A FOUR-FACTOR MODEL OF EXECUTIVE FUNCTIONING: THE RELATIONSHIP BETWEEN PERSONALITY, INTELLIGENCE, AND EXECUTIVE FUNCTIONING

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by

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ABSTRACT

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Executive functioning is commonly assessed in neuropsychological evaluations, however, the construct of executive functioning is widely defined and understood within the literature. Additionally, researchers have begun to examine the relationship between personality and executive functioning. The present study conducted an exploratory factor analysis using common measures of executive functioning. Results yielded a four-factor model. The Big Five personality traits were used to predict performance on executive functioning factors and intelligence was used as a moderator for this relationship. The present study adds to the literature by expanding upon previous studies examining the factor structure of executive functioning. Further, to our knowledge, this is the first study to investigate how intelligence may influence the relationship between personality and executive functioning.

KEY WORDS: Executive functioning, Factor analysis, Personality, Five Factor Model Intelligence, Neuropsychological assessments

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CHAPTER I

Introduction

The rise of neuropsychology dates back to the First World War. Men were returning from combat with brain injuries that required diagnoses and rehabilitation (Lezak, Howieson, Bigler, & Tranel, 2012). At the time, neuropsychological assessments provided an invaluable means to assess for and diagnose brain damage. However, as technology has advanced, neuroimaging techniques provide more accurate diagnoses for brain damage, making neuropsychological assessments obsolete for this purpose (Lezak et al., 2012).

Currently, neuropsychologists are often asked to complete a neuropsychological assessment for purposes of diagnosis, patient care and planning, treatment planning and remediation, treatment evaluation, research, and forensic neuropsychology (Lezak et al., 2012). The wide variety of referral questions that neuropsychologists may encounter requires neuropsychologists to be competent in administering and interpreting numerous types of assessments for a variety of reasons. Neuropsychological assessments have been developed to measure various cognitive domains, including receptive and expressive language, memory, visuospatial and analytical thinking, fine and gross motor skills, mental activity variables (e.g., sustained and focused attention), executive functions, and personality (Lezak et al., 2012). Describing all cognitive domains is beyond the scope of this study and the reader can seek out this information from a variety of sources (e.g., see Coslett & Saffran, 1992; Livingston & Hubel, 1988; Weschler, 2009). The current study focuses primarily on measures of executive functioning and personality.

Executive functions involve the capacities that enable an individual to act in a self-serving and purposeful manner (Chan, Shum, Toulopoulou, & Chen, 2008; Lezak et al., 2012) and executive functioning is a large area in which neuropsychological assessments target. Personality is also relevant in neuropsychological testing, largely due to the common changes in personality that occur after a traumatic brain injury or in conjunction with neurological disorder (Lezak et al., 2012; Mendez, Owens, Jimenez, Peppers, & Licht, 2013; Robins-Wahlin & Byrne, 2011).

Executive Functioning Theory and Assessment

Executive functioning includes "a wide range of cognitive processes and behavioral competencies which include verbal reasoning, problem-solving, planning, sequencing, the ability to sustain attention, resistance to interference, utilization of feedback, multitasking, cognitive flexibility, and the ability to deal with novelty" (Chan et al., 2008, p. 201). In contrast to cognitive functions, which typically refer to what an individual knows and what they can do with that knowledge, executive functions refer to how a person is going to perform a task (Lezak et al., 2012). Further, an individual can sustain significant cognitive damage and still have intact executive functioning, enabling that individual to live an independent and productive life (Lezak et al., 2012). When executive functioning is compromised, an individual may no longer be able to care for themselves, even if cognitive capacities are still intact (Lezak et al., 2012). One difficulty that arises when measuring executive functioning abilities is determining why an individual performed poorly on any given task due to the wide range of reasons that affect executive skills (Chan et al., 2008). Although many tests of executive functioning exhibit clinical utility, individuals with brain injuries often perform similarly to healthy

controls, yet continue to demonstrate difficulty accomplishing everyday tasks (Chan et al., 2003). This pattern suggests that current strategies for measuring executive functioning are lacking.

