THE RELATIONSHIP BETWEEN ANXIETY, PERSONALITY CHARACTERISTICS, AND
WORKING MEMORY PERFORMANCE

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ABSTRACT

THE RELATIONSHIP BETWEEN ANXIETY, PERSONALITY CHARACTERISTICS, AND

WORKING MEMORY PERFORMANCE

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The relationship between anxiety and working memory capacity (WMC) and

performance is a widely researched topic in the field of psychology. Typically, anxiety has a

negative effect on working memory performance (Coy, O'Brien, Tabaczynski, Northern, &

Carels, 2011). However, the direction of the relationship between anxiety and working memory

is somewhat poorly understood. Test anxiety, a form of state anxiety, has also been shown to

negatively impact working memory performance. In addition, personality impacts all aspects of

human behavior. Therefore, it is realistic to expect personality to have an impact on anxiety. In

fact, many studies have established an association between job characteristics and anxiety and

personality characteristics such as neuroticism. The purpose of the present study was to

investigate and examine the relationship between anxiety, personality, and working memory

performance. There were 45 participants, all of whom were students at Western Carolina

University. The Beck Anxiety Inventory – Trait Version and Reactions to Tests inventory were

both used to gather information on the participants' levels of anxiety. The M5-120, which is

based on the FFM of personality, was used to gather information on the participants' personality.

Automated Complex Span Tasks were used to gather information on that participants' working

memory performance. Findings revealed significant relationships between gender and working memory performance and RTT scores as well as between type of instructions and BAIT scores. Findings also revealed significant relationships between RTT scores and working memory performance, BAIT scores, and the Neuroticism domain. Furthermore, findings revealed significant relationships between the Neuroticism domain and BAIT scores, the Extraversion domain, and the Agreeableness domain. A significant relationship was also revealed between the Openness to Experience domain and BAIT scores. Lastly, two multiple regression models were statistically significant in their ability to predict working memory performance using RTT scores alone, and RTT scores and the Conscientiousness domain as predictors. This study suggests that both anxiety and personality play a role in working memory performance but additional research is needed to further explore this relationship.

INTRODUCTION

The relationship between anxiety and working memory capacity (WMC) and performance is a widely researched topic in the field of psychology. Typically, anxiety has a negative relationship with working memory performance (Coy et al., 2011). However, the direction of the relationship between anxiety and working memory is somewhat poorly understood. In some instances, low WMC leads to an increased susceptibility to anxiety's effects on working memory performance (Johnson & Gronlund, 2009). This suggests a bi-directional relationship between anxiety and WMC, where anxiety and working memory capacity interact to affect scores on measures of working memory performance.

Differences between trait and state anxiety have been found that help explain some of the relationship between anxiety and WMC. While trait anxiety typically has a negative relationship with working memory performance (Coy et al., 2011), state anxiety does not always show the same relationship. According to Walkenhorst and Crowe (2009), state worry, an important aspect of anxiety, unexpectedly lead to enhanced performance on visual tasks for individuals low in trait anxiety. In addition, individuals with high trait anxiety and/or high state worry showed shorter response latencies than individuals low in trait anxiety. Test anxiety, a form of state anxiety, has also been shown to have a negative relationship with working memory performance. According to Cognitive Interference Theory, test, or evaluation, anxiety leads to diminished cognitive performance through increased use of negative off task self-dialogue. Using working memory tasks as a measure of cognitive performance, Coy et al. (2011) demonstrated that participants receiving anxiety producing instructions had lower performance on working memory tasks and reported significantly more evaluation anxiety and off task self-dialogue.

Like trait anxiety, personality impacts all aspects of human behavior. The Five-Factor Model (FFM) of personality is a scientifically developed model of personality. All five factors in the FFM of personality emerged to explain the many different facets of personality that have been measured. The five factors include Neuroticism, Extroversion, Openness to Experience, Conscientiousness, and Agreeableness. Therefore, it is realistic to expect personality to have a relationship with anxiety. In fact, many studies have established an association between job characteristics and anxiety and personality characteristics such as neuroticism. Specifically, it seems that neuroticism is the personality characteristic that is most associated with anxiety. Results of a study by Booth, Murray, Marples, and Batey (2013) showed that neuroticism accounted for a large portion of the association between negative job characteristics and anxiety. In another study of medical students, neuroticism was associated with levels of perceived job stress and higher levels of anxiety symptoms. Neuroticism also indirectly predicted stress reactions and levels of depression (Gramstad, Gjestad, & Haver, 2013).

In testing situations, anxiety can have a negative relationship with working memory performance. Certain personality characteristics also have a relationship with an individual's level of anxiety. The purpose of this study is to explain the relationship between individual differences in personality using the FFM, trait anxiety, and working memory performance under low and high anxiety conditions.

CHAPTER ONE: LITERATURE REVIEW

Trait Anxiety

Trait anxiety, as opposed to state anxiety, is defined as an acquired disposition to perceive a wide range of situations as threatening and to respond to them anxiously (Kohn, Kantor, DeCicco, & Beck, 2007). Anxiety is influenced by a number of things. According to Chorpita and Barlow (1998), certain events activate the emotion of anxiety through the Behavioral Inhibition System (BIS). According to this model, the BIS responds to signals for both punishment and frustrative nonreward, as well as novel stimuli. These inputs are then mediated by what is called the "comparator" a subsystem of the brain. The main function of the comparator is to analyze information from numerous sources and regulate BIS activity. These sources of information include the current observed state of the world, the next planned step in the motor program, stored regularities about the world, and stored regularities about the behavior-outcome relations (Chorpita & Barlow, 1998). This means that, through associations made by Pavlovian conditioning, the comparator uses the information to predict the next sensory event, and to regulate the BIS accordingly. It is important to note that these associations by conditioning usually occur during early development.

