceptualizes attentional interference as the sole cognitive influence of anxiety, while the authors argue that a theory on anxiety and performance needs also take into account the potential for worry to increase motivation and compensatory strategies, thereby increasing performance. Second, the authors argue that attentional requirements as well as storage requirements are involved in defining the difficulty of a task. In an effort to improve upon the perceived inadequacies of this theory, the authors argue for the processing efficiency theory.

Processing Efficiency Theory

This theory is designed to explain the effects of state anxiety on cognitive task-performance within the normal population, including those subjected to conditions of stress (Eysenck & Calvo, 1992). "Worry" is often referred to and is operationally defined as the cognitive component of anxiety, similar to the conceptualization mentioned earlier by Craske (1999). Also essential to the theory is working memory, which is briefly described as a three part system involving a central executive and active processing center (closely associated with attention and considered the single most important component of the system), an articulatory loop or verbal rehearsal system used for the purposes of verbal storage, and a sketch pad used for visual and/or spatial storage. Worry is thought to most likely impact the former two aspects of working memory. Via improved capacity in the working memory system, worry functions to increase amount of on-task resources allocated and effort in processes consistent with improved performance. It is thought that such increased effort and resource allocation may occur in an attempt to avoid the potential costs of less than adequate performance as well as avoid feelings of worry. Increased performance may be facilitated by a self-regulatory system that augments available cognitive capacity when necessary. In addition to applying extra cognitive resources in order to simply overcome the negative consequences of worry, a second method described by the authors may involve compensation and reduction in worry (e.g., calming down, denial) also allowing for improved working memory.

High anxiety participants differ from low anxiety participants in that high anxiety participants more frequently use the self-regulatory control system to adjust resource allocation and effort. This occurs for several reasons including the following, many of which have been discussed or alluded to above: increased levels of motivation due to worry about performance; the tendency of high-anxious individuals to attend more freely to task-irrelevant or threat-related information and subsequent detection of discrepancies in expected performance and actual performance; setting of excessively high standards resulting in a discrepancy between performance and expectation; and detection of expected and actual performance discrepancies in testing situations that occurs more readily due to increased attentiveness to feedback of poor performance (Eysenck & Calvo, 1992).

The authors distinguish between performance *effectiveness* (quality of performance) and performance *efficiency* (quality of performance divided by effort). Processing efficiency theory is unique in its assertion that anxiety is related only to performance efficiency, as this incorporates effort exerted as a result of anxiety experienced. The authors however admit that while performance effectiveness is simply calculated, measurement of efficiency is greatly complicated by the entanglements of accurately quantifying effort.

Other Relevant Literature

In addition to the above theories, it is necessary to mention the Yerkes-Dodson inverted U-Law that suggests very high and low levels of arousal are associated with decreased performance, while mild levels of arousal are associated with improved performance. In his discussion of this curvilinear relationship, Mahoney (1979) cites relevant research corroborating the law in athletic performance, although there is also an indication that reviews of the literature are not particularly conclusive on the matter. There is a recognizable relationship between this and the processing efficiency theory of Eysenck & Calvo (1992) who assert that anxiety and related levels of arousal can improve performance, while Yerkes-Dodson would indicate this to be true depending on the level of arousal.

Related physiological research has largely involved measuring the degree to which the startle reflex is modulated by picture-evoked affect using a system of photographs of people, animals, nature, objects, events, and scenes known as the International Affective Picture System (IAPS; Lang, 1995). Lang explains that while these evoked emotions may not reflect the exact emotions humans experience in reaction to the everyday world, visual images can function as effective "generators" of emotion and easily control for such variables as time and intensity across individual and/or repeated presentations. Lang and his colleagues have collected substantial normative data on participant response to the IAPS in terms of reported valence and arousal levels, as well as neural action potentials associated with variability in eyeblink amplitude. Perhaps one of the most interesting findings discussed by Lang, Bradley, and Cuthbert (1997) relates to the present study and suggests that "some motivationally [and therefore emotionally] relevant information is, indeed, processed in an eyeblink" (p. 116). Other research involving emotion provoking photographs corroborates this claim based on self-report of anxiety (Richards, French, Johnson, Naparstek, & Williams, 1992).

Both pleasant and unpleasant photographs stimulate higher levels of cortical processing as well as larger portions of neurological matter when compared to neutral stimuli (Lang, Fitzsimmons, Bradley, Cuthbert, & Scott, 1996). Authors that reviewed these data argue that the findings are consistent with the hypothesis that more interesting stimuli utilize greater amounts of attentional resources (Lang, Bradley, & Cuthbert, 1997). Findings thus far suggest that unpleasant stimuli and subjective feelings of fear potentiate startle response (increase amplitude), a defensive reflex designed to help avoid injury and deal with potential threat by freeing cognitive processors. Potentiated startle response is associated with high levels of vigilance or "freezing." Such freezing of cognitive processors is similar to discussions mentioned earlier by Gray (1982) and Craske (1999), the combination of which indicates that a motivated response set spurred by aversive stimuli and associated BIS activity heightens cognitive processors and resources to focus on threat-relevant, non-task-relevant, stimuli. Pleasant pictures conversely inhibit startle reflex (decrease amplitude), and this effect is positively associated with increased level of picture arousal (Lang, 1995). Based on these findings, researchers argue that affective cues elicit responses in the appetitive and aversive motivational drive systems (i.e. BIS and BAS) which are fundamentally related to the modulation of cognitive functions such as attention and perception (Lang, Bradley, & Cuthbert, 1997).

In brain imaging studies, increased levels of cerebral blood flow (CBF) and glucose metabolism are associated with increased functional brain activity. Positron emissions tomography (PET) is used by researchers to measure such activity within specific neural structures. Drevets and Raichle (1998) observed increased CBF in areas associated with emotional processing (amygdala, posteromedial orbital cortex, ventral anterior cingulate cortex) while completing an emotionally related experimental task, and decreased CBF in these same areas when completing an attentional/cognitive processing task. Attentional/cognitive tasks stimulated increased CBF in neural areas associated with attention/cognition (dorsal anterior cingulate, dorsolateral prefrontal cortices), and decreased CBF in these areas during emotionally oriented tasks. Based on these data, the authors argue for the presence of reciprocal cognitive and emotional processing on a neurological level. They suggest that such findings may help to explain phenomena such as improved affect in depressed or anxious individuals while occupied with completing a cognitive task, or decreased cognitive activity while experiencing intense emotions.

Eysenck (1982) provides a helpful review of literature on the effects of stressors on performance. Data repeatedly indicate the performance in high-anxiety individuals is impaired more by failure feedback, while low-anxiety individuals' performance has been found to be unaffected and sometimes improved by failure feedback. Conversely, low-anxiety participant performance is most affected by electric shock or threat of shock while the performance of high-anxiety participants is either unaffected or improved in this condition. The author cites research that analyzed these findings isolating worry and emotionality (emotionality is interpreted by the present author as an index of general emotion without indication of valence). It was found that failure feedback produces a greater sense of worry rather than emotionality, and worry is highly associated with decreased performance due to such things as task-irrelevant processing. Threat of shock was conversely found to produce emotionality rather than worry, although Eysenck admits it is difficult to use this information to discern differences revealed in performance.

Anxiety and Neuropsychological Testing

In addition to the studies mentioned thus far, there have been investigations on the effects of anxiety on neuropsychological measures. As mentioned earlier, a myriad of medical and psychological disorders include symptoms of attentional dysfunction. However, dysfunction of attention is not unique to the presence of medical or psychiatric conditions. Research indicates that slight manipulations can alter attentional performance. This is of particular importance because the results of neuropsychological testing are assumed to represent an individual’s best performance. Put more succinctly, subtle differences in stressors that increase levels of state anxiety may hinder an individual’s best performance, resulting in inaccurate conclusions. However, the amount of literature is limited, as is the consistency of methodological design and subsequent findings.

In a discussion of the effects of state anxiety and working memory, Eysenck (1982) cites his own research as well as additional studies indicating a negative association between performance on Digit Span and state anxiety, while no such association was found with trait anxiety. However, the author points out that data from other studies are not entirely definitive, sometimes indicating the opposite state anxiety-Digit Span relationship, or an inverted curvilinear relationship of performance similar to that of the Yerkes-Dodson U. In addition to effects on the central processor, the author also cites research indicating that anxiety may affect the articulatory loop of the working memory system.

Chavez, Trautt, Brandon, and Steyaert (1983) investigated the degree to which test anxiety, measured using the Test Anxiety Scale (Sarason, 1972; cited in Chavez et al., 1983) and both state and trait anxiety levels, measured using the State-Trait Anxiety Inventory (STAI; Spielberger, 1983) affect performance on an abbreviated Halstead-Reitan Neuropsychological Test Battery (HRNB; Reitan & Wolfson, 1993) and an abbreviated Wechsler Adult Intelligence Scale® (WAIS®) (Psychological Corporation, San Antonio, TX, www.psychcorp.com). Subtests included were Trail Making and Finger Tapping of the HRNB, and Digit Span, and Digit Symbol of the WAIS. Also measured were differences in performance due to gender. Findings indicate that male participants performed better than female participants on the Finger Tapping Test. Higher trait anxiety scores were associated with decreased performance on Part A of the Trail Making Test and the forward section on Digit Span, and such findings are consistent with theories mentioned earlier. However, high trait anxiety was also found to be associated with higher levels of performance on the Digit Symbol Test and the Finger Tapping Test. Test anxiety was not associated with performance on any of the tests administered. The inconsistency of these findings is attributed by the researchers to limitations in sample selection, and the research itself seems deficient in offering potential direction for future efforts. The results suggesting positive effects of anxiety on performance are also difficult to substantiate when compared with past findings in which trait anxiety was negatively associated with performance on Finger Tapping and a Form Board test (King, Hannay, Masek, & Burns, 1978).

In addition to the studies discussed above, three articles are related to this topic and important to the present study in that they involve the effects of anxiety on cognitive performance as manipulated by experimenters through variations in assessment contexts. Tyler and Tucker (1982) conducted a study in which both high and low trait anxious participants, as identified by the STAI, completed several cognitive tests in either a stress or a no stress context. Cognitive measures included a verbal counting task, Digit Span of the WAIS, the Seashore Tonal Memory Test (Saetveit, Lewis, & Seashore, 1940; cited in Tyler & Tucker, 1982), and the Mooney Closure Faces Test (Mooney, 1956; cited in Tyler & Tucker, 1982). The stress condition was defined by presentation of the following instructions:

> Now we will do some additional visual and auditory perception tasks. The main goal is for you to enjoy the tasks, so relax and take it easy. I do want you to pay attention to the task, but don't be so concerned about how you do (p. 214).

In contrast, the stress condition received the following instructions:

> Now we will do some additional visual and auditory perception tasks. You have been chosen to be in the high stress condition. You will be anxious throughout these tasks, and you will be quite uptight. However, you should work hard and do your very best because this is extremely important (p. 214).

Results indicate that participants high in trait anxiety performed poorer on the Mooney Closure Test and the Seashore Tonal Memory Test when in the stress condition, as compared to no stress. On these same measures, low anxiety participants performed better in the high stress condition and these data as a whole indicate that stressors involving the testing contexts can impact performance.

Martin and Franzen (1989) administered a battery of neuropsychological tests - including the Randt Memory Battery (Randt & Brown, 1983; cited in Martin & Franzen, 1989), the Knox Cube Tapping Test, the Stroop Word and Color Test (Golder, 1978; cited in Martin & Franzen, 1989), and the Finger Tapping Test (Reitan & Wolfson, 1985; cited in Martin & Franzen, 1989) - to non-clinical participants screened for a history of neurological disorders or traumas and randomly assigned to two different conditions labeled “neutral” and “anxiety.” Participants in the anxiety condition were tested by experimenters in casual yet appropriate clothing and a white lab coat in a room with “official looking” electronic equipment and a visible neuroanatomy chart. Participants in this condition completed the STAI and were then read the following statement:

> Before we begin testing, I want you to know that these tests are used to screen for neurological problems, whether they are from brain damage, a tumor or an abnormal condition existing from birth. Scores on these tests correlate highly with

> ability to accomplish tasks, including academic success and professional development. Although it is not the purpose of the study to screen for neurological problems, your test results will be evaluated by a clinical neuropsychologist. If abnormal results are obtained, we are ethically obligated to contact you for further diagnostic procedures and intervention, if necessary. Because this study is extremely important, I want you to try as hard as you can to do well (pp. 4-5).

The neutral stimuli condition was conducted in the same room, but out of sight of the neurological chart and with covers concealing the electronic equipment exposed in the anxiety condition. The experimenter dressed casually, did not wear a lab coat, and read the following script prior to beginning testing:

> Before we begin testing, I want you to know that these tests are generally used to screen for neurological problems, whether they are from brain damage, a tumor or an abnormal condition existing from birth. As a normal college student, you should have no difficulty doing well. Scores on these tests have been found to have some correlation with academic achievement, though they are not a reflection of IQ in any way. As we progress through this session, I want you to relax and follow the instructions to the best of your ability (p. 5).

Participants completed the State Anxiety scale after the experiment was complete in order to assess anxiety level during the actual experimental task. Based on previous studies of anxiety and performance on neuropsychological tests that produced less than robust findings and did not treat gender as an independent variable, Martin and Franzen identified both treatment condition and gender as such. On two indices of the Randt Memory Battery, the authors found that males scored higher than females, and participants in the neutral condition scored higher than those in the anxiety condition. There were higher mean scores for the neutral condition on the Surprise Misses Score of the Knox Cube Tapping Test, and other summative scores of this test were non-significant but found to occur in a similar direction. Significant effects were found for condition on all Stroop scores, as well as a significant effect for the gender X condition interaction. While participants as a whole performed better in the neutral condition, females exhibited better performance on two of three Stroop scores when compared to males in the anxiety condition. Findings on the Stroop Color-Word Interference Test are of particular interest to the present study because it is one of the tests that Mirsky and colleagues (1991) found to be consistent with the "encode" element of attention. Lastly, males were found to perform better on the Finger Tapping Test, similar to the findings of previous studies (Chavez et al., 1983; King et al., 1978). The only significant result related to self-reported anxiety was found in a correlation between a residualized state anxiety score and the Randt, although similar trends were found with other measures. The difference between subjective state anxiety of the two conditions was found to be non-significant, although a trend did exist.

The authors point out that the lack of significant differences in reported state anxiety between the two conditions may be explained by the possibility that the experimental manipulation was not salient enough to elicit disruptive levels of anxiety. Post-test levels of the STAI may have also inadequately reflected the feeling of anxiety during testing, or may have been administered at a time when participants' feelings of "relief" after having finished influenced their responses. Nonetheless, the condition variable was found to be significant for several measures, and anecdotal observations of participant movements (fidgeting) and impromptu commentary were interpreted as indicating the presence of increased levels of anxiety in the anxiety condition.

Martin and Franzen's (1989) research is of particular importance because it clearly indicates that easily introduced assessment contexts (assessment explanation, potential for negative feedback, physical surroundings, and demeanor of the assessor) are likely to negatively impact neuropsychological functioning. It also suggests that gender differences exist in neuropsychological functioning, oftentimes depending upon the testing context variables. While male performance proved to be superior on some measures, there are also data to indicate that males perform worse during the anxiety condition while female performance remains more consistent in this context. Although past research has found an effect for assessment context (Chavez et. al 1983; Tyler & Tucker, 1982), the authors submit that the practice of collapsing participants across gender may have precluded more robust findings.

In a related study, von Kluge (1992) used a non-clinical sample to administer the Stroop color-naming task during either a "low-anxiety" or "high-anxiety" condition. Use of the term "low-anxiety" was used as the authors believed it to be an accurate descriptor of the level of anxiety experienced by any individual completing a psychological experiment regardless of condition. Participants in this low-anxiety condition were approached by a casually dressed experimenter who read the following:

> Would you mind participating in a short psychology experiment? I am going to present you three stimulus lists that have four basic colors . . . For each list please recite the colors only - do not read the words. Please don't use your hands and stand at a comfortable distance from the lists (p. 654).

The high-anxiety condition instead involved four or five experimenters in formal dress approaching participants, reading the same instructions as the low-anxiety condition along with the following addition:

> This study is designed to evaluate your mental acuity and color perception. First, may I have your name [pretend to write it down]. My three colleagues are here to observe and record the speed and accuracy with which you complete the task and to aid them we will record your responses. Speed and accuracy are critical (p. 654).

The author reports, similar to the anecdotal observations of Martin and Franzen (1989), that participants in the low anxiety group appeared only somewhat anxious based on their tendency to giggle, while participants in the high anxiety group appeared more serious during the experimental manipulation.

Consistent with the findings of Martin and Franzen (1989), von Kluge found that, when comparing error rates, performance was better in conditions of low anxiety rather than high anxiety. Females also made fewer errors than males. When analyzing reaction times, the author found a significant effect for the gender X condition interaction; females performed slower than males during the low-anxiety condition while females and males did not differ during the high-anxiety condition. As with Martin and Franzen (1989), von

Kluge emphasized the importance of using gender as an independent variable, arguing that failure to do so is likely to result in non-significant and potentially non-discernible data. von Kluge submits that gender and stressors such as those in the present study are more “natural” independent variables and likely to produce very different responses than studies involving threatening stimuli (e.g., a loud noise) or comparing participants high or low in trait anxiety. No mention is made in the studies listed above on the potential effects of the experimenters’ gender.