Illustrating the complexity in measuring executive functioning, as well as finding consistency among research, Jurado and Rosselli (2007) state, "definitions abound for the concept of executive functions, as well as for its possible subcomponents and the variables that measure them" (p. 214). Executive functioning measures are often used to measure a unitary construct, despite executive functioning not being best understood in that sense (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). Researchers debate whether executive functioning can be measured as a core construct with underlying components, or if executive functioning constructs are independent (Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Jurado & Rosselli, 2007). Part of the problem when measuring executive functioning is the lack of a universal operational definition as well as an unclear understanding of the skills relevant in measuring it (Testa, Bennett, & Ponsford, 2012). This complicates interpretation of test data, and measures of executive functioning tend to have low internal and test-rest reliability (Miyake et al., 2000), diminishing the utility of these instruments. Further, there has been significant criticism in the literature that measures of executive functioning exhibit minimal construct and ecological validity and do not provide valuable information about an individual's "real-life," performance (Burgess et al., 1998; Chan et al., 2008). One possible reason that executive functioning measures tend to have poor psychometric properties (e.g., test-retest reliability, construct validity, ecological validity), is the differing factor structures used to conceptualize executive functions (Latzman & Markon, 2010; Miyake et al.,

2000). As a result, researchers have worked to identify an appropriate fractionation of executive functions (Burgess et al., 1998; Chan et al., 2008; Miyake et al., 2000).

Executive Functioning Factors

Currently, a three-factor structure of executive functioning, comprised by shifting, updating, and inhibition, is the most well-supported factor structure in the literature (Latzman & Markon, 2010; Miyake et al., 2000; Murdock, Oddi, & Bridgett, 2013). Shifting, sometimes referred to as cognitive/conceptual flexibility, describes an individual's ability to shift his or her attention between multiple mental tasks (Miyake et al., 2000). As an example, the Wisconsin Card Sort Test (WCST) is often used as a measure of shifting and is used to "assess the ability to modify one's goal-seeking behavior based on changes in the rules or goals presented during the task" (Campbell, Davalos, McCabe, & Troup, 2011, p. 721).

Updating, which is closely related to the cognitive construct of working memory, requires an individual to monitor and code incoming information in a way that is relevant to the current task (Miyake et al., 2000). Additionally, "the essence of updating lies in the requirement to actively manipulate relevant information in working memory, rather than passively store information" (Miyake et al., 2000, p. 57). Tasks such as Letter Fluency (i.e., naming as many words that begin with a specific letter in a given amount of time) are often used to measure updating (Murdock et al., 2013).

Inhibition refers to one's capacity to intentionally suppress dominant or automatic responses so that one can express non-dominant responses (Miyake et al., 2000; Murdock et al., 2013). In executive functioning research, the Stroop test (i.e., naming the color of

ink a colored word is written in rather than reading the word) has proven to be the prototypic measure for inhibition (Miyake et al., 2000).

Executive Functioning in the Literature

Much of the early executive functioning and neuropsychological assessment research used populations of individuals with frontal lobe damage (Miyake et al., 2000); however researchers are beginning to recognize the value of understanding how neurologically intact populations perform on executive functioning tasks (Testa et al., 2012; Van der Elst, Van Boxtel, Breukelen, & Jolles, 2008). Further, early research in executive functioning tests focused on individual differences, such as age and education, rather than actual constructs of the assessments (Lam et al., 2013; Miyake et al., 2000). For example, one study found that within an English-speaking Chinese sample, education was significantly associated with fluency tasks, reasoning tasks, and measures of executive functioning, whereas age and education combined were significantly associated with working WMS tasks (Lam et al., 2013). Education was also found to moderate performance on the Iowa Gambling Task (IGT), another commonly used neuropsychological test, in a sample of neurologically-intact adults (Davis et al., 2008). Age-related differences in the factor structure of executive functioning have also been found, including a two-factor structure in pediatric populations and samples of older adults (i.e., updating and shifting; Hull, Martin, Bier, Lane, & Hamilton, 2008; Huizinga, Dolan, & van der Molen, 2006), whereas middle-aged adults typically yield three factors (i.e., updating, shifting, and inhibition; Miyake et al., 2000). However, these age-related differences have not been consistent across studies. One study using a sample group of adolescent males found support for a three-factor model of executive functioning

(Latzman & Markon, 2010) and another study using a sample of children and adolescents found support for a five-factor model of executive functioning (Levin et al., 1996). Although individual differences do appear to influence the factor-structure of executive functioning, research is vastly inconsistent. In addition to age and education, literature has investigated the relationship between individual differences in personality traits (i.e., Five Factor Model) and executive functioning (e.g., Fleming, Heintzelman, & Bartholow, 2016; Murdock et al., 2013). Prior to exploring these studies in detail, it is first necessary to provide a brief overview of personality theory and assessment.