An important aspect in the development of anxiety is control. Control is defined, broadly, as the ability to personally influence events and outcomes in an individual's environment (Chorpita & Barlow, 1998). Given this definition of control, there is a substantial amount of support for the idea that a diminished sense of control is associated with the expression of anxiety (Barlow, 1991; Lazarus, Averill, & Opton, 1970; Mandler, 1972; Sanderson, Rapee, & Barlow, 1989). What this means is that a history of lack of control may lead to an increased risk

of developing chronic anxiety. More specifically, evidence suggests that early experience with events out an individual's control may lead to an increased tendency to process events as out of one's control, therefore leading to the experiencing of anxiety (Chorpita & Barlow, 1998). According to Rotter (1966), early experiences with control contribute the most to the formation of the psychological vulnerability of anxiety.

Others define trait anxiety as an individual-difference variable that reflects variations in state anxiety elevations as they result from exposure to a stressor. Trait anxiety is also not just a unidimensional construct. According to the current research, there are two dimensions that, it is argued, make independent contributions to trait anxiety scores. These dimensions are anxiety reactivity and anxiety perseveration, and both contribute to an individual's anxiety vulnerability. Anxiety reactivity is the increased probability of experiencing state anxiety reactions to stressors while anxiety perseveration is the persistence of symptoms once exposed to a stressor (Rudaizky, Page, & MacLeod, 2012).

It is important to note the strong relationship between anxiety and depression. According to Clark (1989), these two have been viewed as separate phenomena, heterogeneous syndromes that are associated because of shared subtypes, different points along the same continuum, alternative manifestations of a common underlying diathesis, and conceptually and empirically distinct phenomena. However, Clark and Watson (1991) argue that anxiety and depression fall within a tripartite model that consists of three different factors. By using data collected from numerous measures of anxiety and depression, three factors consisting of general distress, physiological hyperarousal, and anhedonia emerged. Based on this model, anxiety and depression would no longer be separate syndromes. Instead, a diagnosis of mixed anxiety-depression would be used (Clark & Watson, 1991). This relationship between anxiety and

depression is important because efforts to minimize the influence of depressive content have allowed for the development of better measures of anxiety, such as the Beck Anxiety Inventory – Trait Version (BAIT; Kohn et al., 2007).

State and Test Anxiety

State anxiety is viewed as an acute anxious reaction that combines subjective apprehension and arousal of the autonomic nervous system (Kohn et al., 2007). One of the most common measures of state anxiety is the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), which measures both state and trait anxiety and, according to Piotrowski (1999), has become one of the most widely cited measures of anxiety. The Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) is another measure of state anxiety.

Unlike trait anxiety, state anxiety can come in many situation-specific forms. One of the most common situation-specific forms of state anxiety is that of test anxiety. Test anxiety is a well-studied personality variable and provides a measure of the personal salience of one definable class of threatening situations, those in which people are being tested or evaluated (Sarason, 1984). One well-accepted model of test anxiety involves a two-factor conceptualization consisting of physical and cognitive aspects. The physiological reactions, labeled the emotionality component, involved the reactions of the autonomic nervous when test taking. The cognitive aspect, labeled the worry component, involves task-irrelevant thoughts (Nelson, Lindstrom, & Foels, 2013). According to Hembree (1988), the worry component has been shown to be more negatively correlated with performance than the emotionality component. Some of the common test-anxiety-based thoughts include comparing an individual's predicted performance with that of their peers, the possibility of failure and the associated consequences,

perceiving their preparation and knowledge as inadequate, and the possibility of causing sorrow in their parents is test performance is poor (Nelson et al., 2013). Highly anxious individuals will divide their attention between these types of thoughts and test-relevant thoughts. Due to their attention to inappropriate or irrelevant thoughts, the performance of highly anxious individuals will be negatively affected (Macher, Paechter, Papousek, Ruggeri, Freudenthaler, & Arendasy, 2013). This is due to the fact that anxiety uses a portion of the processing capacity that is needed for task completion and performance (Cassady & Johnson, 2002).

According to Macher et al. (2013), anxiety brought on through examinations is a severe problem for many students. In a survey of German students, about 15-20% reported feelings impaired by nervousness and anxiety in examination situations. These experiences of anxiety may have long-lasting effects beyond a single testing situation. Evidence suggests that students are more likely to fail tests, or to delay or drop out of their degree program because of their test anxiety. Many studies have shown the adverse effects of state and test anxiety on performance but many of these studies have operationalized state anxiety in such a way as to suggest that trait anxiety is the predominant form of anxiety affecting performance (Macher et al., 2013). Additionally, research suggests that personality may also play a role in the relationship between anxiety and performance.

The Five-Factor Model of Personality

There have been many attempts in the field of psychology to create a functional and comprehensive model of personality. Many of the previous theories of personality have been questioned by others, and have been described as having a shaky empirical foundation (Costa & McCrae, 1996). However, there has been a dramatic shift, in recent years, in the scientific study of personality. Much of this shift and the increasing empirical interest in personality can be

attributed to the Five-Factor model (FFM) and its development. According to Wiggins and Pincus (1992), Costa and McCrae's Five-Factor model of personality is the most comprehensive model of personality to date. The FFM has been important enough that Costa and McCrae (1996) believe that the FFM is an indispensable aspect for any future theory because of its strong empirical basis.

While the development of the FFM is relatively new, that personality is comprised of factors is a theory that has been around for quite a while. McDougall, in 1932, proposed that, "personality may be broadly analyzed into five distinguishable, but separate behaviors." Only two years after this proposal, Louis Thurstone (1934), the President of the American Psychological Association, reported the occurrence of five emergent factors of personality. He discovered this by factor analyzing 60 adjectives known to reflect human personality and, through this process, discovered five categories that accurately described all of the adjectives. Not only was this an important finding in terms of creating a lexical database of adjectives that also provides the availability of an empirical database for personality description, but multiple researchers have replicated this analysis of lexical knowledge on a much larger scale (Goldberg, 1990; Hendricks, 1997; Saucier & Goldberg, 1996).