The Present Study

Statement of Problem

Given the existence of related studies conducted in years past, it is necessary to state not only the intent of the present study but also how the study relates to previous research while contributing an original investigation. Much as with the studies discussed above, it was the intention of the present author to investigate the degree to which testing context influences state anxiety and the ability of normal individuals to utilize their cognitive abilities as assessed through neuropsychological measures. Assessment context variables were manipulated in an effort to influence state anxiety by presenting the participant with 1) physical settings, 2) interpersonal demeanors, 3) and explanations of the purpose of testing that, combined, would theoretically increase activation of the participants’ Behavioral Inhibition System (Gray, 1982). It was believed that the nature of the stimuli presented would necessarily involve cognitive associations in order to experience feelings of imminent threat, and therefore fall within the construct of anxiety, as defined by Craske (1999). Increased anxiety and activation of the BIS would then also theoretically increase threat-relevant/task-irrelevant attention and deplete cognitive resources (Eysenck & Calvo, 1992). Such findings might validate the worry and attentional interference theory in the context of neuropsychological testing, or support other theories mentioned, such as the processing efficiency theory or the Yerkes-Dodson Law.

Performance on the cognitive measures was the sole method for determining whether such systems and changes in cognitive processing in fact occurred. Findings from related studies would suggest that assessment context stressors do negatively impact performance on cognitive measures (Martin & Franzen, 1989; Tyler & Tucker, 1982; von Kluge, 1992). There are also trends in the data to suggest that the experience of anxiety is the factor by which the assessment context variables affect test performance (Martin & Franzen, 1989). Given that there are only limited statistically significant findings involving these data, such findings could be attributable to the measures and constructs examined, sample size, or methodological issues, each of which was intended to be improved upon in the present study.

It was believed that a study intended to measure the simultaneous effects of affect on several cognitive factors may be flawed in the simplicity with which each cognitive construct was conceptualized. In order to measure several cognitive skills, practicality requires limiting the number of measures for each construct despite increased recognition that cognitive skills are multi-dimensional. The present study investigated specifically how assessment context variables influence state anxiety and one cognitive function in particular - attention - a highly dynamic non-unitary cognitive skill involving a variety of elements. Mirsky's model of attention is of particular interest in explaining the divisions of these elements. As mentioned earlier, it is a model of attention based on the administration of neuropsychological measures to a variety of populations, scrutinized by statistical analyses. Consequently, the present study involved investigating the effects of assessment context variables and situational anxiety on attention as defined and measured by Mirsky's model in an effort to better understand how this particular phenomenon impacts the many dimensions of one cognitive construct.

It was believed that a greater degree of anxiety in the Structured/Medical Condition (SMC) would be achieved through presentation of salient stimuli (objects in the experimental room, dress of the experimenter, etc.), austere demeanor of the experimenter, and a salient explanation of the purpose of testing (i.e. discussion of attentional and brain dysfunction), and the offer for feedback of results. It was hoped that a lower degree of anxiety would be achieved in the Relaxed Condition (RC) by juxtaposing as many of the methodological variables mentioned above as possible from the SMC, while still maintaining standardization of all other aspects of the experimental procedure, such as the actual test administration instructions. Such methodological contrasts were intended to maximize the opportunity to observe the effects of assessment context variables on anxiety and attention. Additionally, an effort was made to evaluate the participants' experience of state anxiety at the experiment's outset during the height of the manipulation, rather than relying on potentially tainted retrospective report as studies have done in the past.

Implications of Study

How testing is completed is of increasing concern amongst neuropsychologists, as exemplified by the National Academy of Neuropsychology's recently published official statement that testing be conducted in the absence of third party observers who may distract an individual from giving his/her best performance (NAN, 2000). Continued research indicates that results from neuropsychological testing are susceptible to inaccuracies manipulated with conscious intent, such as in the case of malingering (Rogers, Harrell & Liff, 1993). There are also data to suggest that aspects of assessment context typically ignored by test developers are likely to affect measurement outcome significantly. For example, D'Reaux, Neumann, and Rhymer (2000) found that outcome on neuropsychological measures varied depending on the time of day of administration. Relatedly, Llorente (2000, November) found that test outcome differed depending on the order of test administration. Careful consideration of the methodologies employed in our testing procedures must be made in order to facilitate the best possible performance and accurate results, and the literature cited above indicates that current testing methods and practices are in need of stringent evaluation.

In addition to potentially offering valuable information regarding the influences of assessment context on anxiety and attentional processes, the present study is of particular interest because the manipulations entailed in order to investigate this issue were designed to retain reasonably good ecological validity. There is indeed a great deal to be gained in the process of investigating the degree to which state anxiety affects performance when induced through the presentation of noxious or startling stimuli (e.g., an unexpected loud noise). However, there is very little likelihood that an ethical practicing psychologist would ever wittingly employ such techniques in a clinical setting when testing an actual client. Manipulations used in the current study, conversely, were less salient than a loud noise. They were instead designed to subject to scientific scrutiny the effects of two contrasted testing contexts likely created by practicing neuropsychologists in everyday interactions with clients.

The literature unfortunately remains limited in its investigation of the effects of anxiety on psychological testing, as manipulated by assessment context. When considering the lack of investigation into the specific effects of situational anxiety on attentional processes, the absence of research appears still more salient. Lang, Bradley, and Cuthbert (1997) appropriately point this out:

> In cognitive studies of human beings it is usual to manipulate attention through instructions. We tell the participant to attend to x and not to y, or to respond quickly when z appears. Cooperative subjects are pre-selected, and the experimenter gives little thought to what environmental events generally motivate an attentional set (p. 119).

The intention of the present study was to specifically investigate this very factor in the hopes of offering valuable information relevant for researchers and applicable to clinicians.

Questions

Lack of research on the effects of assessment context and state anxiety on Mirsky's model of attention preclude highly specific hypotheses for the present study.

While some of the limited literature involves the effects of trait anxiety on neuropsychological performance, those involving the effects of state anxiety were fairly limited, as were those involving the specific attentional measures to be employed in the present study. These issues contributed further to the difficulty of generating detailed and directional hypotheses. Consequently, focus was placed on asking more open-ended research questions.

1) Whether an association existed between assessment context and reported state anxiety and affect was investigated. Also investigated was the association between assessment context and attentional processes. A positive association between the SMC and state anxiety was expected. A negative association was expected between the SMC and measures of attention, although the elements of attention were not specified. 2) An analysis was performed in order to determine whether request for feedback in the SMC was associated with changes in attentional performance. A negative association was expected, although the elements of attention were not specified. 3) The present study also investigated, via a series of analyses, the degree to which performance on the five factors of attention differed as a function of several predictor variables, including age, estimated IQ, years of education, experimental condition, state and trait anxiety, state affect and general affect, and motivation. Assessment context and state anxiety were expected to be significant predictors, although the predicted elements of attention were not specified. 4) In addition, factor analyses were completed on the measures of attention in order to determine whether or not Mirsky's model of attention remained consistent despite the

effects of testing contexts and experienced state anxiety. Given the consistency of the five-factor model across populations and past studies, a similar outcome was expected.

CHAPTER 2

METHOD

Participants

Eighty female students at the University of North Texas participated in the present study and received extra credit points for doing so. All participants were randomly assigned to one of two experimental conditions, which varied depending upon the nature of the testing context (either relaxed or structured/medical). Because data suggest that completion of attentional tests vary depending upon age (Connelly, Hasher, Zacks, 1991; Trenerry et. al., 1990) and some of the tests involved in the present study do not include norms, participants in the present study were between the ages of 18 and 29. The sample collected was limited to females due to availability of participants, and this controlled for gender which has been found to be a mediating variable in related studies (Martin & Franzen, 1989). Based on self-report, participants were screened for a history of neurological difficulties, physical handicaps, diagnosis of learning disabilities, attention deficit/hyperactivity disorder, anxiety disorders, or other psychiatric illnesses. In order to help control for potential differences in hemispheric dominance, participants were screened for handedness. Only right-handed volunteers were tested. Because some of the attentional measures of the study required color discrimination, participants were screened for color blindness.

Participants ranged in age from 18 to 27 years of age. They averaged 20.98 years of age, 14.3 years in education, and 103 in estimated IQ. In terms of ethnic identity, 60% of the participants were Caucasian, 25% were African American, 7.5% were Hispanic, and 3.8% were Asian. The remaining 3.9% of the subjects identified themselves as either Native American, Indian, or Bi-racial. Table 2 presents the ethnic identity of participants in the two respective experimental conditions.

Materials

Signup, Consent, and Screen

Participants responded to one of two notices posted for research participation in the Department of Psychology at the University of North Texas. The only difference between these announcements were the titles of the study advertised. For participants included in the Relaxed Condition (RC), the notice was entitled “Peak Performance Study,” while participants included in the Structured/Medical Condition (SMC) responded to a notice entitled “Attentional Dysfunction Study.” The “Peak Performance Study” notice was the only notice presented until all 40 RC participants completed the study, after which time the “Attention Dysfunction Study” notice was used to collect the remaining 40 SMC participants. This notice was intended to contribute to the experimental manipulation of the study. Both notices explained that the study involved completion of attentional measures, four extra credit points to be earned through participation, and the parameters necessary for such participation. Potential participants were asked to complete a consent form and screening form in order to answer questions relevant to the requirements for participation in the study. Phone numbers and email addresses were provided and used to contact those who qualified for participation.

Visual Search and Attention Test

The Visual Search and Attention Test (VSAT; Trennery et al., 1990) involves four search and cancellation tasks, including 10 rows of stimuli and 10 targets randomly placed throughout the rows. Different stimuli help vary participants' level of familiarity for both the distracters and targets. Task 1 consists of letters while Task 2 consists of various typing symbols, and both are printed in black ink. Tasks 3 and 4 are similar to 1 and 2, except that the stimuli are printed in blue, green, or red ink and targets must be matched for color as well as form. The authors introduced the added variable of color in order to increase the range of complexity between the target and distracter stimuli. Participant scores are based on performance of tasks 3 and 4 and calculated using age-normed percentile scores. Tasks 3 and 4 were selected for scoring because they were found to have the highest level of sensitivity for detecting brain damage. Therefore, tasks 1 and 2 function as required practice trials. Scores on the VSAT include totals and percentiles for performance in the left visual field, right visual field, and a combination of both visual fields.

Poor performance on cancellation tests is considered indicative of neuropsychological impairment (Lezak, 1995), and the VSAT was developed for this purpose. The measure was validated using a normative sample of 272 adults, and a sample of 100 adults with confirmed neurological damage or disease. In the course of this validation study, gender and education were not found to have a significant relationship with scores on the VSAT. However, age was found to be a significant factor. Consequently, age-adjusted scores were developed for six age groups including (a) 18-19, (b) 20-29, (c) 30-39, (d) 40-49, (e) 50-59, and (f) 60+. Using age adjusted scores, the VSAT effectively discriminated 117 of 136 normal participants, and 43 of 49 brain damaged participants. These findings translate to a specificity level of .86 and a sensitivity level of .88. In addition, Trenerry et al. (1990) tested and re-tested a 28 participant subset of the normative sample with a two-month interval between test administrations. Test-retest reliability was estimated by a correlation coefficient which was found to be high (.95). However, a practice effect occurred for this sample in which the mean performances improved by 11%. A recently conducted factor analysis found that the VSAT and the Paced Auditory Serial Addition Test (Levin, undated; cited in O'Donnell et. al, 1994) define the same factor as the Trails B test (Reitan & Wolfson, 1985) which the authors labeled focus/execute, in keeping with the Mirsky et al. (1991) model of attention. The present study used percentiles of total number of correct responses on the VSAT as an indicator for focus/execute. Percentile scores of left and right visual field scores were also used.

Continuous Performance Task – Identical Pairs

In the years during and shortly after World War II, Haldor Rosvold evaluated Canadian soldiers who participated in combat during the war. After making the observation that contemporary psychological assessments lacked an adequate measure of attention, he developed the first Continuous Performance Test (CPT) with the help of his then graduate student, Allan Mirsky. The apparatus involved the use of a simple computer and a test sequence that required participants to respond to presentation of the letter “X” only on those occasions when it followed the letter “A” (Mirsky, 2000, October). Since that time, several versions of the CPT have been developed and continue to be used in current day research and clinical practice. The Identical Pairs version of the Continuous Performance Task (CPT-IP; Cornblatt, 1998) is, like its predecessor, a computer-based test and was used in the present study. Although there are some differences between this particular CPT and that used by Mirsky and his colleagues in the development of their attentional model, the tasks are similar. The CPT-IP is designed to be a more challenging task and has a higher test ceiling than other CPTs. This was believed to be more appropriate for the present study, given that the sample used was limited to college students between the ages of 20-29 – individuals who tend to have greater cognitive skills than much of the general or clinical populations.

The CPT-IP involves responding to stimuli presented on a computer screen in both verbal format (in a series of digits) and visual format (nonsense shapes). Participants are instructed to respond with a key stroke when identical stimuli are presented in sequence, one after the other. Thirty target pairs exist within a series of 150 rapidly flashed trials in each condition of the task. Thirty of 150 “catch” trials are also presented involving similar, though not identical, stimuli. The first two conditions (C-1 for verbal attention, and C-2 for spatial attention), are typically presented in order to establish a baseline for processing of verbal and spatial information. Cornblatt explains that digit strings with no numerical properties were used for C-1 because they are less likely to be confounded by issues related to saliency and frequency. The shapes in C-2 are considered nonsense shapes because they were designed with the intention of being unassociated with any form of verbal labeling. In both C-1 and C-2, each trial lasts for 1 second (1000 msecs) and the total administration time of the 150 trials therefore lasts approximately three minutes.

Like many of its predecessors, the CPT-IP was originally developed for the purpose of identifying individuals suffering from brain damage. Cornblatt offers suggestions on what combinations of the nine CPT-IP conditions are best suited to answer a variety of research questions, including the following: Is there a deficit in sustained attention? Is there evidence of abnormal distractibility? Is there a deficit in speed of processing? At what point is a decline in processing capacity evident? Because Mirsky's research suggested that the CPT is suited to measure the element of attention known as sustain, which is consistent with the intention of the CPT-IP developers, the present study focused on the first research question posed and the corresponding recommended conditions. To this end, both C-1 and C-2 are presented with stimulus presentation lasting 50 msec followed by a 950 msec period of dark screen. It is recommended that, in an effort to better quantify attentional skill, C-1 and C-2 are presented in expanded form (300 trials each instead of 150) in order to establish adequate reliability. Cornblatt asserts that faster presentation times are too difficult and reduce reliability, while slower times limit the diagnostic usefulness of the measure. While C-1 and C-2 differ in the type of stimuli presented, the performance of over 300 participants suggests that the two conditions are equal to one another in terms of difficulty. Problems in verbal or spatial processing can then be inferred based on differences found in performance between these two conditions. Furthermore, the verbal and spatial conditions are roughly consistent with left and right hemisphere specialization, and patients suffering from depression have been found to have greater difficulty with the spatial task.

The CPT-IP offers several scores of participant performance. The percentage of “Omission Errors” or false negatives (which are inverse to the percentile of “Hits”) involves failing to correctly respond to target stimuli and are believed to reflect participants’ inability to focus for an extended period on a task. The percentage of “Commission Errors” or false positives involves incorrectly identifying stimuli as targets, and these errors are said to reflect impulsive behavior, or difficulty to inhibit. “Natural Log Beta” reflects participants’ tendency to increase the likelihood of correct responses by over-responding and consequently increasing rate of error. The Natural Log Beta score also reflects efforts to under respond in an effort to decrease the likelihood of committing errors of commission. A measure of overall attentional sensitivity, “D Prime,” is scored based on a combination of hits and false alarms in order to assess ability to discriminate signal from noise. Also offered is “Reaction Time” (RT) and variance in RT. Each of the scores listed above is separated into subscores that correspond with responses to the respective verbal and visual stimuli of the measure. According to the Mirsky model (Mirsky, 1987; Mirsky, 1996; Mirsky et al., 1991; Mirsky & Duncan, 2000) the factor sustain corresponds with Hits, False Alarms, and RT for correctly identified targets, while stabilize is defined by variance in RT to correctly identified targets.

Digit Span

As mentioned earlier, the Digit Span task is consistent with the encode element of attention (Mirsky et al., 1991). Digit Span has long been regarded as a measure of attention and included in the Wechsler scales since their inception, including the recently developed Wechsler Adult Intelligence Scale®-Third Edition (WAIS®-III) (Psychological Corporation, San Antonio, TX, www.psychcorp.com). The task is divided into two parts including Digits Forward and Digits Backward. In the forward version, digits are presented in strings ranging in length from two to nine digits, while string length ranges from one to eight digits during Digits Backward. Two trials are included for each digit string length. For Digits Forward, the examiner reads aloud each string of numbers which the examinee then repeats in identical sequence, while Digits Backward entails repeating each string in reverse sequence. Each pair of the Digit Span strings receives a score of 2, 1, or 0, and testing is discontinued after failure of two consecutive trials. In the present study, Digit Span total scores were calculated, as well as separate Digits Forward and Backward scores.

Developers of the Wechsler tests and researchers agree that Digit Span functions as a measure of both short-term memory and attention (Sattler, 1992; Wechsler, 1997). When divided into its separate sections, Digits Forward is considered a more pure measure of focused attention, although rote memory is also considered a skill tested by the forward task. Digits Backward, on the other hand, allows for measurement of working memory: the cognitive skill that allows an individual to hold the mental image of a digit string for a short period of time, rotate that image in memory, and restate it in reverse sequence. Interestingly, this definition of working memory is consistent with the Mirsky et al. (1991) definition of encode. In addition to attention and working memory, Sattler (1992) argues that Digit Span performance is sensitive to such variables as relaxation and stress tolerance, which are of particular interest in the present study.