Personality Theory and Assessments

Similar to neuropsychological assessments, the rise of personality assessments can be traced back to World War I (Weiner & Greene, 2008). Personality assessments provided a means to identify soldiers who were likely to be psychologically unfit for duty (Weiner & Greene, 2008). With the development of personality assessments, personality psychology as its own field of psychology emerged (Weiner & Greene, 2008). Analogous with the initial use of neuropsychological assessments, personality assessments were used to identify abnormal or deviant personality traits in order to make diagnoses, as opposed to identifying normal or typical personality traits (Weiner & Greene, 2008). After World War I, many researchers proposed various theories of personality and personality assessment (e.g., Allport & Odbert, 1936; Cattell, 1943). However, in the 1980's there was a surge of literature focusing on typical personality traits, with the preponderance of research suggesting a five factor model of personality (Digman, 1990; McCrae & Costa, 1991; Noller, Law, & Comrey, 1987; Weiner & Greene, 2008). The Big Five personality model is one of the most widely accepted

conceptualizations of personality theory, and includes openness to experience (e.g., intellect, imagination, alertness to feelings, independence of judgment), conscientiousness (e.g., planning, organizing, carrying out tasks), extraversion (e.g., sociable, assertive, active, talkative), agreeableness (e.g., interpersonal tendencies, altruism), and neuroticism (e.g., hostility, negative affect, poor impulse control; McCrae & Costa, 2010). This model is unique when compared to other personality assessments, as it is a true measure of 'personality,' rather than psychopathology – which is the intention of many other personality assessments.

Executive Functioning and Personality

Increased interest in the relationship between cognitive abilities, intelligence, executive functions, and the big five personality traits has led to an influx of research in this area (Fleming et al., 2016; Murdock et al., 2013; Unsworth et al., 2009). For example, openness to experience has been correlated to intelligence in a number of studies (Bates & Shieles, 2003; McCrae, 1993; Schretlen, van der Hulst, Pearlson, & Gordon, 2010). Specifically, one study found that openness to experience had a stronger correlation with crystalized intelligence compared to executive functioning and fluency (Schretlen et al., 2010), and neuroimaging studies have shown the prefrontal cortex to be related to openness and intelligence (DeYoung, Peterson, & Higgens, 2005). However, another study found openness to be related to fluency tasks, but unrelated to fluid intelligence, whereas neuroticism had a negative relationship with fluid intelligence (Unsworth et al., 2009).

The relationship between executive functioning and the Big Five personality traits has been researched in several populations, including older adults (Denburg et al., 2009;

Williams et al., 2010), inpatients diagnosed with schizophrenia (Gurrera, MacCarley, & Salisbury, 2014), community samples (Fleming et al., 2016; Hall, Fong, & Epp, 2014; Schretlen et al., 2010), and undergraduate samples (Campbell et al., 2011; Murdock et al., 2013; Unsworth et al., 2009). Moreover, each of the five factors has been shown to be significantly related to a factor of executive functioning in at least one study, but these associations are largely inconsistent across studies. In older adult populations, higher levels of neuroticism have been associated with poorer executive functioning, including decision making (Denburg et al., 2009; Williams et al., 2010). Additionally, greater levels of openness to experience and agreeableness have been associated with higher executive functioning in older adult samples (Williams et al., 2010). In a sample of inpatients diagnosed with schizophrenia, performance on executive functioning tasks was significantly related to abnormalities in personality that are associated with schizophrenia (Gurrera et al., 2014). Further, within a sample of community members, executive functioning has been found to partially explain the relationship between conscientiousness and health behaviors, as well as neuroticism and health behaviors (Hall et al., 2014).