Despite the initial findings by Thurstone (1934), several decades passed before his research on the five factors of personality was properly acknowledged (Borgotta, 1964). However, Fiske (1949) was one of the few researchers of his time who reported significant findings that supported the occurrence of five factors of personality. Using correlational data collected from the Michigan Veterans Administration (VA) Selection Project, Kelley and Fiske (1951) performed a factor analysis that demonstrated five factors. The data were collected from VA trainees, independent evaluators, and VA trainee peers utilizing 22 of the 35 Temperament

Rating Scales developed by Cattell (1933). Results from the factor analysis of the rating scales completed by the three groups revealed the same five factors. These five factors are, in fact, very similar to those that are accepted today and were labeled by Fiske as Social Adaptability, Conformity, Emotional Control, Inquiring Intellect, and Confident Self-Expression.

Several years later, in 1961, Tupes and Christal reanalyzed Cattell's (1933) Temperament Scales through factor analysis, much like Kelley and Fiske (1951). Using data that were collected from US Air Force trainees for 30 of the 35 rating scales revealed five distinct factors, essentially confirming Kelley and Fiske's findings. Tupes and Christal also performed a meta-analysis on Fiske's original study (1949) and again, verified the five emergent factors of personality. However, due to poor circulation, their findings were available to only a limited number of personality researchers. Because of this, the FFM was widely overlooked and no clear model of personality existed until the 1980s (Digman, 1996).

At the 1980 Western Psychological Association Conference, a reemergence of the five factors of personality occurred. The symposium was attended by Goldberg, Digman, Comrey, and Takemoto-Chock and they met to discuss the factors of personality (Digman, 1990). Based on a meta-analysis of lexical information, Goldberg presented his research that demonstrated only five factors of personality were stable across studies (Wiggins, 1994). A couple of years earlier, Costa and McCrae (1992) had developed a three-factor model of personality with the three factors labeled Neuroticism, Openness, and Extraversion. At a seminar in Baltimore hosted by Costa and McCrae, Goldberg convinced them to add two factors, Agreeableness and Conscientiousness (Wiggins, 1994). Based on these five factors, Costa and McCrae were able to develop a personality inventory. In some alternative models, a single Psychoticism factor has been used in place of the two domains of Agreeableness and Conscientiousness (Eysenck, 1992).

Personality and Anxiety

Personality impacts all aspects of human behavior. Therefore, it is realistic to expect it to have an impact on anxiety. In fact, many studies have established an association between job characteristics and anxiety and personality characteristics such as neuroticism (Booth et al., 2013). For example, a study of the Neuroticism domain of the Five-Factor Model of personality (Rosnov, Pickup, & McCord, 2003) found significant positive correlations with Spielberg's (1983) State Trait Anxiety Inventory and significant negative correlations with Rosenberg's (1965) Self-Esteem Scale. Also, results of a study by Booth and colleagues (2013) showed that neuroticism accounted for a large portion of the association between negative job characteristics and anxiety. However, significant effects on anxiety remained that were independent of neuroticism. This indicates that while neuroticism plays a role in the relationship between negative job characteristics and anxiety, it is likely a confounding instead of an explanatory variable.

Gramstad and colleagues (2013) found similar results suggesting a connection between neuroticism and anxiety. Among medical students, neuroticism was associated with levels of perceived job stress and higher levels of anxiety symptoms. Neuroticism also indirectly predicted stress reactions and levels of depression. According to this, it is clear that certain personality characteristics such as neuroticism have a substantial impact on the level of anxiety in a given individual. Another personality characteristic found to be associated with higher levels of anxiety is that of reality weakness. According to Tyssen, Vaglum, Grønvold, and Ekeberg (2000), reality weakness is a dimension of personality that includes perceptions and thoughts on the borderline between reality and fantasy, much like psychotic distortions. In the medical student study, reality weakness was, like neuroticism, related to higher levels of anxiety and stress reactions

(Gramstad et al., 2013). While not a part of the Five-Factor Model of personality, it is important to note what other personality characteristics can contribute to psychological symptoms and, in this case, anxiety.

On the other hand, there are certain personality characteristics that protect against symptoms. In the study of medical students, Gramstad et al. (2013) found that extraversion protected against symptoms of depression. One could argue that, by the close relationship anxiety and depression share, this could extend to protecting against anxiety symptoms as well. However, there is no data currently to support this.

<center>**Measuring Personality and Anxiety**</center>

All five factors in the Five-Factor Model of personality were developed to measure several different facets of personality. The Neuroticism domain was developed to assess emotional instability versus adjustment. Other constructs identified in this domain are maladaptive coping strategies, proneness to psychological distress, and excessive cravings or urges (Costa & McCrae, 1992). Often referred to as introversion versus extraversion, the Extraversion domain assesses intensity and quantity of interpersonal interaction, activity level, need for stimulation, and the capacity for joy. The Openness to Experience domain, sometimes referred to as intellectual openness versus closedness, assesses the proactive seeking and appreciation of experience and exploration of the unfamiliar (Costa & McCrae, 1992; Widiger & Lynam, 1998). The Agreeableness domain assesses the quality of an individual's interpersonal orientation and is measured along a continuum from compassion to antagonism in actions, thoughts, and feelings (Costa & McCrae, 1992). According to Widiger and Lynam (1998), Agreeableness is often interpreted as interpersonal agreeableness versus antagonism. The fifth

and final domain, Conscientiousness, assesses persistence, organization, and motivation in goal-directed behavior (Costa & McCrae, 1992).