Whereas data collected using normal participants indicate that the forward task remains stable across age groups, performance on the backward task tends to deteriorate with age (Weintraub & Mesulam, 1985; cited in Wechsler, 1997). Data collected on the WAIS-III Digit Span subtest corroborate the measure's reliability and validity (Wechsler, 1997). The normative sample for the WAIS-III included 2,450 adults, consisting of an equal number of males and females across 13 age bands. The normative sample was representative of racial proportions in each of the designated age groups within the U.S., according to 1995 census data. All Digit Span data reported here involve participants ranging in age from 20 to 29, corresponding to the present study's sample.

Split-half reliability coefficients for ages 18-19, 20-24, and 25-29 were .91, .90, and .92, respectively. Test-retest stability for ages 16-29 was also found to be high, yielding a coefficient of .83. In reference to issues of criterion-related validity, Digit Span of the WAIS-III correlated strongly with Digit Span of the WAIS-R and WISC-III at .82 and .73, respectively. Corrected correlation coefficients between Digit Span of the WAIS-III and the Stanford-Binet Intelligence Scale-Fourth Edition (SB-IV; Thorndike, Hagen, & Sattler, 1986; cited in Wechsler, 1997) were highest when comparing Digit Span to the Short Term Memory Area of the SB-IV (.52). Construct validity of Digit Span was evaluated based on factor analysis with other subtests of the WAIS-III.

Exploratory factor analyses support a four factor solution of the WAIS-III and indicate that a single construct is defined by Digit Span, Letter-Number Sequencing, and Arithmetic subtests. Pattern loadings of each of the three subtests on the labeled Working Memory factor were .71, .62, and .51 respectively, indicating that Digit Span accounted for the greatest degree of variability in relation to this particular construct. Confirmatory factor analysis supported the stability of the above factor structure across five age bands, including ages 16-19 and 20-34 (since these are of interest to the present study), and WAIS-III developers labeled the aggregate of this construct as the Working Memory Index. Comparisons with other measures suggest that the Working Memory Index is a valid measure of attention; correlations with the Attention/Concentration Index of the Wechsler Memory Scale®-Revised (WMS®-R) (Psychological Corporation, San Antonio, TX, www.psychcorp.com), the Trail Making Test (Parts A and B) of the Halstead-Reitan Neuropsychological Battery (HRNB; Reitan & Wolfson, 1993), and the Attention/Mental Control Index of the MicroCog (Powell et al., 1993; cited in Wechsler, 1997) yielded coefficients of .66, -.37, -.65, and .65, respectively (Wechsler, 1997).

Wisconsin Card Sorting Test – Computerized Version 2

Performance on the Wisconsin Card Sorting Test™ (WCST™) (Psychological Assessment Resources, Lutz, FL, www.parinc.com) is consistent with the attentional element that Mirsky (1991) identifies as shift. Indeed, the WCST was originally developed to evaluate non-verbal abstraction skills and ability to shift set as participants are required to use abstract reasoning skills in order to match stimulus and response information depending upon environmental feedback (Berg, 1948; cited in Heaton, 1981). The WCST has evolved to become one of the more commonly used measures of neuropsychologists in order to assess for frontal lobe dysfunction (for a review of studies on normals and patient groups, see Heaton, 1981). The test involves presentation of stimulus cards displaying figures of various shapes (crosses, squares, circles, or triangles), in various colors (red, green, blue, and yellow), in various numbers (one, two, three, or four). Researchers have developed several different administration procedures, but the most commonly used method involves presentation of four stimulus cards in the following left-to-right order: one red triangle, two green stars, three yellow crosses, and four blue circles. The participant is then provided with a stack of response cards and instructed to use their own judgement in order to match the response cards with the proper stimulus cards. Accurate responses require that the participant base their match by either the color, form, or number (or some combination of the three) of figures on the stimulus and response cards. While the examiner is aware of the criteria for a correct match, the participant is not informed of this information. They are simply given verbal feedback as to whether each match is “right” or “wrong.” Once the participant has completed a total of 10 consecutively correct matches based on the designated criteria, the criteria change without instruction or redirection other than continually provided feedback.

The first criterion is form, followed by number, color, form, and number. The test is discontinued once the participant has either completed six full categories (with a minimum of 60 responses) or the entire set of 128 response cards. For the present study, administration complied with the directions prescribed in the WCST manual (1981), although the administration of the test was completed on a computerized version of the measure known as the Wisconsin Card Sorting Test™: Computerized Version 2 Research Edition (WCST™: CV2, Psychological Assessment Resources, Lutz, FL, www.parinc.com). Variations in administration include viewing of the stimuli on a computer screen, and movement of the left and right arrow keys of a computer key board followed by pressing the "Enter" button in order to complete a response. The computerized version of this test was employed for the purposes of the present study because it is believed to facilitate greater accuracy and ease of both the administration and scoring processes. Research indicates that performance on the computerized version and the traditional administration of the WCST are similar, with the exception of the finding that the computerized version results in a need for more trials to complete the first category (Fortuny & Heaton, 1996).

Several scores are derived from the computerized program including the "Trials Administered," "Total Correct," and "Total Errors" (Heaton, 1993). "Perseverative Responses" include all instances of perseveration (when the response given would have been correct during the previous set) and Heaton (1981) reports that this score is of particular assistance when using the test for diagnosis of brain dysfunction. "Perseverative Errors" are calculated because not all "Perseverative Responses" are errors, given that it is possible to provide an ambiguous response in which the match is based on more than one criterion. For example, after correctly matching 10 consecutive cards based on color, the following card may be matched on color – and is therefore considered a perseveration – but is not scored as an error if the response is ambiguous and happens to correspond to the correct form criterion. “Nonperseverative Errors” are also included based on the difference between total perseverative errors and total errors (errors that were not made as a result of a perseverative response). Also of interest are the “Conceptual Level Responses” (based on the presence of three or more consecutively correct responses), “Categories Completed,” “Trials to Complete the 1st Category” (a useful measure of conceptual ability but not shift), “Failure to Maintain Set” (the number of times the participant responds correctly five to nine times but fails to maintain set long enough to complete the category), and “Learning to Learn” (which reflects improved ability to conceptualize the requirements of the test, based on the amount of change in percentage of errors over the course of consecutive categories). WCST scores used by Mirsky in his testing of the five factor model of attention include Percentile Correct and Categories Completed. Because the computerized version of the WCST does not include a Percentile Correct score, the Total Correct score was substituted in its place. Also used were the Total Errors and Perseverative Responses.

Heaton (1981) reports the findings of a normative study involving 208 (145 males; 63 females) brain damaged patients (identified by neuroradiological procedures or neurosurgical operative report), and 150 normal controls. Within the clinical sample, participants mean age was 42.1 and mean level of education was 12.7 years. Clinical participants were divided into four sections depending on localization of injury, including “frontal only,” “frontal plus non-frontal,” “only non-frontal” and “diffuse.” The normal participants (123 males; 27 females) had no history of neurological damage and their mean age was 35.9 while their mean level of education was 13.9 years. Differences in education and age were controlled for through statistical analyses. Participants in the normal group scored significantly better than the total brain damaged group on all WCST scores except Failure to Maintain Set. The Learning to Learn score was also found to be a poor discriminator for the presence of brain damage. Participants in the frontal group performed more poorly on Total Errors, Perseverative Errors, percentile of Perseverative Errors, Perseverative Responses, and percentile of Conceptual Level Responses when compared with participants in the nonfrontal group. Nonsignificant differences were found on Categories Completed, Learning to Learn, and Failure to Maintain Set. Relationships in both normals and the clinical sample were found between age and performance. Four age groups were established (<40, 40-49, 50-59, >59), and the mean IQ among these samples was relatively similar. Group differences in age were most poignant when comparisons were made between the younger three groups and the "older than 59" group, across a variety of WCST scores. When comparing groups on education, a significant effect was found for IQ, although Heaton (1981) argues that these data are to be expected and IQ is not a confounding variable of WCST performance. Three educational groups were established (<12, 12-15, >15) and the "greater than 15" group was found to perform significantly better across a variety of WCST scores. Findings also indicated that both the "over 59" age group and "under 12 years" education group scored within a range considered indicative of impairment. Heaton (1981) points out, however, that such findings are based on small sample sizes and calls for caution in making clinical interpretations of individuals in either group.

Wide Range Achievement Test – 3 Reading

The Reading subtest of the Wide Range Achievement Test 3 (WRAT3™) (Wide Range, Wilmington, DE, www.widerange.com) is a measure designed to evaluate word recognition. Completion of the measure entails reading words of increasing difficulty across several rows of three to four words each. Participants are instructed to read the words aloud. Based on observations of the present author, the measure typically takes approximately one minute to complete. Upon making their first reading error only, they are asked to make a second attempt at the word and given full credit if correct. A maximum of ten consecutive errors are allowed, after which time the measure is discontinued. A fifteen point basal score is added to the final raw score, assuming the first five items are read correctly. The total raw score, with a maximum of 57 points, is then converted to a standard score. Standard scores have a mean of 100 and standard deviation of 15, similar to intelligence tests. Alternate forms of this test are available (Tan and Blue), and the Tan version was used for the present study. The WRAT3 Reading subtest was included in the present study in order to roughly estimate participants' intellectual functioning.

In terms of psychometrics, the reliability of the Tan Reading subtest appears quite strong, but it should be noted that some of the data provided are limited to combined aggregate scores of both the Tan and Blue Reading forms. According to Wilkinson (1993), the median internal consistency reliability for ages included the in present study (17-19, 20-24, 25-34), were high (.91, .91, and .89, respectively). Alternate forms reliability between the Tan and Blue forms were also high (.92, .94, .91, respectively).

Test-retest reliability coefficients yielded a corrected correlation of .98. In terms of content validity, a Rasch statistic of item separation was found to be 1.00 for all subtests of the WRAT3, including the Tan version of Reading. Construct validity of the WRAT3 was established by its developers via several different methods, some of which are discussed here (Wilkinson, 1993). First, a strong relationship was found between the WRAT3 and WRAT-R Reading subtests, with a corrected correlation of .95 for the Tan version. Relationships between the combined Reading score of the WRAT3 and other tests of achievement were also high; such as the Total Reading of the California Test of Basic Skills – 4th Edition (.69), Total Reading of the California Achievement Test – Form E (.72), and Total Reading of the Stanford Achievement Test (.87). A discriminant analysis found the WRAT3 Blue scores to be relatively accurate overall (68%) in distinguishing between children at various levels of cognitive functioning, while matched for age, gender, and race. Specifically, the scores were 85% correct for identifying gifted children, 72% correct for identifying learning disabled children, 83% correct for identifying mentally handicapped children, 56% correct for identifying normal children (Wilkinson, 1993). Accuracy scores for the Reading subtest in particular were not provided.

Lastly, the data indicate, a moderate relationship between the WRAT3 scores and intellectual functioning. Wilkinson (1993) found that the combined Reading score was correlated with the WISC-III at .70 for Verbal IQ, .52 for Performance IQ, and .66 for Full Scale IQ. The stronger correlation between Reading and Verbal IQ is consistent with the verbal content of the respective items involved in each measure. In terms of adults, a combined Reading score was correlated with the WAIS-R at .63 for Verbal IQ, .31 for Performance IQ, and .53 for Full Scale IQ (Wilkinson, 1993). In addition to adding to the construct validity of the WRAT3 Reading subtest, the data presented above suggest that the WRAT3 Reading test offers an adequate estimate of intellectual functioning.

Positive and Negative Affect Schedule

In order to control for variance in participants' performances on attentional measures attributable to feelings of sadness or depression, the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) was included in the present study. The PANAS involves presentation of two 10-item mood scales. Each of the items is intended to measure either Positive Affect (PA) or Negative Affect (NA) which are represented by one word mood descriptors rated based on the following scale: 1 = very slightly or not at all, 2 = a little, 3 = moderately, 4 = quite a bit, and 5 = extremely. While there are seven different versions of the PANAS distinguishable by their temporally related instructions, the "General" version to be used for this study entails evaluating the extent to which they generally feel on average. PA and NA are estimated by summing the total scores reported for mood descriptors representing the two respective scales.

Watson et al. (1988) explain that high PA is associated with high energy, good attention, pleasurable engagement, and social satisfaction, while low PA is associated with sadness and sluggishness. On the other hand, high NA is associated with a number of negative mood states such as anxiety, anger, contempt, disgust, fear, and nervousness, while low NA is associated with a state of calmness. The authors argue that depressive symptomology is most associated with low ratings of PA and high ratings of NA. In addition to PA and NA, attention was paid to the dimensions of Positive Affect, Depression, Anxiety, and Arousal, as implicated in a recent factor analysis of the PANAS (Reynolds, Greher, & Neumann, 2001, November).

Research on the PANAS has generated strong reliability and validity data. Because the present study involved the “General” form of the PANAS, the psychometric data reported correspond to this version only. Watson et al. (1988) found the internal consistency reliability of the measure to be strong, with alpha reliabilities of .88 and .87 for the PA scale and NA scale respectively. A low intercorrelation was found between the PA and NA scales (-.17), suggesting good discriminant validity. Test-retest reliability data after an eight week retest interval were good, with correlations between first and second administrations equaling .68 for PA, and .71 for NA. These data indicate that the long-term instructions of the “General” version elicit responses with trait-like stability. Factor analyses suggest that the PANAS also exhibits both strong scale validity and strong item validity.

State-Trait Anxiety Inventory

Form Y of the State-Trait Anxiety Inventory (STAI; Spielberger, 1983) has been used in well over 2,000 publications involving the measurement of stress and anxiety. As discussed earlier, trait anxiety (T-anxiety) is introduced as an index of stable tendencies to react to feelings of impending threat of harm with varying intensity and frequency of state anxiety (S-anxiety), given momentary stressors. Increases in S-anxiety are unassociated with T-anxiety during threats of physical danger, although T-anxiety has been found to be positively associated with S-anxiety levels in those who experience threats of self-esteem. This is relevant to the present study given that the experimental manipulations could have threatened feelings of self-esteem.

The measure is organized into two indices, each incorporating 20 statements of state and trait anxiety. State anxiety questions require the participant to respond based on how they feel “right now,” while trait anxiety questions require participants to respond based on how they feel “generally.” In order to reduce the effects of labeling on performance, the STAI is titled the “Self-Evaluation Questionnaire” during administration. According to Spielbeger, proper use of the STAI involves administration of the S-anxiety section for several given time period(s), such as before and after an experimental manipulation. This includes reporting such information as how the participant might have felt while completing the treatment or once the treatment was completed. Standardized administration entails presentation of the S-anxiety questions followed by those of T-anxiety. For ratings of S-anxiety, participants are asked to rate their experience of intensity for each symptom based on the following scale: 1) not at all; 2) somewhat; 3) moderately so; 4) very much so. For T-anxiety, participants are required to rate the frequency of symptoms experienced based on the following scale: 1) almost never; 2) sometimes; 3) often; 4) almost always. Ten S-anxiety and 11 T-anxiety items are worded such that a low score indicates low anxiety and a high score indicates high anxiety. The remaining items are reversed. A weighting system of 1 to 4 is then applied to convert each reversed item, again with lower weighted scores indicating low anxiety and higher weighted scores indicating high anxiety. Aggregate S-anxiety and T-anxiety scores can range from 20-80 each and are based on the sum of the 20 weighted items from the two respective scales. The author explains that items of the STAI are written for the sixth grade reading level or higher.

Normative data involve a variety of samples including working adults, college students, high school students, military recruits, male neuropsychiatric patients, general medical and surgical patients, and young prisoners. Normative data discussed below are limited to those involving college students. Eight hundred and fifty-five college students completed the STAI Form-Y, and this sample was not stratified. Female students were found to have slightly higher T-anxiety than male students. Mean S-anxiety was similar or somewhat lower than T-anxiety, which is to be expected when administered in a relatively non-anxiety-producing context.

In terms of validity, the research indicates that T-anxiety scores adequately distinguish between normals and neuropsychiatric patients suffering from symptoms of anxiety, as well as between general medical and surgery patients without a psychiatric diagnosis and general and medical patients suffering from psychiatric problems (Spielberger, 1983). Construct validity of the STAI appears to be well established based on significant differences found between S-anxiety scores of groups in stressful and non-stressful situations. Findings of significant difference between S-anxiety and T-anxiety scores in stressful situations also indicates that the measure adequately distinguishes state and trait experiences of anxiety. S-anxiety was also found to vary according to the degree of situational stress imposed on participants (i.e. no stress, after a relaxation exercise, after taking a brief IQ test, or after watching a stressful movie clip about woodshop accidents). The median correlation between S- and T-anxiety was found to be .65 and, as stated earlier, individuals who were challenged with social evaluation exhibited higher correlations between the S- and T-anxiety than those confronted with threats of physical harm. While S-anxiety was found to vary depending upon the stress imposed in a given situation, T-anxiety remained relatively stable. Researchers also found that although both genders scored higher with greater degrees of stress, females also scored significantly higher than males in the more stressful situations. Spielberger argues that these data indicate that females exhibit, as a whole, greater reactivity to stress. Concurrent validity with other measures of T-anxiety were high and ranged between .76 and .85 for male and female college students with the IPAT Anxiety Scale (Cattell & Scheier, 1963; cited in Spielberger, 1983) and the Taylor Manifest Anxiety Scale (1953; cited in Spielberger, 1983). Items written to measure the absence of anxiety and those written to measure the presence of anxiety were found to be better discriminators depending upon the corresponding level of anxiety in a given situation (i.e. absence questions discriminated better for low anxiety situations and vice versa). Spielberger refers to this effect as item-intensity specificity, and argues that such specificity facilitates use of the STAI across a variety of situations involving the subjective experience of stress.

Factor analyses have yielded a two-factor structure consistent with the items of the S- and T-anxiety scales. For college students, test-retest reliability ranged between .73 and .86. Internal consistency was measured and found to be high for both S-anxiety (.91 for males and .93 for females) and T-anxiety (.90 for males, .91 for females). Alpha reliability of S-anxiety was notably higher for participants experiencing high levels of stress.

Self-Assessment Manikin

The Self-Assessment Manikin (SAM) is a measure originally devised by Peter Lang for the purposes of measuring valence, arousal, and dominance experienced in response to a variety of stimuli (Lang, Bradley, & Cuthbert, 1999). The constructs of valence and arousal coincide directly with the conceptualization of emotion discussed earlier, describing an interaction of motivation for approach or avoidance modified by degree of arousal. It is for this reason that this particular measure was chosen for the present study. The measure itself involves making three separate ratings for each of these emotional dimensions. For each of the three dimensions, five manikins are arranged along a continuum from high to low. The manikins themselves are graphically depicted human figures that are non gender, age, or culturally specific. Ratings made using the manikins are scored using a nine-point scale. Low ratings of each dimension correspond with lower numerical scores, while high ratings of each dimension correspond with higher numerical scores. Both paper-and-pencil and computerized versions of the SAM are available, although the present study used the former exclusively.

The SAM was developed as an analog of the 18 item Semantic Differential Scale (Mehrabian & Russell, 1974; cited in Bradley & Lang, 1994), an 18 item measure including verbally presented bipolar terms of emotional experience. The Semantic Differential Scale was factor analyzed and found to yield three factors corresponding to valence, arousal, and control. In correspondence with this original measure, the SAM presents a non-verbal response rating system and facilitates a more timely administration. Bradley and Lang (1994) found that both the paper-and-pencil and computerized versions of the SAM correlated highly with mean factor ratings from the Semantic Differential Scale for pleasure (.97 and .96, respectively), and arousal (.94 and .95, respectively). The dominance scale, on the other hand, resulted in far weaker relationships (.23 and .18, respectively). However, specific item analysis of SAM ratings versus those of the Semantic Differential Scale indicate that SAM ratings better reflect the emotional experience of dominance in the subject (as intended by the developers) while viewing emotionally latent pictorial stimuli. Based on data collected, anxiety patients typically display a negative correlation between arousal and valence (i.e. high arousal, low valence). Also associated with anxiety on the SAM is low dominance.

In addition to strong associations with previously defined measures of affect, relationships between the SAM and physiological correlates of emotion have been evaluated. Greenwald, Cook, and Lang (1989) found that an association exists between facial EMG and ratings of valence according to the SAM. Specifically, corrugator activity was found to decrease with increased ratings of valence ($p < .0002$), and zygomatic activity was found to parallel increased ratings of valence ($p < .02$). Skin conductance was found to relate positively to SAM ratings of arousal ($p < .00005$), although this association was found to be greater in males than females. Finally, heart rate was found to increase with increases in ratings of valence ($p < .005$), although the stability of heart rate/valence relationships are often found to be elusive (Greenwald, Cook, & Lang, 1989). Reliability of the SAM has also been well-established (Lang, Bradley, & Cuthbert, 1999), with split-half reliability coefficients for valence (*rs* = .94 and .94 for paper-and-pencil and computerized administration, respectively), and arousal (*rs* = .94 and .93 for paper-and-pencil and computerized administration, respectively). Between subject reliability was found to be similarly strong for mean valence (*r* = .99) and arousal ratings (*r* = .97) in reaction to emotionally latent pictorial stimuli.

Hand Preference Questionnaire

All participants in the present study were right handed, thereby helping to control for potential differences in attentional abilities attributable to variability in neurological hemispheric dominance. The Hand Preference Questionnaire developed by Peters and Servos (1989) was used to more specifically identify variations in hand preference. The scale includes eight items involving common tasks that require the use of one’s hand (e.g., write, throw, use knife for cutting bread, use toothbrush) and instructs participants to rate their degree of preference for each item with the following scale: 1 = always left, 2 = usually left, 3 = right or left, 4 = usually right, and 5 = always right. The questionnaire was originally used to classify left-handers into two separate categories. Those who responded with two or more items scored as 4 or 5 were labeled an inconsistent left-hander (ILH), while those who responded with one or fewer items scored as 4 or 5 were labeled a consistent left-hander (CLH). Results obtained by Peters and Servos (1989) corroborate the validity of this classification system, based on findings that CLHs exhibited greater strength in the left hand, while ILHs exhibited greater strength in the right hand. Although Peters and Servos used the above criteria to classify differences in left-handers, the researchers’ criteria were adapted for use with right-handed individuals, allowing for classification of inconsistent right-handers (IRH) and consistent right-handers (CRH) in the present study.

Motivation Scale

Wolverton and Salmon (1991) observed that direction and degree of motivation is associated with anxiety. For this reason, the present study included a measure of motivation. While Wolverton and Salmon (1991) developed a measure of motivation, the present author believes that this measure was designed for the express purposes of measuring motivation relative to music performance. Consequently, a different measure of motivation was employed, designed for the purposes of the present study. The Motivation Scale was completed by all participants. Consistent with the approach of Wolverton and Salmon, the scale includes three main items requiring participants to rate the degree to which they were motivated by external cues (a desire for approval from others), internal cues (a desire to meet one's own expectations of one's self), or attention-oriented cues (a desire to focus on attending to the tasks at hand). For each of these dimensions of motivation, the following scale was used: 1= not motivated, 2 = slightly motivated, 3 = quite motivated, and 4 = extremely motivated. In addition, a total score intended to reflect overall motivation was calculated based on the sum of responses to the scale's three items. The Motivation Scale was developed for this study and there are no data on its reliability or validity.

Health Questionnaire

An additional questionnaire was administered in order to control for potential confounding variables related to health. Specifically, questions were asked regarding caffeine and tobacco intake in the hour prior to completion of the experiment. Participants were also asked to list the number of hours they slept during the two nights prior to the experiment. Finally, participants were asked to report the number of days since the first day of their most recent menstrual period.

Procedure

As mentioned earlier, many of the procedures of the present study are consistent with related past studies (Martin & Franzen, 1989; Tyler & Tucker, 1982; von Kluge, 1992). The present study was completed in a single laboratory room in Terrill Hall at the University of North Texas. Because the two experimental conditions were run in blocks, the physical setting of the room was only changed once.

All participants were met individually for completion of the study. For both the SMC and RC, participants completed the experiment individually with the same experimenter present at all times. Approximately 60 minutes were required to complete the experiment. Upon completion of the experiment, participants were offered the opportunity to ask questions. Participants were also asked at this time not to share the procedures of the experiment with anyone.

For each of the two conditions, the experimental manipulation is described in terms of its three primary elements described earlier, including 1) the physical setting of the experiment, 2) demeanor of the experimenter, and 3) the explanation of the purpose of testing. As stated earlier, it was believed that these factors would increase levels of state anxiety in the SMC. Conversely, it was hoped that the contrasts of these factors in the RC would limit the degree of state anxiety in this condition.

Structured/Medical Condition

Physical setting. During the SMC, the door to the lab was labeled “Attentional Dysfunction Study.” The experimenter wore a white lab coat throughout the experimental procedure. The experimental room included electronic physiological equipment (two oscilliscopes) and other experimental apparatuses (a chin rest held across from a slide viewer), a human skeleton, a human body model, and two human brain models. Books on neuroanatomy and brain functioning, a brain chart, a human body chart, and a chart of all DSM-IV (APA, 1994) diagnoses were also in view of the participant. No decorations or “creature comforts” were present.

Demeanor of the Experimenter. The experimenter avoided engaging in social niceties (e.g., brief spontaneous conversation or use of slang in their language) or any efforts consistent with those recognized as conducive to building rapport. Instead, the experimenter focused on completing the experimental script in an apparently stringent, methodical manner. The experimenter also avoided using any form of verbal encouragement during the testing procedure and maintained a manner of speech best described as highly directive, structured, and austere.

Explanation of testing. Once in the room, the experimenter read the following to the participant:

> What you are going to do today is complete a number of neuropsychological tests. The reason these tests are used is to try to gain a better understanding of your thinking abilities, which are directly related to the functioning of your brain. While brain-imaging procedures such as CT scans, MRIs, and PET scans (each of

which you may or may not have heard of), can tell us about the structure of brain tissue and the metabolic activity of your brain, they do not give us detailed information about thinking abilities. What we will be testing today is a particularly important aspect of brain function having to do with attention. The following tests will involve a variety of tasks that will challenge your attention in different ways. These tests allow neuropsychologists to determine what particular types of attention you are strong or weak at, as well as identify potential brain dysfunction. The results of the test can even allow us to speculate about the localization of dysfunction, if it exists. The most important thing for you to do is to try hard and be as accurate as you can so that we can get the most precise information about your thinking abilities and brain activity. If you would like us to provide you with feedback regarding your performance, please tell me now.

It was then noted by the experimenter whether participants in the SMC were interested in receiving feedback on their performance.

Relaxed Condition

Physical setting. Participants in the RC were tested by the same experimenter who was professionally but casually dressed during this condition. The experimental room was labeled "Peak Performance Study" instead of "Attentional Dysfunction Study," and lacked the scientific props present during the SMC. Instead, the room included a variety of "creature comforts" such as personal photos (e.g., pictures of the experimenter in different settings with friends and family), a bean bag in one corner of the room, plants, artwork on the walls, pleasure books (e.g., a compilation comic-strip book), and old newspapers.

Demeanor of the experimenter. Upon meeting, the experimenter made an effort to be friendly and quickly establish rapport with each participant, using conjunctions and slang and engaging in spontaneous, brief social conversation when appropriate. The experimenter also offered fitting words of encouragement throughout the testing procedure.

Explanation of testing. Participants in the RC group were given the following instructions:

> Thanks for participating in our research. What you're going to do today is complete some psychologically oriented tasks. It's believed that these tasks help us to assess how well you're able to pay attention to things. We know that attention is a gift and that we probably couldn't function day in and day out without attention and this study involves learning how to best evaluate this important cognitive skill. So just relax and do the best you can.

Organization of the Experimental Procedure and Feedback

For both conditions, the initial meeting in the experimental room and explanation of the purpose of testing was identified as Treatment-1 (T-1). Measurement-1 (M-1) followed and involved the administration of the health questionnaire, handedness questionnaire, PANAS, STAI, SAM, Motivation Scale, and WRAT3. The attentional measures were then completed during a period referred to as Measurement-2 (M-2). Although Mirsky (1987) does not describe a particular order of the measures used in his original study, he consistently discusses them in a particular order, which may reflect the sequence of their completion. Correspondingly, all participants completed the attentional measures in the order of the VSAT, CPT-IP, Digit Span, and WCST: CV2. A sequence table is provided to better illustrate the order and content of each treatment and measurement period (see Table 1).

Those in the SMC who requested feedback on their performance were given a brief report providing this information. The reports were reviewed and signed by both the experimenter and a licensed clinical psychologist. Participants received the report by mail and were given the option of contacting the experimenter by phone to schedule a face-to-face individual meeting in order to inquire about the findings. For those interested in further testing or psychotherapy, the University of North Texas Psychology Clinic phone number was provided in each report.

Modifications of the Present Study

As noted in several memos distributed throughout the data collection process, several editions were made to the methodology of the present study in addition to those prescribed during the study's initial proposal. Each of these modifications were the result of unforeseen practical limitations of successful data collection in the manner proposed, but an effort was made to minimize the changes made in order to maintain the integrity of the study's original purpose. For the sake of convenience and clarity, these modifications are specified here. 1) Due to limitations of both space and availability of reliable research assistants, the baseline portion of the study was eliminated, and it is recognized that this change reduced the ability to interpret affective ratings as being a result of the experimental condition. 2) Subjects of 18 and 19 years of age were included in the study due to the low response rate. Consequently, age-normed scores were calculated when available and used for the present study's analyses. For those measures without normative data (i.e. the CPT-IP), analyses were completed in order to determine if a significant difference in performance existed based on age. 3) Due to the markedly low response rate of males relative to females, males were excluded from the study. This was determined to be the best solution to control for gender effects while maximizing potential for successful data collection. 4) Finally, the sample size was reduced from 100 to 80, due to slow response rate and the need to complete the study by the end of the Spring 2002 semester. It was agreed that this change would be unlikely to reduce significantly the power of the proposed analyses, and result in minor limitations in terms of the statistical tests to be conducted.

CHAPTER 3

RESULTS

Descriptive Statistics

Descriptive statistics from the present study are provided, including means and standard deviations for measures of state affect (see Table 3), and means and standard deviations of attentional measures (see Table 4). In addition, means and standard deviations of the present study's covariates are provided (see Table 5). These incorporate general information about participants, health information, self-ratings of trait anxiety and general affect, and self-ratings of motivation. The participants were well matched on each variable accounted for across conditions.

In terms of the testing of assumptions, several of the dependent variables in the present study violated the Shapiro Wilks test of normality. The most severe of these was the Perseverative Responses of the Wisconsin Card Sorting Test™: Computerized Version 2 Research Edition (WCST™-CV2, Psychological Assessment Resources, Lutz, FL, www.parinc.com) for the Structured/Medical Condition (SMC), and WCST: CV2 Categories Completed for the Relaxed Condition (RC) and SMC. These observations were not surprising given the simplicity of this task for a non-clinical population, as in the present study. Square-root transformations were completed in an effort to correct for the large degree of skew and kurtosis of these variables and this was accomplished in the transformation involving the WCST: CV2 Perseverative Responses. Transformation of the WCST: CV2 Categories Completed variable was found to be unhelpful in this effort. The Central Limit Theorem, however, applied to these variables and all others thatviolated the ShapiroWilks test, given the high number of participants for both the RC and SMC. Outlying data that would otherwise decrease normality of distributions were also eliminated by method of trimming. The data for each of the variables presented was, therefore, considered to meet the assumption of normality and valid for the purposes of all analyses that follow. In addition, the assumption of independence of observations for all correlations and regressions that follow was met because the present study involved two between subjects conditions.

Preliminary Analyses

Covariates

Prior to answering the questions of the present study, analyses were performed in order to determine the degree to which covariates of the present study were associated with the experimental condition and the dependent attentional measures. Pearson Product Moment Correlation Coefficients and Point-biserial Correlation Coefficients were calculated and the covariates included general information (e.g., age and IQ) and health information, motivation, and trait anxiety and general affect.

For general information, health information, and experimental condition (see Table 6), a limited number of relationships were observed. These included a moderate relationship between the Wide Range Achievement Test 3 (WRAT3™) (Wide Range, Wilmington, DE, www.widerange.com) Reading Standard Score/Estimated IQ and Digit Span, r = .355, and Continuous Performance Task-Identical Pairs (CPT-IP) False Alarms

(Numbers), *r* = -.313. However, these relationships were not surprising. The cognitive abilities required for each of the attentional tests administered are often viewed by neuropsychologists as essential components of a global construction of intelligence, such as IQ. The strength of the relationships, furthermore, was only moderate. Based on these arguments, it was not deemed necessary to include IQ as a covariate in any of the analyses of the present study. In addition, age was found to correlate with experimental condition at the -.314 level. Once again, the moderate strength of this relationship was not sufficient to incorporate age as a covariate in any of the analyses that follow.

No correlations of notable strength were found between motivation and experimental condition, or between motivation and the attentional measures (see Table 7). When examining covariates of trait anxiety and general affect (see Table 8), a single moderate relationship was found between the Positive and Negative Affect Schedule (PANAS) Anxiety Factor and the CPT-IP RT Hits (Numbers), *r* = .300. This finding was not factored into subsequent analyses, however, because of the limited strength of the relationship. No other correlations of moderate strength were observed.

CPT-IP and Age

As mentioned above, age was not related to performance on any of the attentional measures, including the various scores of the CPT-IP (see Table 6). However, because a substantial age range (18-27 years) existed in the participant sample and the CPT-IP was the only attentional measure not normed for age, this issue was given further scrutiny. Based on normative data collected in the development of the Visual Search and Attention Test (VSAT), participants within each condition were included in either an 18-19 age group or a 20-29 age group. Three independent samples t-tests were calculated for each of the experimental conditions (RC and SMC), as well as both conditions combined. These analyses were conducted because the 18-19 age group was added in order to improve response rates to the study and subsequent sample size. Findings from both the RC and SMC t-tests revealed no statistically significant differences between age groups, although the sample sizes of the 18-19 groups were small for both conditions ($n = 2$ for the RC, and $n = 13$ for the SMC). An additional independent samples t-test of the RC and SMC combined also revealed no statistically significant differences in CPT-IP scores between age groups. Based on these results, it is argued that age did not function as an extraneous variable in the present study, and therefore need not be included as a covariate in the analyses involving the CPT-IP that follow.

Answering Questions

The following results were organized to correspond with the research questions asked. Many of the analyses performed were intended to address the conceptually unique aspects of the proposed study that involve investigation of the five factor model of attention.

Question 1

Point-biserial correlation coefficients were calculated in order to test whether the assessment context was related to reported state anxiety. Such a relationship was observed between the experimental condition and scores on the State-Trait Anxiety Inventory (STAI) State scale, $r = .334$. The direction of other relationships between experimental condition and items on the three Self-Assessment Manikin (SAM) scales appeared appropriate in nature (either positive or negative) given the content of the items, but did not meet notable strength (see Table 9).

The second portion of this question involved investigating the relationships between the assessment context and attentional measures of the study, and between the state anxiety/affect scales and attentional measures of the study. Point-biserial Correlation Coefficients were conducted to examine the relationships between assessment context and attentional performance. Correlation coefficients revealed that no relationships meeting moderate strength existed between experimental condition and attentional measures. When examining the relationships between the state anxiety/affect measures and attention as follow-up analyses, Pearson Product Moment Correlation Coefficients were conducted. The results of these analyses revealed a relationship between SAM Valence and CPT-IP False Alarm Rate (Shapes), $r = -.311$. For those variables that were skewed and kurtotic, square-root transformations did not yield noteworthy differences in results. No other relationships were observed of moderate strength or approaching moderate strength.