The FFM of personality has received extensive empirical support. Three of the most prominent instruments used to measure the FFM are the Hogan Personality Inventory (HPI; Hogan, 1986), the NEO Personality Inventory-Revised (NEO-PI-R; Costa & McCrae, 1992) and the Big-Five Inventory (BFI; John, Donahue, & Kentle, 1991). The NEO-PI-R is a comprehensive personality inventory that measures the five factors as well as specific traits, called facets. Within each domain there are six facets being measured, with a total of 30. The inclusion of the scores reflecting each facet, in addition to the five domains, provides a more precise view of personality traits. Statistically, each of the facets is separate from each other but they remain unified under their respective domain (Costa & McCrae, 1995). The NEO-PI-R is a widely successful inventory that has impressive validity, but there are some limitations in its use due to the fact that it is sold commercially and the associated cost of its use. According to Goldberg (1999), the proprietary nature of modern personality inventories inhibits the research needed to assess validity and to allow for refinement. This is why the creation of a public domain item set is necessary. The proposal for an item set, one that would be based off questions from leading inventories, led to the construction of the International Personality Item Pool (IPIP). The IPIP is free to access and allows researchers to develop personality inventories to complement their research.

One such inventory that used the IPIP in its development was the M5-120 Questionnaire (McCord, 2002). McCord utilized the IPIP to select 120 items that best measure the 5 domains and 30 facets of the FFM. At the domain and facet levels, the M5-120 has been shown to be highly correlated with the NEO-PI-R and also possesses a high degree of internal reliability

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(McCord, 2002). Previous research has also shown that each of the five domains have high correlations with other validated personality measures (Proctor & McCord, 2009a; Proctor & McCord, 2009b; Socha, Cooper, & McCord, 2010).

There are many inventories that have been designed to measure anxiety. The Beck Anxiety Inventory (BAI; Beck et al., 1988) was an attempt at developing a measure of anxiety, but there were some problems. In measuring anxiety, the trait-state distinction is an important one, and the BAI fails to conform to this distinction. The BAI might best be characterized as a measure of prolonged state anxiety (Kohn et al., 2007). Another problem, not specifically with the BAI but with other anxiety measures, is the contamination of depressive content. Studies have shown several anxiety measures, including the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983), to be highly correlated with depression (Dobson, 1985; Endler, Cox, Parker, & Bagby, 1992). Minimizing this contamination by depressive content was a major motive for developing the BAI (Beck et al, 1988). This effort was extended to the Beck Anxiety Inventory – Trait Version (BAIT; Kohn et al., 2007). Like the trait version of the STAI (STAIT), the BAIT assesses dispositional or trait anxiety while also minimizing depressive content, unlike the STAIT. In a series of three studies, Kohn and colleagues (2007) demonstrated high correlations with other trait-anxiety measures, while also showing low correlations with state anxiety and trait depressiveness. They also demonstrated high convergent validity with the BAI and self-rated trait anxiety. Across all studies, the BAIT showed good internal consistency and high stability. Factor analyses of the BAIT supported a 2-factor structure across all studies consisting of one Somatic and one Subjective factor. The Somatic factor consisted of items that referred to somatic indicators of anxiety while the Subjective factor referred to items with subjective content (i.e. "fear of the worst happening").

Measuring Working Memory

Working memory refers to a limited-capacity system that is responsible for active maintenance, manipulation, and retrieval of task-relevant information that is needed for ongoing cognition (Unsworth, Redick, Heitz, Broadway, & Engle, 2009). Working memory is a critical construct for cognitive functioning that involves both the processing and storage of information (Redick, Broadway, Meier, Kuriakose, Unsworth, Kane, & Engle, 2012). Numerous studies have shown that working memory capacity (WMC) is strongly related to intelligence and executive functions (Kane, Hambrick, & Conway, 2005; Redick et al., 2012). In terms of psychological difficulties, low WMC is viewed as a core cognitive deficit in theories of Attention-Deficit/Hyperactivity Disorder (ADHD), schizophrenia, reading disability, aging, and Alzheimer's disease (Engle & Kane, 2004; Redick et al., 2012). It has also been demonstrated that WMC is important in social psychological phenomena such as emotion regulation and intrusive thought suppression. Memory performance across the human life span shows large variation, with an increase across childhood and adolescence, a peak in young adulthood, and a marked decline with advanced age (Fandakova, Sander, Werkle-Bergner, & Shing, 2014). Because of the impact WMC has on many facets of an individual's functioning, the proper measurement of WMC and individual differences is critical (Redick et al., 2012).

In terms of measuring WMC, working memory simple span tasks have been used in a number of ways. For years, simple span tasks have been included on standard intelligence tests and were mainly a measure of the storage aspect of working memory (Redick et al., 2012). Working memory span tasks have also been used to assess and predict higher order and lower order cognitive tasks. Span tasks have also been shown to predict reading comprehension and performance on the Stroop task (Daneman & Carpenter, 1980; Kane & Engle, 2003; Unsworth,

Heitz, Schrock, & Engle, 2005). However, although these span tasks have been shown to have good reliability and validity, they require a large amount of experimenter time. For example, to run the operation span task, where participants are asked to solve a series of math operations while also trying to remember a set of words, would require about 20 minutes of experimenter time to run the participant and score the responses (Unsworth, et al. 2005). Because of this, an alternative that was easy to administer and took less time was needed.

In 2005, Unsworth and colleagues presented an easy-to-administer and automated version of the popular working memory task Operation span. According to the authors, the automated Operation span task (Aospan) is mouse driven, scores itself, and requires little intervention on the part of the experimenter. The introduction of an automated version also allowed for the analysis of response times, which helps to account for additional variance in predicting fluid abilities. In the years that followed, two more automated span tasks were created, one for Symmetry and one for Reading. Overall, all three automated span tasks demonstrate good reliability and validity (Redick et al., 2012). Unfortunately, according to Oswald, McAbee, Redick, and Hambrick (2014), implementation complex span measures is generally time-consuming for both administrators and examinees. Because researchers must often deal with limited testing time and a need to measure several constructs reliably, Oswald and colleagues developed shortened versions of the automated complex span tasks described above through a series of two studies. These shortened versions were shown to reduce testing time by about 30%, on average, and showed good cross-validation with other measures of working memory performance.