Question 2

In order to evaluate whether or not SMC participants' expressed interest in receiving feedback on their performance was associated attentional performance, point-biserial correlation coefficients were performed. For those variables that were skewed and kurtotic, squared transformations did not yield noteworthy differences in results. A positive relationship was observed between participants' request for feedback and the CPT-IP Hit Rate (Numbers), $r = .310$. All other relationships, whether positive or negative, varied between strength levels not considered indicative of a noteworthy relationship (see Table 10). Follow-up analyses involved point-biserial correlations between the request for feedback and measures of both state and trait anxiety, state and general affect, and motivation. The results of these analyses revealed a moderate relationship between the request for feedback and the PANAS Anxiety Factor, $r = .349$.

Question 3

Stepwise multiple regression analyses were performed in order to determine the predictive power of several variables on the attentional measures of the study (see Table 4). Predictor variables included age, years of education, WRAT3 Reading Standard Score/Estimated IQ, experimental condition, PANAS Positive Affect scale, PANAS Negative Affect scale, STAI State Anxiety scale, STAI Trait Anxiety scale, SAM Valence scale, SAM Arousal scale, SAM Dominance scale, and Motivation Scale Total. For each of these multiple regressions, the assumption of non-collinearity was met.

In examining measures associated with Encoding attention, WRAT3 Reading Standard Score/estimated IQ positively predicted performance on Digit Span Scaled Score and accounted for 11.5% of the variance on this measure (based on Adjusted R^2). SAM Arousal negatively predicted Digit Span performance and when combined with WRAT3 Reading Standard Score/Estimated IQ accounted for 15.8% of the variance in this same attentional measure (see Table 11). In examining measures associated with shifting attention, response to the SAM Dominance scale positively predicted performance on the WCST: CV2 Total Errors and accounted for 5.2% of the variance on this attentional measure (see Table 12). For measures of sustained attention, WRAT3

Reading Standard Score/Estimated IQ negatively predicted performance on the CPT-IP False Alarm Rate (Numbers) and accounted for 8.6% of the variance on this measure. STAI State scale positively predicted this same measure and when combined with WRAT3 Reading Standard Score/Estimated IQ accounted for 12.6% of the variance on this attentional measure (see Table 13). SAM Valence negatively predicted performance on the CPT-IP False Alarm Rate (Shapes) and accounted for 8.5% of the variance on this attentional measure (see Table 14). Subjective report on the PANAS Negative Affect scale positively predicted CPT-IP RT Hits (Numbers) and accounted for 7.2% of the variance on this attentional measure (see Table 15). SAM Dominance negatively predicted CPT-IP RT Hits (Shapes) and accounted for 3.7% of the variance on this attentional measure (see Table 16). Dependent attention variables that were not affected by these predictor variables were the VSAT Total Percentile (Focus/Execute), the WCST: CV2 Total Correct and WCST: CV2 Perseverative Responses (Shift), the CPT-IP Hits (Numbers) and CPT-IP Hits (Shapes) (Sustain), and CPT-IP RT Variability Hits (Numbers) and CPT-IP RT Variability Hits (Shapes) (Stabilize).

Question 4

In order to determine whether or not Mirsky's model of attention remained consistent when applied to the present study's data, a factor analysis was performed including both assessment contexts. This factor analysis was of particular interest because of the disparity in findings on the five factor model thus far. An exploratory factor analysis was performed using Principal Axis Factoring (PAF) and the factors were restricted to an Oblimin Rotation with Kaiser Normalization. Factor loadings of .4 or more were considered relatively high and therefore meaningful.

Examination of various solutions indicated that inclusion of the Digit Span Forward and Backward trials, rather than the Total or Scaled Score, facilitated the most coherent factor structure. The WCST: CV2 variables were confined to Total Correct and Total Errors as these were found to be the most normally distributed of the WCST: CV2 scores. For the purposes of simplicity, select variables from the many CPT-IP measures consistent with the Sustain element of attention were included. Because CPT-IP Hit Rate for both shapes and numbers accounted for a greater degree of variance than CPT-IP False Alarms in preliminary analyses, Hit Rate was chosen for the presented factor analysis.

A four component solution was generated and found to be largely coherent. The factor solution accounted for 50.06% of the total variance, with the first component accounting for 20.13% of the variance, the second component accounting for 15.67% of the variance, the third component accounting for 8.03% of the variance, and the fourth component accounting for 6.05% of the variance. Individual component pattern loadings of the four component solution are presented (see Table 17). Digits Forward and Digits backward loaded highly on to Factor 4 (encode), while the WCST: CV2 Total Correct and Total Errors loaded highly on to Factor 2 (shift), and the CPT-IP Hit Rate loaded highly on to Factor 1 (sustain). However, inconsistencies with the Mirsky model were observed. These included the CPT-IP RT Hits, which loaded on Factor 3, separate from the CPT-IP Hit Rates and the sustain factor as in the original model. CPT-IP RT

Variability Hits (Numbers) loaded on to the sustain factor rather than a separate stabilize factor as in the original model. CPT-IP RT Variability Hits (Shapes) loaded on to the unidentified Factor 3 along with CPT-IP RT Hits, rather than onto a stabilize factor.

Alternatively, a PAF analysis was performed in which the structure of the analysis was forced into five components as this was the factor structure discovered by Mirsky. In the present study, however, this approach yielded a less coherent factor structure not included in the present results. Yet another PAF analysis was conducted that excluded the measures consistent with Stabilized attention as this is the newest and least well-established element of the Mirsky model. The five factor solution generated was no more consistent with the Mirsky model than the four factor solution presented .

Exploratory Analyses

Exploratory Analysis 1

Exploratory analyses involved investigating the relationship between assessment context and motivation to complete the attentional measures of the experiment. Point-biserial correlation coefficients were calculated between the experimental condition and the Motivation Scale. The results revealed coefficients of minimal strength for each of the motivation items and total score, therefore not considered indicative of noteworthy relationships.

Exploratory Analysis 2

A series of mean comparisons were conducted in order to determine if a statistically significant difference existed between the two experimental conditions on the dependent measures of attention and state anxiety and affect. The analyses were organized using the five factor Mirsky model of attention. Two independent samples t-tests were conducted on the Digit Span Scaled Score (encode), and the VSAT Total Percentile Score (focus/execute), respectively. Because the remaining elements of attention are each represented by several different scores on several different measures, three Multiple Analyses of Variance (MANOVAs) were conducted corresponding to each of these attentional elements. Specifically, MANOVAs were conducted on the WCST: CV2 data (shift), the CPT-IP accuracy and reaction time data (sustain), and the remaining CPT-IP data (stabilize). See Table 4 for specific measures of each element of attention.

For the independent samples t-test of Digit Span Scaled Score, the assumption of homogeneity of variance was met based on Levene's Test for Equality of Variances. The t-test revealed no statistically significant difference between the two conditions on Digit Span performance, t (78) = .354, p = .724. When conducting the independent samples t-test of the VSAT Total Percentile, the assumption of homogeneity of variance was met based on Levene's Test for Equality of Variances. Again, the t-test revealed no statistically significant difference between the two conditions on VSAT performance, t (69) = .853, p = .396.

As stated earlier, a MANOVA was conducted in order to compare the RC and SMC in terms of their performance on the WCST: CV2. The assumption of homogeneity of variance was met based on a Levene's Test for Equality of Variances. The findings reveal that significance for the overall model was not met, based on Wilk's Lambda = .916, p = .273. In examining the univariate results, however, a higher number of WCST: CV2 Perseverative Responses were observed in the RC (M = 11.83, SD = 6.27) than the

SMC (*M* = 9.51, *SD* = 5.18), *F* (1, 75) = 4.412, *p* = .039. The effect size for this analysis approached moderate strength (.24), suggesting that the results are statistically meaningful. Significant differences were not observed for the WCST: CV2 Total Correct, *F* (1, 75) = 1.496, *p* = .225, WCST: CV2 Total Errors, *F* (1, 75) = 1.906, *p* = .172, or WCST: CV2 Categories Completed, *F* (1, 75) = .924, *p* = .339. For those variables that were skewed and kurtotic, squared transformations did not yield noteworthy differences in results.

A second MANOVA was conducted in order to determine whether differences between conditions occurred on the CPT-IP variables representing the sustain element of attention. For those univariate results found to be significant, the assumption of homogeneity of variance was met based on a Levene's Test for Equality Variances. For those univariate results in which this assumption was not met, it was determined that the robustness of the MANOVA accounted for this error. According to the findings, the overall model was not statistically significant, based on Wilk's Lambda = .927, *p* = .462. However, amongst the univariate results the CPT-IP False Alarm Rate (Numbers) was higher for the SMC (*M* = .203, *SD* = .108) than the RC (*M* = .156, *SD* = .097), *F* (1, 78) = 4.134, *p* = .045 (see Figure 1). The effect size for this analysis approached moderate strength (.22), suggesting that the results are statistically meaningful. Significant differences were not found for CPT-IP Hit Rate (Numbers), *F* (1, 78) = .053, *p* = .818, CPT-IP Hit Rate (Shapes), *F* (1, 78) = .200, *p* = .656, CPT-IP False Alarm Rate (Shapes), *F* (1, 78) = .715, *p* = .400, CPT-IP RT Hits (Numbers), *F* (1, 78) = .043, *p* = .836, or CPT-IP RT Hits (Shapes), *F* (1, 78) = .856, *p* = .358.

A third MANOVA was conducted to test for differences between conditions on the CPT-IP variables corresponding to the stabilize element of attention. The assumption of homogeneity of variance was met based on a Levene's Test of Equal Variances. The findings indicate the overall model was not significant, based on Wilk's Lambda = 1.00, $p = .987$. Also, no statistically significant univariate differences occurred between the two conditions on the CPT-IP RT Variability Hits (Numbers), $F(1, 78) = .024$, $p = .878$, or CPT-IP RT Variability Hits (Shapes), $F(1, 78) = .013$, $p = .910$.

A fourth and final MANOVA was conducted involving the state anxiety and state affect measures of the study. Many of the univariate analyses met the assumption of homogeneity of variance. For those that did not, this was understood to be accounted for by the MANOVA, which is a particularly robust test. Statistical significance for the overall model was met, based on Wilk's Lambda = .872, $p = .034$. In examining the univariate results, it was found that participants in the SMC scored significantly higher for the STAI State scale ($M = 38.33$, $SD = 11.31$) than did RC participants ($M = 31.60$, $SD = 7.52$), $F(1, 78) = 9.807$, $p = .002$ (see Figure 2). The effect size for this analysis was moderate to strong (.33), indicating that this finding is very statistically meaningful. The SAM Valence scale was also significantly higher for RC participants ($M = 7.08$, $SD = 1.23$) than SMC participants ($M = 6.38$, $SD = 1.84$), $F(1, 78) = 4.020$, $p = .048$ (see Figure 3). The effect size of this analysis approached moderate strength (.22), suggesting that the finding was statistically meaningful. Significant differences were not found for the SAM Arousal scale, $F(1, 78) = .242$, $p = .624$, or the SAM Dominance scale, $F(1, 78) = .726$, $p = .397$.

Anecdotal Observations

In addition to quantitative results, valuable observations were made by the experimenter during completion of the experimental trials that were both anecdotal and qualitative in nature. In both conditions, participants entering the room typically expressed euthymic affect, made good eye contact, and were fairly loquacious. This behavior continued and sometimes increased over the course of the experiment during the RC. During the RC, they oftentimes commented on the tasks presented, made jokes about their own performance, or asked spontaneous questions about the experiment at its conclusion. In the SMC, this type of behavior quickly tapered off in the first few minutes of the experiment. By the time the attentional tests were administered in the SMC (approximately 10-15 minutes into the experiment), participants' affect appeared negative and they had discontinued all spontaneous speech or attempts at eye contact. Three separate SMC participants verbally complained to the experimenter about his demeanor during the experiment, and made their frustrations apparent through such behaviors as long sighs and/or eye rolling.

CHAPTER 4

DISCUSSION

Summary and Integration of Results

Question 1 Summary

The Structured Medical Condition (SMC) of the study was found to be associated with increased state anxiety during the experiment. No relationship was observed between experimental condition and performance on the attentional measures of the study. However, an inverse relationship was observed between the Self-Assessment Manikin (SAM) Valence scale and the Continuous Performance Task-Identical Pairs (CPT-IP False) Alarm Rate (Shapes). Increased valence (pleasure) was, therefore, associated with improvement in one element of sustained attention measured by decreases in errors of commission. In sum, the data analyzed to address this question would suggest that assessment context is moderately related to state affective experience, and that state affective experience is moderately related to sustained attention. The data do not indicate that assessment context itself is directly related to elements of attentional performance as expected.

Question 2 Summary

The results of Question 2 indicate that a positive relationship existed between request for feedback and sustained attention as measured by the CPT-IP Hit Rate (Numbers). Other relationships between the request for feedback and attentional performance did not exist. Follow-up analyses revealed a moderate positive association between request for feedback and trait-like anxiety.

Question 3 Summary

Multiple regressions were performed in an effort to determine the degree to which various predictor variables influenced performance on the attentional measures of the present study. These predictor variables included age, years of education, estimated IQ, experimental condition, Positive and Negative Affect Schedule (PANAS) Positive Affect scale, PANAS Negative Affect scale, State-Trait Anxiety Inventory (STAI) State Anxiety scale, STAI Trait Anxiety scale, SAM Valence scale, SAM Arousal scale, SAM Dominance scale, and Motivation Scale Total. For many dependent variables, none of these independent variables significantly predicted attentional performance. Those aspects of attention that were affected conform to the encode, shift, and sustain elements of attention, according to the Mirsky model. Results discussed below are limited to those regressions regarded as the most meaningful, based on beta values of .3 or higher. This is consistent with the benchmark discussed earlier for correlation coefficients regarded as indicative of moderate relationships. In interpreting these data, it is also essential to note that certain increases in variables on the CPT-IP, such as False Alarms and RT, represent decreased performance and thereby decreased sustained attention.

Improved encoding attention, as represented by Digit Span, was somewhat accounted for by participants' increased reading skills/estimated IQ. Increased self-reported arousal during the experiment was associated with decreased Digit Span performance, and the combination of these predictors accounted for a greater degree of variance. Increased reading skills/estimated IQ negatively predicted the CPT-IP False Alarm Rate (Numbers) and thereby improved sustained attention for verbal information. Self-reported state anxiety positively predicted this same CPT-IP measure and thereby poorer sustained attention, and the combination of these predictors accounted for yet more variance on the CPT-IP False Alarm Rate (Numbers). For sustained attention to visual-spatial information represented by the CPT-IP False Alarm Rate (Shapes), increased self-report of pleasure during the experiment negatively predicted performance on this measure, and thereby improved sustained attention.

Question 4 Summary

The factor solution of the present study's attentional data are consistent with three of Mirsky et al's five factors, representing the encode, sustain, and shift elements of attention. However, the remaining items of the factor analysis yielded pattern loadings that were either non-coherent or reflected deviations from Mirsky et al's proposed model. Specifically, factor loadings for the Visual Search and Attention Test (VSAT) Total Percentile were not sufficiently strong enough to load on to a separate focus/execute component as the Mirsky model would suggest, nor did it share a common factor with the other measures. Secondly, Mirsky's model suggests that the sustain element of attention is represented by measures of accuracy (CPT-IP Hit Rate) and reaction time (CPT-IP RT Hits). However, CPT-IP Hit Rate and CPT-IP RT Hits loaded highly on to separate factors. Thirdly, in the Mirsky model a separate factor, stabilize, is represented by variability in reaction time (CPT-IP RT Variability Hits). The factor analysis presented instead suggests that CPT-IP Hit Rate and CPT-IP RT Variability Hits (Shapes) represent a common dimension of attention. The CPT-IP RT Variability (Numbers) also loads on the same unidentified factor as CPT-IP RT Hits, lending further indication that much of the present data do not conform to the Mirsky model. Neither a forced five factor solution nor a PAF analysis without the stabilize element measures of reaction time variability, the newest addition and least well-supported aspect of Mirsky's model, yielded better results.

Exploratory Analysis 1 Summary

Exploratory analyses were performed to determine if either assessment context was associated with motivation. No such relationship was observed.

Exploratory Analysis 2 Summary

A series of exploratory analyses were performed to determine whether or not participants performed differently on measures of attention in their respective assessment contexts. These analyses were organized based on Mirsky's five factor model of attention and are discussed here accordingly. There was no difference between assessment contexts for Digit Span (encode). There was no difference between assessment contexts for the VSAT (focus/execute). However, analyses revealed a significantly higher number of Perseverative Responses on the Wisconsin Card Sorting Test™: Computerized Version 2 Research Edition (WCST™-CV2, Psychological Assessment Resources, Lutz, FL, www.parinc.com) for participants in the Relaxed Condition (RC) than those in the SMC. This result was found to be statistically meaningful, and indicates greater performance by SMC than RC participants in the shift element of attention. Further analyses also reveal that participants in the RC committed significantly fewer CPT-IP False Alarms (Numbers) than participants in the SMC. This was determined to be a statistically meaningful finding and indicates some degree of superior sustained attention in the RC. Finally, the analyses reveal no statistically significant differences between RC and SMC participants in CPT-IP Reaction Time Variability, suggesting similar performance of stabilized attention.

An additional analysis was conducted in order to determine whether participants' subjective emotional experience during the experiment was significant differently in the two assessment contexts. The findings indicate that participants in the RC reported significantly less state anxiety than SMC participants during the experiment. Valence (subjective feelings of pleasure) was also significantly higher in RC participants. Each of these results was found to be statistically meaningful.

Anecdotal Observation Summary

Anecdotal observations were made during both experimental conditions. RC participants tended to be more talkative during the experiment, made appropriate eye contact, expressed affect that appeared euthymic, and asked questions about the experiment after its completion. In contrast, participants in the SMC tended to become increasingly quiet with exposure to the experimental context, made minimal to zero eye contact, expressed negative affect, and were less interested in learning about the experiment after it was completed.

Explanations for Findings

Question 1 Explanation

The positive and moderately strong association between completion of the SMC and reported state anxiety on the STAI indicate that the study was successful in manipulating the anxiety of participants while they were completing the experiment. It should be noted, when consulting the covariates of the study, that such a relationship was not observed between assessment context and trait anxiety. It can be argued that the greater degree of state anxiety in participants in the SMC was, therefore, a function of the experimental manipulation and increased environmental stress rather than an artifact of unrelated differences in trait anxiety.

The finding that assessment context was not associated with performance on any of the attentional measures would indicate that a direct relationship between the two variables did not exist. Valence, though, was associated with improved attentional sustain, as measured by decreased CPT-IP False Alarm Rate (Shapes). That such an association involved valence rather than state anxiety was surprising, given that assessment context was most strongly associated with state anxiety on the STAI. However, it would seem that while the SMC increased participants' subjective experience of state anxiety, it was the subjective experience of pleasure that was associated with ability to maintain sustained attention.

Although no direct relationship was found between assessment context and attention, the association between assessment context and state anxiety in combination with the association between valence and sustained attention suggests that affect/anxiety might function as a mediating variable between assessment context and attention. Furthermore, the results support previous research indicating the existence of a positive relationship between increased positive affect and cognition (Greher, 2000), rather than the more popularly discussed relationship between increased negative affect and cognition per the cognitive interference theory and worry and attentional interference theory.

Question 2 Explanation

The positive relationship between SMC participants' request for feedback and increased accuracy on the CPT-IP Hit Rate (Numbers) suggests that inclusion of this element did not result in impaired attentional processes as expected, but rather improved attentional processes within the sustained attention domain. When taken into account with follow-up results which indicate a moderate relationship between request for feedback and the anxiety factor of the PANAS, potential interpretations become more clear. It might have been the case that participants with personalities more prone toward anxiety requested feedback. Oftentimes, such individuals are high achievers who might have performed well for a variety of reasons, such as personal accomplishment, desire for praise, or fear of the health implications of poor performance. Eysenck and Calvo's (1992) processing efficiency theory states that high anxiety individuals typically employ a self-regulatory system that augments effort and working memory capacity in response to worry, and that such improved capacity may occur due to concerns about potential substandard performance as a result of worry or avoidance of worry itself. Eysenck (1982) discussed findings that performance in high anxiety individuals is reduced in response to failure feedback, while the findings in this study indicate that improvement might occur for this group in anticipation of failure feedback.

Question 3 Explanation

The association found between estimated IQ and encoding attention, as measured by Digit Span, is not surprising. As stated earlier, the finding is consistent with the assertion by many psychologists that attentional processes are an essential element of a global index of overall cognitive ability, such as IQ. In fact, normative data collected during development of the Wide Range Achievement Test 3 (WRAT3™) (Wide Range, Wilmington, DE, www.widerange.com) included a correlation between Digit Span of the Wechsler Adult Intelligence Scale®-Revised (WAIS-R®) (Psychological Corporation, San Antonio, TX, www.psychcorp.com) and WRAT3 Reading combined score of .45 (Wilkinson, 1993), and the findings from the present study appear to be confirmatory of such a relationship. That this predictor along with self-reported arousal explained an even greater degree of variance may best be explained by the Yekes-Dodson law. The law, as stated earlier, suggests that very high and low levels of arousal are associated with decreased performance and, in the case of the present study, increased arousal was a negative predictor of encoding attention. As arousal increased, access to cognitive and attentional resources specific to encoding attention decreased. Because arousal is an integral part of anxiety, the findings might also suggest that, in the case of encoding attention, increased arousal is a key element which, when increased, results in cognitive interference due to threat-relevant/task-irrelevant attentional bias.

As with encoding attention, estimated IQ likely negatively predicted CPT-IP False Alarms (Numbers) and thereby improved sustained attention because attention functions as a component of IQ. After also accounting for the positive predictive power of self-reported state anxiety on CPT-IP False Alarms (Numbers) and thereby decreased sustained attention, there was an increase in the amount of variance explained. Several theories would interpret such findings to indicate that participants in the study experienced anxiety on the threat imminence continuum or activation of the BIS to the degree that attentional processes were affected. Cognitive interference may have occurred due to attentional bias toward threat-relevant stimuli (such as the experimenter's demeanor or the physical setting of the room) instead of task-relevant information (Craske, 1999). According to worry and attentional interference theory, the level of difficulty of the cognitive task, in this case the CPT-IP False Alarms (Numbers), also contributed to the degree of cognitive interference experienced. This finding is consistent with those which suggest a reciprocal relationship between the neurological processes involved in cognition and emotion (Drevets & Raichle, 1998). Finally, from the perspective of the Yerkes-Dodson Law, the findings would suggest that the anxiety experienced by participants was sufficient to simultaneously increase their arousal (although this was not specifically reported on the SAM) to the degree that performance was impeded.

The association between increased pleasure during the experiment and increased sustained attention according to reduction of CPT-IP False Alarms (Shapes) is something of a diversion from the association described above between increased state anxiety and increased CPT-IP False Alarms (Numbers). As previously discussed, much of the theory on anxiety/affect and cognition details a relationship between increased negative affect/anxiety and decreased cognitive performance. Like one of the preceding analyses (see Question 1), this finding instead supports literature highlighting the importance of the relationship between increased positive affect and improved cognitive performance (Greher, 2000).

In considering the overall findings of the multiple regressions of the present study, it is important to note that only a small portion of the dependent variables were significantly predicted by the independent variables chosen for these analyses. Second, for each of the predictors and combinations thereof found to be statistically significant, the amount of variance accounted for in half of the analyses was not regarded as meaningful. Potential reasons for such limited findings include the possibility that the experimental manipulation was not salient enough to manipulate state anxiety and affect levels to predict attentional performance in a normal population, as discussed in such theories as worry and attentional interference theory and processing efficiency theory. Attentional processes are, as Mirsky points out, hard-wired neurological systems and contextual variables such as those imposed by neuropsychologists during an assessment may not impact such systems as a result. Also, college students may be predisposed to lower levels of anxiety relative to a clinical population, decreasing the degree to which the present assessment contexts influenced affective and attentional processes.

Question 4 Explanation

Elements of attention revealed by both Mirsky (1996) and the present study included encode, shift, and sustain. The consistency of these manifest constructs across studies, populations, assessment contexts, and slight variations in methods of measurement would suggest that they accurately represent latent constructs consistent with varying elements of attentional processes. Inconsistencies found between previous research and the present study, involving focus/execute, stabilize and certain measures of sustain, may have many potential explanations. It is conceivable that these findings are attributable to differences in measurement. Mirsky used Trails A and B and Digit Symbol-Coding for focus/execute, while the present study used the VSAT to measure this construct. Mirsky also used his own version of the CPT for sustain and stabilize while the present study used the CPT-IP. Subtle differences in these tasks may have unwittingly resulted in failure to tap into similar cognitive constructs. Yet another explanation is the fact that the present study involved a smaller, healthier, and more heterogeneous population than collected by Mirsky, and differences in performance as a result of these variables may have influenced factor structure. The manipulation of the present study and consequent effects on anxiety and affect may have also contributed to the present deviation from the original model. However, this explanation seems unlikely given the model's consistency in the past across populations.

Finally, Mirsky used a method of factor analysis throughout the development of his model which assumes that the dependent variables of attention are purely measuring the intended latent variables without error (Principal Component Analysis). The factor analysis of the present study, however, assumes there is error (Principal Axis Factoring). This difference in statistical methodology could explain some degree of difference between Mirsky's five factor structure and that of the present study. The use of this particular statistic may furthermore suggest that the present findings are more representative of the elements of attention. That is, the factor structure represented may offer a more accurate representation of these manifest variables. This assertion would require replication of course, and should therefore be interpreted with caution.

In specifically examining the problematic aspects of sustain in the present factor solution, the division of hit rate and reaction time may indicate that this element of attention is in itself multi-dimensional. In examining the problems of stabilized attention in the present factor solution, it is essential to recognize that this is the most recently presented addition to the five factor model of attention, and Mirsky has expressed some level of skepticism regarding its validity (Mirsky, 2000, October). Such skepticism appears warranted, given the low level of factor loadings and coherence associated with its representative measures. Because these measures do not consistently and strongly load on an independent factor, the findings are interpreted to indicate that they do not represent an independent element of attention.

Exploratory Analysis 1 Explanation

The results indicate that motivation did not vary depending on whether participants experienced the RC or SMC assessment contexts. It can be argued, therefore, that the differences in these contexts were not related to motivation and it is unlikely that motivation influenced the previously discussed relationships between affect and attention (Question 1), feedback and attention (Question 2), or differences between assessment contexts on measures of affect and attention (Exploratory Analysis 2). Nonetheless, psychometric considerations are viable as well, given that no data have previously been collected through use of this measure. It is possible that the motivation scale was insensitive to its intended psychological construct or yielded responses that lacked validity due to such factors as social desirability.

Exploratory Analysis 2 Explanation

The RC participants performed better than SMC participants on a measure of sustained attention (CPT-IP False Alarms [Numbers]) because some aspect of the relative differences in assessment contexts caused this difference. Simultaneously, RC participants reported significantly higher valence and lower state anxiety than SMC participants because some aspect of the relative differences in assessment contexts caused this difference as well. It is conceivable that these phenomenon were related. Differences in assessment context resulted in manipulation of state anxiety and valence, which may have thereby functioned as mediating variables resulting in the differences observed in attentional performance. Cognitive interference theory and worry and attentional interference theory support this assertion. They suggest that attentional resources are reduced by anxiety, which causes attentional bias for threat-relevant rather than task relevant stimuli (Craske, 1999; Eysenck & Calvo, 1992). By this logic, the cognitive capacity of the SMC participants to sustain attention to task-relevant stimuli on the CPT-IP was reduced by feelings of anxiety and lower valence, caused by greater allocation of attentional resources to threat-relevant stimuli embedded in the assessment context. RC participants' sustained attention resources were better focused on the task-relevant demands of the CPT-IP, as lower state anxiety and higher valence were facilitated by a less threatening assessment context. Worry and attention interference theory also highlights task difficulty as a component of attentional interference. This might help to explain why the present findings involve the CPT-IP as this is a particularly challenging task to complete correctly. Of course, it is possible that differences in RC and SMC attentional performance are not linked to anxiety and valence and instead reflect something as simple as a greater degree of relative innocuous distraction during the SMC than during the RC. However, the previously discussed relationships between assessment context and state anxiety and between valence and the visual-spatial version of this same attentional measure are considered supportive of the above argument.

Relatively better performance by SMC participants of shifting attention on the WCST: CV2 may be in part explained by the fact that this is the only measure of all those administered that does not involve a time element. While Digit Span is not a formally timed test, rapid responses are required by most participants before the encoded information is lost in working memory. At its outset, the WCST: CV2 may also have appeared the simplest of the tasks to complete. Given its un-timed format and appearance of simplicity, lowered levels of subjective anxiety during the RC may have resulted in increased relaxation to the degree that participants in this condition no longer put forth the effort necessary to complete the test with accuracy and efficiency. Such an effect would be consistent with the lower end of arousal on the Yerkes-Dodson curve. Processing efficiency theory would suggest that greater anxiety in the SMC increased motivation for allocation of cognitive resources that, when applied to the un-timed and simple format of the WCST: CV2, allowed for improved frontal activity specific to shifting attention (Eysenck & Calvo, 1992). Anxiety would then function again as a mediating variable between assessment and attention.

In considering the overall findings of mean differences between conditions on measures of attention, it is noted that participants did not perform significantly differently on measures of encode, focus/execute, and stabilize. This may be best explained similarly as the findings involving sustaining and shifting attention. Although the RC and SMC caused a significant difference in anxiety and valence, such affective experiences may not have been intense enough to elicit changes in these particular hard-wired attentional systems. Localization of neurological processes involving state anxiety and valence may have also been unrelated to the unaffected elements of attention. Given that cognitive interference is largely related to task difficulty (Eysenck, 1982), it may have also been the case that the measures of the unaffected elements of attention were not sufficiently difficult to yield differences in performance despite differences in anxiety and valence.

The finding that SMC participants reported relatively greater state anxiety and lower valence during the experiment than RC participants may best be interpreted to indicate that they did in fact experience such differences in affective phenomena. In terms of emotional theory, such lower valence and greater anxiety in the SMC could be characterized as relatively greater activity in the aversive motivation system, or Behavioral Inhibition System (BIS). Higher valence and lower state anxiety in the RC might also be characterized as greater activity in the appetitive motivation system, or Behavioral Activation System (BAS). The psychometric quality of the measures involved are well established and the SAM measure has even been correlated with psychophysiological aspects of emotion. However, it should be noted that such objective measures of anxiety and affect (e.g., EMG, GSR) were not collected during the present study. Because of the subjective nature of these data, the results may also be explained by some confounding variables of self-report data, such as social desirability. However, the consistency across both measures would suggest that the findings are in fact valid and representative of their corresponding emotional constructs.

Anecdotal Observation Explanation

The consistent disparity in participant presentation during the two experimental conditions suggests that the two groups differed in terms of their affective experience. This observation in turn suggests that the study was effective in manipulating affective state, depending on participants' randomly assigned assessment context.

Integration of Findings With Past Literature

Few studies have investigated the effects of assessment context on anxiety and neuropsychological functioning, although no known research has taken a comprehensive view of such effects on attention. Several previous studies detail results involving male and female differences as well as gender X condition interactions. Comparisons with such findings in the research are, however, precluded by the limitation of the present study to an exclusively female sample.

Tyler and Tucker (1982) found that high trait anxiety participants in a high stress condition performed poorer on the and the Seashore Tonal Memory Test than participants in a low stress condition. These data are slightly related to findings of the present study indicating a relationship between general anxiety on the PANAS and performance on the CPT-IP RT (Numbers), and poorer performance on the CPT-IP False Alarms (Numbers) in the SMC. Whether the Seashore Tonal Memory Test conforms to the sustain element of attention as the CPT-IP does is debatable as the Seashore Test is not known to have been included in a related factor analysis. However, the demands of the test are at least somewhat similar to the CPT-IP in that accurate completion requires extreme vigilance over an extended period of time, although the modality of the test is verbal rather than visual.

Martin and Franzen (1989) found that female participants were more consistent across assessment contexts, and this may help to explain the limited effects observed in the present study. Participants in their low stress condition performed significantly better than participants in the high stress condition on all scores of the Stroop Word and Color Test. Such findings were not produced in the present study as participants in the RC and SMC conditions performed similarly on the VSAT, which conforms to the same attentional element of focus/execute as the Stroop according to Mirsky. A similarity does exist in that both studies indicate greater attentional functioning in general when performing in a low stress context. The limited strength of relationships between state anxiety and attentional measures found by the authors was also similar to the present study. However, unlike the present study, Martin and Franzen were unsuccessful in finding a significant difference in state anxiety between assessment contexts. Such difference may be attributed to a more salient manipulation in the present study, or timing of measurement administration. Martin and Franzen administered the STAI toward completion of the study, while the present study involved administration of the STAI closer to its outset. The authors point out that the late administration might have allowed for inaccurate retrospective self-report due to feelings of relief at the study’s conclusion.

Finally, Martin and Franzen made anecdotal observations of behaviors such as greater relative amounts of fidgeting, verbal reports of anxiety, and flushed skin in the high stress condition, which were interpreted as indicators of increased anxiety. Similar anecdotal observations were made in the present study, although the behaviors witnessed during the SMC included limited verbalizations and eye contact, and poor affect.

A greater number of error rates on the Stroop Word and Color Test were found by von Kluge (1992) in a high stress condition than a low stress condition. As stated earlier, the present study did not find similar differences in performance on the VSAT, which conforms to the focus/execute element of attention along with the Stroop task. However, higher error rates as measured by CPT-IP False Alarm Rate (Numbers) in the SMC of the present study is fairly consistent with these findings. As with the present study and that of Martin and Franzen (1989), anecdotal observations of von Kluge (1992) included behaviors indicative of lower anxiety in a low stress condition (giggling), and greater relative anxiety in a high stress condition (portraying a more serious appearance).

Implications of Findings

The context of an assessment is viewed by most psychologists as an important element of psychological testing. However, whether the testing context should be included as a mere footnote of a psychological assessment or can in fact function as an extraneous variable in determining the outcome of performance was investigated by the present study. The findings suggest that a structured medical context relative to a relaxed context is not directly associated with changes in the various elements of attention. However, a structured medical context is associated with increased levels of anxiety.

State anxiety was not the only relevant affective variable of the present study as greater emotional pleasure during the experiment was associated with improved sustained attention. The combination of these associations suggest that assessment context is related to affective experience, and affective experience in turn is related attentional performance. This assertion is supported by the finding that the two assessment contexts produced differences in sustained and shifting attention as well as differences in state anxiety and pleasure. The sum of these findings make it conceivable that affective differences mediated the variance observed in attention between assessment contexts. In the case of the structured medical context, higher anxiety and less pleasure may have resulted in poorer sustained attention. Also in the structured medical context, higher anxiety and less pleasure may have resulted in improved shifting attention. This argument is also supported by the finding that potential extraneous variables, such as motivation, were unrelated to attentional performance and did not differ depending on assessment context. The disparity in attention tasks across assessment contexts therefore appears to be the function of an interaction between the cognitive demands of each respective task and the differential effects of anxiety and emotional pleasure on such demands.