Anxiety and Working Memory

There is a wealth of research literature that provides evidence for a relationship between anxiety and working memory. There are also many theories behind the association that attempt to explain the relationship. Cognitive interference theories suggest that high levels of trait anxiety negatively affect the performance on cognitive tasks (Owens, Stevenson, Hadwin, & Norgate, 2014). According to Cognitive Interference Theory, evaluation anxiety leads to diminished cognitive performance through increased use of negative off task self-dialogue. Using working memory tasks as a measure of cognitive performance, Coy et al. (2011) demonstrated that participants receiving anxiety producing instructions had lower performance on working memory tasks and reported significantly more evaluation anxiety and off task self-dialogue. From a biological perspective, trait anxiety is positively correlated with neural effort expended on task processing (Basten, Stelzel, & Fiebach, 2012). This means that higher levels of anxiety were associated with stronger activation in two regions of the brain associated with goal-directed attention, which leads to lower neural efficiency and lower working memory performance. According to Owens et al. (2014), working memory capacity (WMC) moderates the relationship between anxiety and cognitive test performance. Academic performance is also affected by anxiety. According to Owens, Stevenson, Hadwin, and Norgate (2012), higher levels of anxiety were associated with lower academic performance and there is support for worry and central executive processes mediating the relationship. Additionally, according to Attention Control Theory (ACT), trait anxiety and situational stress interact to impair performance on tasks that involve attentional shifting (Edwards, Edwards, & Lyvers, 2015). This theory suggests that anxious individuals increase their effort to prevent deficits in performance effectiveness, with

specific deficits appearing in processing efficiency, which is a component of working memory performance.

However, it is not just anxiety that has a negative relationship with working memory performance. Individual differences in WMC are related to an individual's susceptibility to anxiety's effect on working memory performance. According to Johnson and Gronlund (2009), individuals low in WMC were particularly vulnerable to the disruptive effect of anxiety on working memory performance. This means that anxiety not only negatively impacts working memory performance, but an individual with an already low WMC is more susceptible to the disruption than an individual with a high WMC. Additionally, working memory load has a relationship with trait anxiety. In a study by Qi, Zeng, Luo, Duan, Ding, Hu, and Li (2014), a high working memory load disrupted participants' ability to overcome distractor interference. This effect was made worse by high trait anxiety. This suggests that high trait anxiety negatively impacts an individuals' working memory performance when experiencing a high load on their working memory. It is important to note that there are also ways in which anxiety positively impacts working memory performance. For example, individuals with higher trait anxiety were better able to suppress memories and had a higher recall rate after repeated suppression on a think/no think experiment (Waldhauser, Johansson, Bäckström, and Mecklinger, 2011). This means that individuals with higher trait anxiety may be better able to manipulate memories in terms of suppression. Also, according to Walkenhorst and Crowe (2009), worry, an important aspect of anxiety, unexpectedly lead to enhanced performance on visual tasks for individuals low in trait anxiety. In addition, individuals with high trait anxiety and/or high state worry showed shorter response latencies than individuals low in trait anxiety.

Other types and states of anxiety can impact working memory performance. Mathematics anxiety has increasingly become a problem with students. According to Witt's (2012) findings, higher levels of mathematics anxiety lead to a decrement in central executive working memory in anxiety-inducing situations. More specifically, the presence of digits caused a decrement performance with higher levels of mathematics anxiety. Mathematics anxiety is also subject to significant gender differences. According to Ganley and Vasilyeva (2014), there was a significant gender difference in math performance, anxiety, and visuospatial working memory, with males performing better than females. Although this difference is present, the authors note that there appears to be a trend towards a decreasing difference between males and females with the help of the removal of female stereotypes surrounding math. There is also a relationship between social anxiety and working memory performance. According to Moriya and Sugiura (2012), visual WMC increases as social anxiety increases. This finding is somewhat surprising but when a demand was placed on individuals to inhibit distractors, the high WMC diminished in socially anxious individuals. This means that individuals high in trait social anxiety potentially have the ability to hold large amounts of visual information in working memory but cannot inhibit distractors under highly demanding conditions, which leads to diminished performance.

Hypotheses

Anxiety and working memory performance have been shown to have a relationship where, typically, anxiety negatively impacts working memory performance (Coy et al., 2011). Research has also shown that the worry component within the model of test anxiety (Nelson et al., 2013) is more negatively correlated with performance than the emotionality component (Hembree, 1988). Highly anxious individuals will divide their attention between test-irrelevant and test-relevant thoughts, and working memory performance will be negatively affected

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(Macher et al., 2013). Anxiety-inducing instructions have also been shown to negatively impact

working memory performance (Coy et al., 2011). According to Owens and colleagues (2014),

working memory capacity (WMC) moderates the relationship between anxiety and cognitive test

performance. These findings suggest that individuals higher in trait and state anxiety will score

lower on measures of working memory performance.

Other research has shown that anxiety is affected by personality characteristics. A study

of the Neuroticism domain of the Five-Factor Model of personality (Rosnov et al., 2003) found

significant positive correlations with Speilberg's (1983) State Trait Anxiety Inventory and

significant negative correlations with Rosenberg's (1965) Self-Esteem Scale. Also, results of a

study by Booth and colleagues (2013) showed that neuroticism accounted for a large portion of

the association between negative job characteristics and anxiety. Among medical students,

neuroticism was associated with higher levels of anxiety symptoms and also indirectly predicted

stress reactions (Gramstad et al., 2013). These findings suggest that high scorers on neuroticism

will also score highly on measures of both trait and state anxiety. In this study, participants were

given measures of trait and state anxiety, a measure of personality characteristics, and a measure

of working memory performance. Thus, based on previous research, the following hypotheses

were made:

Testable Hypothesis #1: Pearson correlations between the Neuroticism domain and

BAIT scores and RTT scores will be significant and positive because research has shown that

neuroticism and both trait and state anxiety have a positive relationship with Neuroticism. This is

due to the emotional instability that the Neuroticism domain assesses, and its relationship with

higher levels of stress and anxiety.

Testable Hypothesis #2: Pearson correlations between BAIT scores, RTT scores, and Neuroticism scores and working memory performance will be significant and negative because we expect that individuals high in trait anxiety, test anxiety, and neuroticism will score lower on the working memory tasks. BAIT scores, RTT scores, and Neuroticism scores will have a significant and negative relationship with working memory performance because of the additive effects anxiety has with neuroticism on working memory performance. This is due to a negative relationship between anxiety and working memory capacity, which is associated with weaker central executive processing, lower neural efficiency, and, therefore, diminished working memory performance.

Additional Analyses: In addition, the relationship between anxiety, personality, working memory performance, type of instructions, and gender used together will be examined, where we expect high BAIT, high Neuroticism, and high RTT scores to be particularly susceptible to anxiety-inducing instructions and have a lower working memory performance.

CHAPTER TWO: METHODS

Participants

This experiment used students recruited from Western Carolina University. Participants were presented with an information sheet and asked to sign a form indicating their informed consent before participating. In addition, none of the participants were aware of the experimenter's purpose until after the experiment was concluded. The final sample used for analysis included 44 participants, the majority of which were male (54.5%) and freshmen in college (36.4%). The average age of the participants was 20.91 years of age.

Measures

Beck Anxiety Inventory – Trait Version

Participants were given the Beck Anxiety Inventory – Trait Version (BAIT) to measure trait anxiety. The BAIT is designed to measure dispositional or trait anxiety and specifically designed to minimize influence by depressive content. The BAIT's instructions are as follows: "In general, how much are you bothered by each of the following problems on a DAY-TO-DAY basis? Please circle a number from 0 to 3 for each of the following items." The response format is as follows: "How you generally feel/0 = rarely or never/1 = occasionally/2 = often/3 = almost always." Good psychometric properties including convergent, divergent validity and internal consistency have been demonstrated for this measure (Kohn et al., 2007).

Reactions to Tests

Participants were given the Reactions to Tests (RTT), which is a 40-item self-report inventory designed to measure test anxiety (Sarason, 1984). Psychometric investigations of the RTT have indicated that it is reliable and has a four-factor structure (Coy et al., 2011). The four

factors measured by the RTT include Tension, Worry, Test-Irrelevant Thinking, and Bodily Reactions. Of the four factors, Worry is the most directly related to test performance (Sarason, 1984). Each item is scored on a 4-point Likert-scale with answers ranging from 1 (Almost never) to 4 (Almost always). Instructions for the RTT can be manipulated to either induce anxiety or give support to the individual. According to Sarason (1984), this has an impact on test performance with anxiety-inducing instructions negatively affecting performance.

M5-120 Questionnaire

Participants completed the M5-120 Questionnaire. The M5-120 Questionnaire is a 120 item self-report measure designed to assess traits of normal personality (McCord, 2002). Each item is scored on a 5-point Likert-scale with answers ranging from 1 (Inaccurate) to 5 (Accurate). The M5 is derived from the International Personality Item Pool (IPIP; Goldberg, 1999) and is based on the Five-Factor Model of Personality. The five domains identified by the M5 are Neuroticism, Extroversion, Openness to Experience, Conscientiousness, and Agreeableness. Within each domain are six descriptive facets. Several studies have reported appropriate levels of validity and reliability in the majority of the domains (Proctor & McCord, 2009a; Socha et al., 2010).

Automated Complex Span Tasks (CSTs)

Participants were given a series of automated complex span tasks (CSTs) designed to assess working memory performance (Unsworth et al., 2005; Unsworth et al., 2009). The three automated CSTs include Reading Span, Operation Span, and Symmetry Span. Reading Span involves reading a series of sentences and attempting to recall the last word of each sentence (Unsworth et al., 2009). Operation Span involves solving a series of math problems while trying to remember a set of unrelated words (Unsworth et al., 2005). Symmetry Span is similar to

Reading Span but has different content (Redick et al., 2012). Automated CSTs are quickly administered, completely computerized and mouse-driven, and are automatically scored. The automated CSTs also generate, at random, different combinations of trials and list lengths at each administration, ranging from 3 to 6 trials. For all tasks, there are three practice conditions before proceeding to the real trials: storage task only, processing task only, and processing and storage task. Separate scores for both the processing tasks and the storage tasks are determined by the amount of correct responses. The automated CSTs show good test-retest reliability and internal consistency, and correlate well with other measures of working memory performance (Redick et al., 2012).

Procedure

Participants were provided with a brief description of the study and informed consent. After informed consent was given, participants were asked to fill out a demographics questionnaire that included age, gender, and current year in college. Participants were then asked to complete the Beck Anxiety Inventory – Trait Version as well as the M5-120 questionnaire. After filling out both of these, participants were given one of two sets of instructions. This made it so that there were some participants who are both high anxiety and high Neuroticism in each group. One set of instructions was designed to support the participant while the other set of instructions was designed to induce anxiety. Examples of the instructions can be found in Appendix A. The instructions pertained to the automated complex span tasks that the participant did on a computer. After they completed the automated CSTs, they filled out the Reactions to Tests inventory. Once they completed both the automated CSTs and the RTT, participants were finished.

CHAPTER THREE: RESULTS

Out of 45 participants, all but 1 completed the study in its entirety. The only participant to

not complete the study could not do so due to a technical error during administration. For this

reason, this data is excluded from the analyses.