These data are relevant to both research and clinical practice, and extreme caution is recommended when considering the potential impact of assessment context on attentional performance of clients and participants. The contexts presented were designed to represent two very different though realistic testing environments, and the findings suggest that attentional performance as measured by neuropsychological tests can vary depending on the context in which such tests are completed. Because attention is required for the completion of other cognitive tasks, such as executive functioning, visual reasoning, and verbal reasoning, changes in attention as a result of differences in assessment context might also impact performance on other neuropsychological measures.

The finding that the two assessment contexts result in significant differences in anxiety and emotional pleasure is also highly relevant. In addition to the fact that it may be these very affective differences which mediate the differences observed in attentional performance, both researchers and practitioners are expected to hold to the ethical guideline to above all do no harm (APA, 1992). Based on the results of the study, completion of neuropsychological testing in a context resembling that of the SMC could result in greater anxiety and less emotional pleasure and could therefore violate this ethical principle.

Admittedly, the findings of the present study on the effects of assessment context, anxiety, and attention were fairly limited. Comprising the five elements of attention evaluated were 14 total dependent variables of attention. Amongst those 14 variables, only two representing sustain and shift were found to be significantly different between the RC and SMC assessment contexts and the nature of these differences varied with the type of attention being evaluated. Furthermore, despite the presence of the aforementioned relationships between assessment context and affect, and between affect and attention, neither the assessment context nor other independent variables such as state and trait anxiety or state affect and general affect accounted for a substantial amount of the variance in attentional performance across Mirsky’s five elements. As stated earlier, one potential explanation of such limited findings lies in recognition of the fact that all attentional processes are associated with hard-wired neurological functions. As a result, the two assessment contexts presented only slightly affected such primary biological systems. Nonetheless, given the highly applicable and relevant nature of this area of study, such findings warrant future research for the purposes of both replication, methodological improvements, and greater depth of investigation.

Other interesting implications of the study apply more generally to the construct of attention. The findings suggest that the four and five factor models of attention proposed by Mirsky may lack some degree of construct validity, and further investigation involving more statistically stringent criteria may help to yield more accurate modeling of the many elements of this cognitive domain. Also, researchers presently focus a great deal of effort on how increased negative affect is inversely related to attentional performance. Findings from the present study are supportive of previous though limited research to suggest that researchers may also wish to focus on the beneficial effects of positive affect on attention. One might be able to make the argument that it is not the presence of negative affective experiences (e.g., anxiety, depression) which negatively impacts attentional performance, but rather the absence of positive affective experiences (e.g., lack of anxiety, pleasure).

Limitations

Given the design of the present study, it remains impossible to determine which aspects of the assessment context caused the observed experimental effects. Examining the differential impact of the various factors used in the experimental manipulation was beyond the scale of the present study and may be addressed in future research. Other limitations were practical in nature. Amongst these was the fact that no baseline data were collected in terms of affective ratings on measures such as the STAI or the SAM. As stated earlier, this was due to difficulties in securing adequate space to collect such data, as well as a reliable research assistant to innocuously conduct this portion of the experiment. More baseline information could be collected in the future in order to allow for more definitive arguments about the affective influences of assessment context.

It is also noted that ratings of emotional experience (i.e. STAI and SAM) would have likely yielded interesting results if collected toward the beginning of the experimental procedure (as was done in the present study), and toward the middle or end of the present study (which was not done). This assertion is made based on the anecdotal observation that participants affect during the SMC appeared to become increasingly flat over the course of the experimental process. This affective change became most apparent by the middle of experimental procedure and continued until the experiment's conclusion, which corresponded to administration of the attention measures. Manipulation of participants' mood may have been greatest at this time, and collection of relevant self-report data would have been helpful in an effort to corroborate this anecdotal observation with more empirical information. However, it was agreed during the study's design that such a mid-experiment measure might unwittingly reveal the purpose of the study to the participants, which could have affected both their performance and the performance of informed participants that followed.

Exclusive use of self-report measures of affect also limited the present study to relying on subjective judgements of mood. The process of collecting more objective data, however, (e.g., EKG, GSR) would likely have influenced such mood as well as attentional performance. Use of some attentional measures that did not conform precisely to those used by Mirsky (VSAT and CPT-IP) may have also limited the degree to which the attentional findings are representative of the original model.

Yet another limitation of the study is its exclusion of males, which eliminates its utility to explore the potential presence of interactions between gender and condition, as have been found in related studies in the past. The findings are also limited, as a result, in terms of the their generalizability to the overall population. Nonetheless, maintaining the study as females only did control for this potential confounding variable. Similar to the exclusively female sample, the relatively small sample size of the study reduces to some degree the generalizability of the present findings.

Finally, because the postings for the separate conditions were different (“Peak Performance Study” and “Attentional Dysfunction Study”), it is possible that these two notices for participation resulted in some degree of sampling bias. Individuals who believed they had some difficulty with attention but received no official diagnosis of such to date might have been more interested in participating in the “Attentional Dysfunction Study” for personal reasons (e.g., learning whether they have attentional problems). Yet another limitation of the study is the fact that participants could have entered the experiment with prior knowledge of the tasks involved and pre-determined response strategies for completing the measures correctly. Many of the participants were likely enrolled in classes together and could have, despite requests made of each participant, shared this information with one another. Because of the challenging nature of each of the attentional measures, the WCST: CV2 is probably the only test that such a phenomenon could have significantly affected given the simple requirements for its correct completion.

Future Directions

The present results warrant replication. Only through such continued investigation can the reliability of the findings be confidently considered for clinical application. In addition to the measures of the present study, future research might incorporate a more extensive list of attentional tests as this would allow for greater sensitivity and comprehensiveness of the findings. Future studies might also address some of the limitations listed above, such as the need for pre-test baseline data on affect/anxiety, mid-experiment measurement of related constructs, non-intrusive methods for the collection of objective affect-related data, and measures more consistent with those used in the original Mirsky model. A sample including both a larger age range and males would also allow for greater generalizability of results as well as continued examination of the role of gender in such studies. A larger scale study might include each of the manipulating factors (experimenter demeanor, physical environment, explanation of the purpose of testing) as separate treatments, in addition to various combinations of one another, in an effort to determine the degree to which each of these factors influences attentional performance.

Because both conditions of this study were completed in the same university laboratory, this aspect of the manipulation might not have maximized the potential experimental effect. In the future, data might be collected in two juxtaposed contexts such as a comfortable private office and an actual hospital room. Also interesting would be a more ecologically applicable study involving the testing of neuropsychological patients matched for course of injury or disease in various settings, in addition to a control group. These settings might include primary and tertiary care hospitals and private offices. Such a study could examine whether an effect existed based solely on various contexts likely to be frequented by neuropsychological patients. Finally, a smaller scale study might involve administering computer-based tests (e.g., CPT-IP, and WCST: CV2) to some participants with an experimenter in the room and to others without an experimenter in the room. The data could then be used in order to determine if the mere presence of the experimenter influenced performance.

Other studies might involve further investigation of the Mirsky model of attention. Mirsky himself regards the model as a work-in-progress in need of continued scientific scrutiny (Mirsky, 2000, October). The current findings imply that application of statistical methods which account for error may allow for a more accurate representation of latent attentional constructs via neuropsychological measures. Confirmatory factor analyses are also recommended for the future in order to subject related data to an even more stringent measure of construct validity. Finally, studies might be designed in order to investigate the degree to which the presence or absence of positive affect rather than negative affect influences the various elements of attention.

APPENDIX A

Tables

Table 1

Sequence Table of Experimental Treatments and Measurements

	T1	M1	M2
Health Questionnaire		X	
Handedness Questionnaire		X	
PANAS		X	
STAI		X	
SAM		X	
Motivation Scale		X	
WRAT3		X	
Entering room-listening to instructions (experimental manipulation)	X		
VSAT			X
CPT-IP			X
Digit Span			X
WCST: CV2			X

Table 2

Ethnic Identity of Participants

	Condition	%	*n*
Caucasian	RC	52.5	21
	SMC	67.5	27
African American	RC	32.5	13
	SMC	17.5	7
Hispanic	RC	7.5	3
	SMC	7.5	3
Asian	RC	5.0	2
	SMC	2.5	1
Native American	RC	2.5	1
	SMC	0.0	0
Indian	RC	0.0	0
	SMC	2.5	1
Bi-racial	RC	0.0	0
	SMC	2.5	1

Table 3

Descriptive Statistics for Measures of State Anxiety and Affect

Measure	Condition	*M*	*SD*	*n*
STAI State Anxiety	RC	31.60	7.52	40
	SMC	38.33	11.31	40
SAM Valence	RC	7.08	1.23	40
	SMC	6.38	1.84	40
SAM Arousal	RC	4.47	1.77	40
	SMC	4.28	1.87	40
SAM Dominance	RC	5.85	1.55	40
	SMC	5.50	2.09	40

Table 4

Descriptive Statistics for Dependent Attentional Measures of the Mirsky Model

Attentional Element/Measure	Condition	*M*	*SD*	*n*
Encode				
Digit Span Scaled Score	RC	10.58	3.10	40
	SMC	10.35	2.56	40
Focus/Execute				
VSAT Total Percentile	RC	24.64	20.92	36
	SMC	20.77	17.00	35
Shift				
WCST: CV2 Total Correct	RC	71.55	7.31	40
	SMC	70.18	7.52	40
WCST: CV2 Total Errors	RC	20.70	11.16	40
	SMC	18.74	10.26	39
WCST: CV2 Perseverative Responses	RC	11.83	6.27	40
	SMC	9.51	5.18	39
WCST: CV2 Categories Completed	RC	5.93	.47	40
	SMC	6.00	.00	37
Sustain				
CPT-IP Hit Rate (Numbers)	RC	.827	.128	40
	SMC	.821	.105	40
CPT-IP Hit Rate (Shapes)	RC	.782	.126	40
	SMC	.794	.118	40
CPT-IP False Alarm (Numbers)	RC	.156	.097	40
	SMC	.203	.108	40
CPT-IP False Alarm (Shapes)	RC	.129	.100	40
	SMC	.149	.106	40
CPT-IP RT Hits (Numbers)	RC	509.178	60.746	40
	SMC	511.641	43.606	40
CPT-IP RT Hits (Shapes)	RC	515.841	60.482	40
	SMC	528.447	61.356	40
Stabilize				
CPT-IP RT Variability Hits (Numbers)	RC	111.816	18.292	40
	SMC	111.091	23.374	40
CPT-IP RT Variability Hits (Shapes)	RC	120.698	24.493	40
	SMC	120.035	27.644	40

Note. Reported CPT-IP RT and CPT-IP RT Variability are in seconds.

Table 5

Descriptive Statistics for Covariates: General Information, Health Information, Trait Anxiety, General Affect, and Motivation

Measure	Condition	*M*	*SD*	*n*
Age	RC	21.55	2.01	40
	SMC	20.40	1.91	40
Years of Education	RC	14.73	1.22	40
	SMC	13.88	1.38	40
Start Time	RC	1424	177	40
	SMC	1459	175	40
WRAT3 Reading/Estimated IQ	RC	104.35	6.84	40
	SMC	101.68	7.87	40
Caffeine Intake Total	RC	.38	.59	40
	SMC	.50	.64	40
Tobacco Intake Total	RC	.23	.73	40
	SMC	.30	.82	40
Sleep in 2 Nights Prior Total	RC	14.00	2.62	39
	SMC	14.54	2.19	40
Days Since 1st Day of Last Menstrual Cycle	RC	17.24	14.15	38
	SMC	16.95	11.09	40
STAI Trait Anxiety	RC	36.20	7.02	40
	SMC	39.88	10.60	40
PANAS Positive Affect	RC	36.83	5.27	40
	SMC	35.60	5.21	40
PANAS Negative Affect	RC	17.65	4.84	40
	SMC	20.95	7.25	40
PANAS Positive Factor	RC	3.58	.63	40
	SMC	3.42	.66	40
PANAS Depressed Factor	RC	1.99	.57	40
	SMC	2.26	.81	40
PANAS Anxiety Factor	RC	1.73	.57	40
	SMC	2.15	.92	40
PANAS Arousal Factor	RC	3.58	.67	40
	SMC	3.60	.76	40
Motivated for Approval From Others	RC	2.38	.74	40
	SMC	2.45	.90	40
Motivation to Meet Own Expectations	RC	3.43	.71	40
	SMC	3.35	.80	40
Motivated to Focus on the Task	RC	3.33	.66	40
	SMC	3.20	.72	40
Motivation Total	RC	9.13	1.34	40
	SMC	9.00	1.92	40

Note. Start Time is calculated according to a 24-hour clock. Caffeine Intake Total = total number of cups of coffee, cola, tea, and coffee ice cream ingested the day of the experiment; Tobacco Intake Total = total number of cigarettes smoked and/or cigars smoked, and tobacco chewed the day of the experiment.

Table 6

Correlations of Covariates: General Information, Health Information, Experimental Condition, and Dependent Measures

	Age	Ed.	Est. IQ	Start Time	Caff.	Tobacco	Sleep	Menst. Cycle
Experimental Condition	$-.285_a$	$-.314_a$	$-.181_a$	$.100_a$	$.103_a$	$.049_a$	$.113_b$	$-.011_c$
Digit Span Scaled Score	$-.091_a$	$.016_a$	$.355_a$	$.202_a$	$.254_a$	$.071_a$	$-.064_b$	$-.091_c$
VSAT Left Percentile	$.042_d$	$-.098_d$	$-.089_d$	$-.079_d$	$.035_d$	$.043_d$	$.056_e$	$-.005_f$
VSAT Right Percentile	$-.048_d$	$-.026_d$	$-.054_d$	$.057_d$	$.038_d$	$.061_d$	$-.013_e$	$.025_f$
VSAT Total Percentile	$-.007_d$	$-.053_d$	$-.075_d$	$-.005_d$	$.037_d$	$.054_d$	$.018_e$	.009f
WCST: CV2 Total Correct	$.049_a$	$.058_a$	$-.166_a$	$.076_a$	$-.093_a$	$.015_a$	$-.054_b$	$-.137_c$
WCST: CV2 Total Errors	$.006_g$	$.133_g$	$-.164_g$	$.093_g$	$-.097_g$	$-.025_g$	$.001_h$	$-.144_i$
WCST: CV2 Perseverative Responses	$.063_g$	$.101_g$	$-.069_g$	$.025_g$	$-.107_g$	$-.094_g$	$.000_h$	$-.165_i$
WCST: CV2 Categories Completed	$-.001_c$	$-.153_c$	$-.044_c$	$-.109_c$	$.080_c$	$.040_c$	$.209_j$	$.027_b$
CPT-IP Hit Rate (Numbers)	$-.026_a$	$-.199_a$	$.175_a$	$.117_a$	$.239_a$	$-.030_a$	$.142_b$	$.042_c$
CPT-IP Hit Rate (Shapes)	$-.082_a$	$-.052_a$	$.036_a$	$.132_a$	$.061_a$	$.003_a$	$.160_b$	$.064_c$
CPT-IP False Alarm (Numbers)	$-.104_a$	$.264_a$	$-.313_a$	$-.127_a$	$-.126_a$	$-.035_a$	$-.122_b$	$-.031_c$
CPT-IP False Alarm (Shapes)	$.006_a$	$.217_a$	$-.092_a$	$-.037_a$	$-.059_a$	$-.018_a$	$-.012_b$	$-.010_c$
CPT-IP RT Hits (Numbers)	$.052_a$	$-.004_a$	$-.045_a$	$.025_a$	$.206_a$	$.089_a$	$-.023_b$	$-.094_c$
CPT-IP RT Hits (Shapes)	$.004_a$	$-.103_a$	$.103_a$	$-.031_a$	$.029_a$	$.071_a$	$.140_b$	$.134_c$
CPT-IP RT Variability Hits (Numbers)	$-.069_a$	$-.087_a$	$-.117_a$	$-.118_a$	$.072_a$	$.000_a$	$-.148_b$	$.037_c$
CPT-IP RT Variability Hits (Shapes)	$.032_a$	$-.054_a$	$-.176_a$	$-.028_a$	$-.013_a$	$.124_a$	$-.032_b$	$.099_c$

Note. $n^a = 80$; $n^b = 74$, $n^c = 77$, $n^d = 71$, $n^e = 65$, $n^f = 69$, $n^g = 79$, $n^h = 73$, $n^i = 76$, $n^j = 72$.

Ed. = years of education; Est. IQ = WRAT3 Standard Score; Start Time = Beginning time of the experiment; Caff. = total number of cups of coffee, cola, tea, and coffee ice cream ingested the day of the experiment; Tobacco = total number of cigarettes smoked and/or cigars smoked, and tobacco chewed the day of the experiment; Sleep = total number of hours in last two nights; Menst. Cycle = number of days since the first day of most recent menstrual cycle.

Table 7

Correlations of Covariates: Motivation Scale, Experimental Condition, and Dependent Measures

	Motivated for Approval From Others	Motivated to Meet Own Expectations	Motivated to Focus on Task	Motivation Scale Total
Experimental Condition	$.046_a$	$-.050_a$	$-.091_a$	$-.038_a$
Digit Span Scaled Score	$.075_a$	$.105_a$	$.067_a$	$.113_a$
VSAT Left Percentile	$.154_b$	$.105_b$	$.106_b$	$.172_b$
VSAT Right Percentile	$.174_b$	$.130_b$	$.082_b$	$.184_b$
VSAT Total Percentile	$.164_b$	$.117_b$	$.096_b$	$.179_b$
WCST: CV2 Total Correct	$.016_a$	$.012_a$	$.186_a$	$.091_a$
WCST: CV2 Total Errors	$-.078_c$	$-.054_c$	$.125_c$	$-.012_c$
WCST: CV2 Perseverative Responses	$-.017_c$	$-.023_c$	$.178_c$	$.056_c$
WCST: CV2 Categories Completed	$.200_d$	$.218_d$	$.048_d$	$.223_d$
CPT-IP Hit Rate (Numbers)	$.073_a$	$.206_a$	$.176_a$	$.204_a$
CPT-IP Hit Rate (Shapes)	$.047_a$	$.049_a$	$.065_a$	$.073_a$
CPT-IP False Alarm (Numbers)	$-.037_a$	$-.046_a$	$.007_a$	$-.037_a$
CPT-IP False Alarm (Shapes)	$.079_a$	$-.081_a$	$-.013_a$	$-.003_a$
CPT-IP RT Hits (Numbers)	$.092_a$	$-.207_a$	$-.116_a$	$-.098_a$
CPT-IP RT Hits (Shapes)	$.067_a$	$-.108_a$	$.110_a$	$.030_a$
CPT-IP RT Variability Hits (Numbers)	$-.132_a$	$-.143_a$	$-.012_a$	$-.136_a$
CPT-IP RT Variability Hits (Shapes)	$-.068_a$	$-.148_a$	$-.034_a$	$-.116_a$

Note. $n^a = 80$, $n^b = 71$; $n^c = 79$; $n^d = 77$.

Table 8

Correlations of Covariates: Trait Anxiety, General Affect, Experimental Condition, and Dependent Measures

	STAI Trait	PANAS Positive Affect	PANAS Neg. Affect	PANAS Positive Factor.	PANAS Dep. Factor	PANAS Anxiety Factor	PANAS Arousal Factor
Experimental Condition	$.203_a$	$-.118_a$	$.262_a$	$-.129_a$	$.191_a$	$.266_a$	$.018_a$
Digit Span Scaled Score	$-.058_a$	$.081_a$	$-.148_a$	$.075_a$	$-.175_a$	$-.079_a$	$.071_a$
VSAT Left Percentile	$.036_b$	$.025_b$	$.033_b$	$.064_b$	$.013_b$	$.040_b$	$.031_b$
VSAT Right Percentile	$.119_b$	$.022_b$	$.084_b$	$.031_b$	$.068_b$	$.095_b$	$.099_b$
VSAT Total Percentile	$.079_b$	$.033_b$	$.057_b$	$.053_b$	$.038_b$	$.068_b$	$.074_b$
WCST: CV2 Total Correct	$.029_a$	$.102_a$	$-.006_a$	$.094_a$	$.011_a$	$-.017_a$	$-.054_a$
WCST: CV2 Total Errors	$.085_c$	$.101_c$	$.001_c$	$.098_c$	$.034_c$	$-.075_c$	$.003_c$
WCST: CV2 Perseverative Responses	$.021_c$	$.141_c$	$-.060_c$	$.155_c$	$-.019_c$	$-.083_c$	$-.048_c$
WCST: CV2 Categories Completed	$-.031_d$	$.053_d$	$.057_d$	$-.026_d$	$.014_d$	$.087_d$	$.096_d$
CPT-IP Hit Rate (Numbers)	$-.090_a$	$-.043_a$	$-.085_a$	$-.037_a$	$-.040_a$	$-.072_a$	$.010_a$
CPT-IP Hit Rate (Shapes)	$-.178_a$	$.133_a$	$-.116_a$	$.129_a$	$-.095_a$	$-.002_a$	$.236_a$
CPT-IP False Alarm (Numbers)	$.206_a$	$.021_a$	$.220_a$	$.025_a$	$.193_a$	$.198_a$	$.000_a$
CPT-IP False Alarm (Shapes)	$.147_a$	$-.097_a$	$.166_a$	$-.096_a$	$.095_a$	$.142_a$	$-.155_a$
CPT-IP RT Hits (Numbers)	$.176_a$	$-.090_a$	$.289_a$	$-.109_a$	$.278_a$	$.300_a$	$-.043_a$
CPT-IP RT Hits (Shapes)	$.137_a$	$-.156_a$	$.187_a$	$-.088_a$	$.250_a$	$.175_a$	$-.088_a$
CPT-IP RT Variability Hits (Numbers)	$.103_a$	$-.034_a$	$.166_a$	$-.088_a$	$.180_a$	$.156_a$	$.031_a$
CPT-IP RT Variability Hits (Shapes)	$-.028_a$	$-.100_a$	$-.054_a$	$-.062_a$	$-.097_a$	$-.061_a$	$-.076_a$

Note. $n^a = 80$, $n^b = 71$; $n^c = 79$; $n^d = 77$.

Table 9

Correlations of Experimental Condition and STAI State and SAM

	Experimental Condition
STAI State	.334
SAM Valence	-.221
SAM Arousal	-.056
SAM Dominance	-.096

Note. n = 80.

Table 10

Correlations of Request for Feedback in SMC, Attentional Measures, and State Affect Measures

	Feedback Request
Digit Span Scaled Score	$.011_a$
VSAT Left Percentile	$-.064_b$
VSAT Right Percentile	$-.130_b$
VSAT Total Percentile	$-.094_b$
WCST: CV2 Total Correct	$-.189_a$
WCST: CV2 Total Errors	$-.009_c$
WCST: CV2 Perseverative Responses	$.231_c$
WCST: CV2 Categories Completed	
CPT-IP Hit Rate (Numbers)	$.310_a$
CPT-IP Hit Rate (Shapes)	$.120_a$
CPT-IP False Alarm (Numbers)	$.122_a$
CPT-IP False Alarm (Shapes)	$-.013_a$
CPT-IP RT Hits (Numbers)	$-.225_a$
CPT-IP RT Hits (Shapes)	$-.028_a$
CPT-IP RT Variability Hits (Numbers)	$-.145_a$
CPT-IP RT Variability Hits (Shapes)	$-.119_a$
STAI State	$.172_a$
SAM Valence	$.056_a$
SAM Arousal	$.086_a$
SAM Dominance	$-.168_a$

Note. $n^a = 40$; $n^b = 35$; $n^c = 39$; Correlation for WCST: CV2 Categories Completed not shown because variables are constant.

Table 11

Stepwise Regression Analysis for Variables Predicting Digit Span Scale Score (N = 80).

Variable	B	*SE B*	*β*
Step 1			
WRAT3 Std. Score	.135	.040	.355*
Step 2			
WRAT3 Std. Score	.145	.039	.382**
SAM Arousal	-.364	.162	-.233***

Note. **p* < .01; ***p* < .001; ***p< .05

Table 12

Stepwise Regression Analysis for Variables Predicting WCST: CV2Total Errors (N = 79).

Variable	B	*SE B*	*β*
Step 1			
SAM Dominance	1.477	.643	.253*

Note. **p* < .05.

Table 13

Stepwise Regression Analysis for Variables Predicting CPT-IP False Alarm Rate (Numbers) (N = 80).

Variable	B	*SE B*	β
Step 1			
WRAT3 Std. Score	-.004	.002	-.313*
Step 2			
WRAT3 Std. Score	-.004	.001	-.307*
STAI State	2.307	.001	.223**

Note. *p < .01; **p < .05.

Table 14

Stepwise Regression Analysis for Variables Predicting CPT-IP False Alarm Rate (Shapes) (N = 80).

Variable	B	*SE B*	β
Step 1			
SAM Valence	-.020	.007	-.311*

Note. *p < .01.

Table 15

Stepwise Regression Analysis for Variables Predicting CPT-IP RT Hits (Numbers) (N = 80).

Variable	B	*SE B*	β
Step 1			
PANAS Negative Affect	2.393	.898	.289*

Note. *p < .01.

Table 16

Stepwise Regression Analysis for Variables Predicting CPT-IP RT Hits (Shapes) (N = 80).

Variable	B	*SE B*	β
Step 1			
SAM Dominance	-7.395	3.664	-.223*

Note. *p < .05.

Table 17

Exploratory Factor Analysis of Attentional Measures

Attentional Element/Measures	Factor 1	Factor 2	Factor 3	Factor 4
Encode				
Digit Span Fwd				-.661
Digit Span Bck				-.738
Focus/Execute				
VSAT Total %				
Shift				
WCST: CV2 Total Correct		-.797		
WCST: CV2 Total Errors		-.847		
Sustain				
CPT-IP Hit Rate (Numbers)	.725			
CPT-IP Hit Rate (Shapes)	.662			
CPT-IP RT Hits (Numbers)			.815	
CPT-IP RT Hits (Shapes)			.722	
Stabilize				
CPT-IP RT Variability Hits (Numbers)			.447	
CPT-IP RT Variability Hits (Shapes)	-.429			

Note. Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization.

Appendix B

Figures

Figure 1

Comparisons of CPT-IP False Alarm Rates

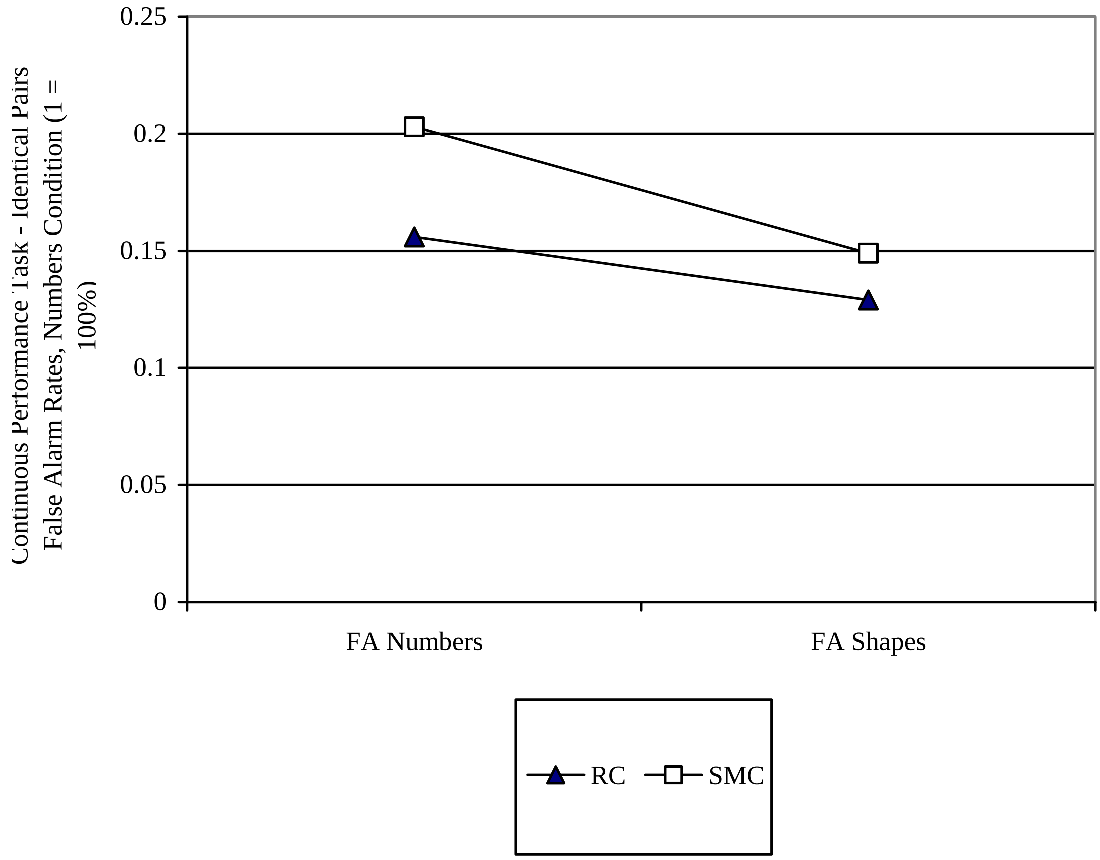


Figure 2

Comparisons of STAI State and Trait Scores

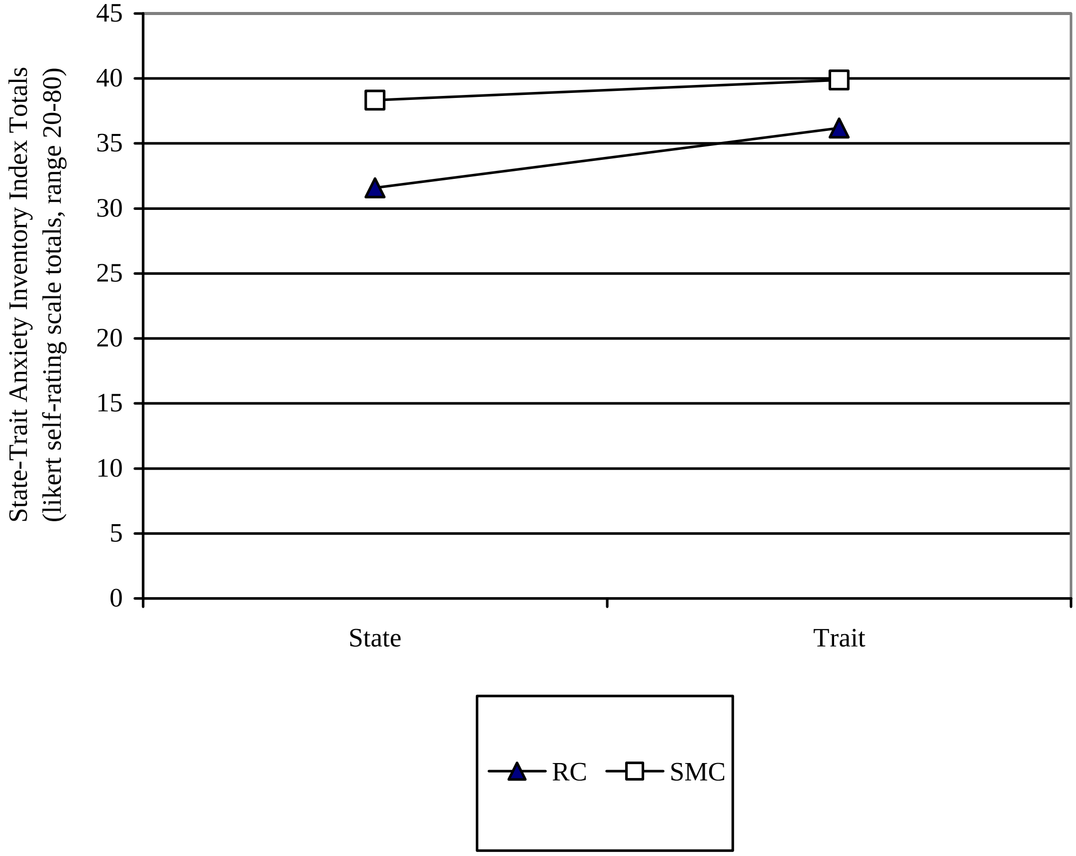
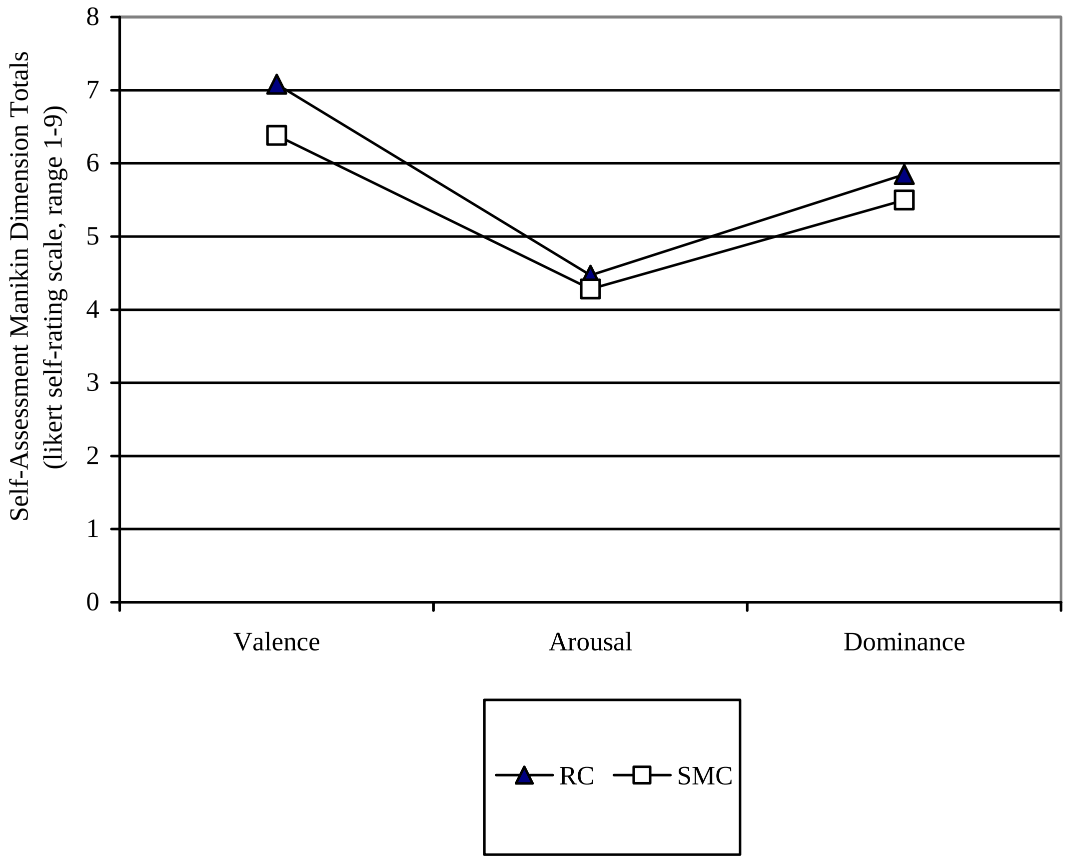


Figure 3

Comparisons of SAM Scores



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