Table 1
Descriptive Statistics for Age, measures of Anxiety, Domains of the FFM of Personality, and
Working Memory scores

Variable	Mean	SD	Min	Max
Age	20.91	2.27	18	28
BAIT	10.52	7.84	0	31
E	54.39	7.295	37	67
A	55.23	6.86	42	65
C	51.50	7.893	38	69
N	44.84	7.716	29	60
O	46.09	10.622	23	69
RTT	74.14	18.936	47	116
WM	59.89	14.048	10	83

Point-biserial and Pearson correlation analyses were conducted to examine the

relationships between the variables of interest for the total participant sample. Participants were

asked to fill out questionnaires about trait and state anxiety, personality characteristics, as well as

complete tasks to assess working memory performance. Therefore, the relationship between

gender, types of instructions, both types of anxiety, personality, and working memory

performance was explored. For a list of correlation coefficients see Tables 2 and 3. Several

significant relationships were revealed between the variables of interest; however, none were

found between gender and type of instructions and working memory performance and measures

of anxiety. A significant negative correlation was revealed between the Reactions to Tests (RTT)

and the Working Memory scores, $r(42) = -.311$, $p < .05$. A significant positive correlation was

revealed between the RTT and Beck Anxiety Inventory – Trait Version (BAIT), $r(42) = .337$, $p <$

.05, as well as between the RTT and the Neuroticism (N) domain of the FFM of personality,

$r(42) = .351$, $p < .05$. A significant positive correlation was revealed between the Openness to

Experience (O) domain and the BAIT, $r(42) = .321$, $p < .05$. A significant positive correlation

was revealed between the N domain and the BAIT, $r(42) = .492$, $p < .01$. A significant negative

correlation was revealed between the N domain and the Extraversion (E) domain, $r(42) = -.358$,

$p < .05$, as well as between the N domain and the Conscientiousness (C) domain, $r(42) = -.336$, p

$< .05$.

Table 2
Point-Biserial Correlations for Gender, Instructions, Working Memory scores, and measures of Anxiety

Variable	Gender	Instructions
WM	-.285*	.026
BAIT	.127	-.284*
RTT	.315*	-.019

*Correlation is significant at the 0.05 level (2-tailed)

Table 3
Pearson Correlations for Working Memory scores, measures of Anxiety, and Domains of the FFM of Personality

Variable	WM	BAIT	E	A	C	N	O
WM							
BAIT	-.202						
E	.037	-.149					
A	.327	-.127	.152				
C	.150	-.260	.037	.259			
N	-.070	.492**	-.358*	-.271	-.336*		
O	.275	.321*	-.073	.081	-.297	.046	
RTT	-.311*	.337*	.119	-.066	-.158	.351*	-.050

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

Lastly, analysis was conducted to explore the variables of interest in their ability to predict working memory scores using multiple regression. Stepwise regression, starting with gender followed by type of instruction, measures of anxiety, and Neuroticism, was used to construct the regression model. This model consisted only of using RTT scores as a predictor and was found to be statistically significant, $r(43) = .311, p < .05$. This model has a low-to-medium effect size ($r^2 = .097$) as it accounts for 9.7% of the variability in the working memory scores. Achieved power for this model was .523, which is below acceptable level. Backwards elimination, starting with all variables of interest, was used to construct an alternative model. Using this method, a second model, consisting of RTT and Conscientiousness domain scores as predictors, was found to be statistically significant, $r(43) = .414, p < .05$. This model has a medium effect size ($r^2 = .171$) as it accounts for 17.1% of the variability in the working memory scores. Achieved power for this model was .655, which is below acceptable level.

CHAPTER FOUR: DISCUSSION

Correlations

The relationship between gender, instructions, trait and state anxiety, personality, and working memory were examined in the current study. The results supported the hypothesis of a significant positive relationship between the Neuroticism domain and both BAIT and RTT scores. This supports previous research that has shown a positive relationship between neuroticism and measures of anxiety (Rosnov et al., 2003). Also, the results partially supported the hypothesis of a significant negative relationship between BAIT, RTT, and Neuroticism domain scores and working memory performance where a significant negative relationship was revealed between RTT scores and working memory performance but no significant relationship was found between the two remaining variables and working memory performance. Given that there is research that shows a negative relationship between anxiety and working memory performance (Rosnov et al., 2003), these findings are surprising. Findings from the analysis did not support the hypothesis of a significant negative relationship between BAIT scores and working memory performance as well as between the Neuroticism domain and working memory performance. This is surprising given research that has demonstrated a negative relationship between anxiety and working memory performance (Owens et al., 2014). It is possible that a restriction of range could be affecting the relationship between BAIT and Neuroticism scores and working memory performance. More specifically, there are a very low number of individuals whose trait anxiety scores place them into either moderate or high anxiety categories. Overall, these findings suggest that participants who scored high on the RTT, a measure of test anxiety, had weaker working memory performance.

Unexpectedly, other significant relationships between the variables of interest were revealed in the analysis. Findings from the analysis revealed a significant negative relationship between gender and working memory performance as well as a significant positive relationship between gender and RTT scores where females had lower working memory scores and higher RTT scores. Additionally, findings revealed a significant negative relationship between type of instructions and BAIT scores where individuals who received anxiety-inducing instructions had lower BAIT scores. It is likely for this reason that type of instructions and BAIT scores did not relate significantly to working memory performance. Findings from the analysis also revealed a significant negative relationship between the Neuroticism domain and Extraversion domain as well as between the Neuroticism domain and Conscientiousness domain. According to Costa and McCrae (1992), the Neuroticism domain assesses emotional instability, the Extraversion domain measures intensity and quantity of interpersonal interaction, and the Conscientiousness domain measures persistence, organization, and motivation in goal-directed behavior. Rationally, these findings are not much surprise given what each domain is intended to measure. An individual who scores higher in the Neuroticism domain, who is more emotionally unstable, is probably unlikely to have high-quality interpersonal interaction. Furthermore, an individual with a high score in Neuroticism may also be unlikely to be persistent and organized in achieving their goals. According to Samuel, Mullins-Sweatt, and Widiger (2013), Neuroticism has a significant negative relationship with both Extraversion and Conscientiousness. Further findings from the analysis revealed a significant positive relationship between BAIT scores and the Openness to Experience domain. According to Costa and McCrae (1992), the Openness to Experience domain assesses the seeking and appreciation of experience and exploration of the unfamiliar. This is a somewhat surprising finding given that experiential avoidance, rather than the seeking of

experience, is associated with higher trait anxiety (Bardeen, Fergus, & Orcutt, 2014). This finding could be due to the nature of recruitment for this study, which was labeled as examining the relationship between anxiety, personality characteristics, and working memory performance, and someone who is higher in both Openness to Experience and trait anxiety may be drawn to participating in this type of study.

Regression

The relationship between gender, type of instructions, trait and state anxiety, personality, and working memory were examined in the current study. Regression models were constructed to analyze the variables of interest as they relate to the prediction of working memory performance using both stepwise and backwards elimination methods. Surprisingly, neither of the models included the Neuroticism domain and instead included the Conscientiousness domain. According to Rosnov et al. (2003), a study of the Neuroticism domain found significant positive correlations with measures of anxiety. In addition, research suggests that anxiety negatively affects working memory performance (Owens et al., 2014). Therefore, it follows logically that there should be some significant, negative relationship between Neuroticism and working memory performance but as the correlations in Table 3 and the regression models show; this is not the case as it applies to the current study. As mentioned above, this could be due to a restriction of range and, more specifically, a low number of individuals who fall into either the moderate or high trait anxiety classifications as specified by the BAIT.

The inclusion of the Conscientiousness domain is somewhat unexpected but not as surprising as the exclusion of Neuroticism. According to Morris and Fritz (2015), the Conscientiousness domain predicts academic coursework performance. However, it does not predict exam performance. In the context of this study, the working memory tasks could be

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analogous to exams and are even labeled as "tests" in the instructions (see Appendix A). Therefore, while Conscientiousness has been shown to predict academic performance overall better than it predicts exam, or test, performance. This difference, as explained by Morris and Fritz (2015), could be a result of overall coursework having a higher reliance on conscientiousness (i.e. organization and motivation) than preparing for one exam.

Overall, it is surprising that neither BAIT scores nor Neuroticism domain scores contributed as predictors of working memory performance and that Conscientiousness domain scores did contribute. The purpose of this study was to examine the relationship between anxiety, personality characteristics, and working memory performance where measures of anxiety and personality were used as predictors of working memory performance. However, it is a distinct possibility that the direction of the relationship between these variables is different from what was examined. According to Coy et al. (2011), the direction of the specific relationship between anxiety and working memory is somewhat poorly understood. This means that it is possible that working memory has an impact on anxiety instead of the opposite. Therefore, where the current study found little in the way of anxiety and personality predicting working memory performance, future studies in this field may instead examine the relationship between these variables with working memory as a predictor.

Limitations

The current study consisted of 45 participants where all but 1 was able to complete the study in its entirety. Although almost the entirety of the sample was able to complete the study, this is still a relatively small sample size and likely had an effect on the results. There was also a restriction of range which led to problems with limited variability. However, it is unclear whether additional data would directly affect findings.

The sample composition is also a significant limitation to this study. The composition of the participants, while normal for a rural southeastern university, does not accurately reflect the general population.

The low number of participants in the moderate-to-high categories of trait anxiety is also a significant limitation to this study. The purpose of this study was to examine the relationship between anxiety, personality, and working memory performance where high anxiety negatively impacts working memory performance (Owens et al., 2014). Having only a small number of individuals who fall into the moderate or high classifications of trait anxiety limit the ability to draw conclusions regarding the relationship between anxiety and working memory performance in this study.

Future Directions

The current study supports the relationship between test anxiety and working memory performance. However, it fails to support the relationship between trait anxiety and personality and working memory performance. Future research is necessary to confirm past findings and accumulate new data. A replication of this study should include a higher number of participants. In addition, a more representative sample of the population should be utilized to include more ethnic diversity and more diverse age groups. Perhaps future research can create a more anxiety-inducing situation in order to better assess the direct relationship between anxiety and working memory performance. It is also suggested that how one copes with anxiety be examined as it could influence the relationship between anxiety and working memory performance. Examining personality at the facet level as it relates to working memory performance could also prove to be beneficial.

Implications and Conclusions

Analyses of the data collected from this study provided both expected and unexpected results. The most likely explanation for these unexpected and surprising results are the small sample size and lack of variability in participants' levels of trait anxiety. The current data suggests that levels of test anxiety, and one domain (Conscientiousness) of personality are significant predictors in working memory performance but, given the limitations described above, it is difficult to accurately assess this relationship between anxiety, personality and working memory performance. It is possible that including information regarding anxiety in the title and the description of the study may have had an unintended effect of dissuading individuals from participating. This would help to explain the lack of variability in participants' levels of trait anxiety, as someone who is high in trait anxiety may be less likely to seek to participate in a study specifically measuring anxiety.

The findings from the present study are somewhat inconclusive but they do reveal some information about the complex relationship between anxiety, personality, and working memory performance. The study of these constructs is not always straightforward and can be susceptible to complex and confounding factors. We must exercise extreme caution when generalizing experimental findings to the larger population. Levels of anxiety and how one copes with it and the anxiety-inducing situation, the complex constellation of personality traits that each individual possesses, and an individual's working memory capacity are some of the variables that must be taken into consideration.

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APPENDICES

APPENDIX A: Working Memory Task Instructions

Anxiety-Inducing Instructions

This project involves you performing tests that assess attention, concentration, and memory.

These tests have been shown to be highly related to intelligence and ability to do college work.

They are also related to success in later life such as earned income and occupational attainment.

It is likely that you have never seen these tests before so many of them may seem difficult.

During each test, you will be timed and notes will be taken regarding your performance. It is

important that you do well because we will compare your performance with the performance of

other college students. Any questions?

Supporting Instructions

This project involves you performing tests that assess attention, concentration and memory.

Before we begin, though, we want to inform you that we are mainly interested in determining if

these tests would be appropriate for a future project. Therefore, we are not that concerned about

your performance, so do not worry so much about whether you are doing good or bad. Although

we are not that concerned about how well you do on these tests, we do want you to try your best.

We want to remind you that no one will see the results of your performance. So, just relax and

follow the instructions as best you can. Before we begin you may just want to take a couple deep

breaths and clear your mind. Any questions?