Although the literature covers a wide range of populations, the majority of studies use undergraduate samples and the relationship between personality and executive functioning continues to be variable. For example, one study used a four-factor model of executive functioning and found significant relations between executive functioning factors and personality traits of extraversion and openness to experience (Unsworth et al., 2009). Openness to experience was positively associated with executive functioning performance, whereas neuroticism was negatively associated with executive functioning

performance (Unsworth, et al., 20909). Other recent studies have used the more common three-factor model of executive functioning (Campbell et al., 2011; Fleming et al., 2016; Murdock et al., 2013). Research suggests that updating, shifting, and inhibition are all differentially influenced by levels of extraversion, with extraversion having the greatest influence on updating tasks (Campbell et al., 2011). Specifically, among undergraduates, extraversion was related to executive functioning, such that individuals with high levels of extraversion performed significantly better on updating tasks, whereas individuals with low levels of extraversion performed significantly better on shifting tasks (Campbell et al., 2011). However, the study conducted by Campbell and colleagues (2011) differs from many of the other studies in that it did not use a measure of the Five Factor Model to derive scores for extraversion and the study looked at how differing levels of extraversion influenced executive functioning performance. Due to the different research methodologies used by Unsworth and colleagues (2009), as well as Campbell and colleagues (2011), it is difficult to compare results to other recent studies.

Another study using an undergraduate sample found that neuroticism was significantly predicted by executive functions of updating, and openness to experience was significantly predicted by updating and shifting (Murdock et al., 2013). Conversely, extraversion, agreeableness, and conscientiousness were not predicted by any of the executive function factors (Murdock et al., 2013). It is striking that conscientiousness was not significantly associated with any of the executive functioning measures, as the definition of conscientiousness "appears to reflect executive functioning abilities" (Williams et al., 2010, p. 486). Specifically, high scores on conscientiousness are associated with individuals who are "purposeful, strong-willed, and determined"

(McCrae & Costa 2010, p. 20), and tend to exhibit self-control, responsibility, and organization (Fleming et al., 2016). In contrast to Murdock and colleagues (2013), conscientiousness has been found to significantly predict performance on the WCST (i.e., shifting) and verbal fluency tasks (i.e., updating; Jensen-Campbell et al., 2002). However, a recent study that examined the relationship between conscientiousness and executive functioning found conscientiousness to be positively associated with shifting (Fleming et al., 2016), but not related to inhibition or updating. While agreeableness was not significantly related to executive functioning in one study (Murdock et al., 2013), another similar study found that agreeableness significantly predicted performance on the Stroop test, which is a measure of inhibition (Jensen-Campbell et al., 2002). Overall, previous research using similar sample groups, similar measures, and a similar factor structures lack consistent findings, which hinders the utility of the research in "real-life" practice.

While prior literature provides valuable information, there are several limitations that can still be addressed. For example, several studies have used more basic statistical analyses (e.g., bivariate correlation, ANOVA) to examine the relationship between executive functioning and personality (Campbell et al., 2011; Higgins et al., 2007; Williams et al., 2010). Furthermore, researchers have commonly used theoretical conceptualizations as a means of assigning measures to specific factors of executive functioning rather than conducting a factor analysis prior to examining the relationship between executive functioning and personality (see Campbell et al., 2011; Murdock et al., 2013). Additionally, many studies have used an abbreviated measure of the five-factor model (i.e., NEO-FFI), which does not provide scores for the 30 sub-facets of the five-

factor model (Fleming et al., 2016; Hall et al., 2014; Jenson-Campbell et al., 2002; Murdock et al., 2013). It is possible that the sub-facets may yield additional insight into the relationship between personality and executive functioning; therefore, a full measure of the five-factor model would expand upon the previous findings.

The Present Study

Overall, much of the literature shows inconsistent findings surrounding personality and executive functioning, making it difficult to understand the true relationship between these constructs. It is the intention of the present study to expand and deepen the results obtained by Murdock and colleagues (2013), as well as Fleming and colleagues (2016). Specifically, this study will conduct a factor analysis of executive functioning measures, rather than using a theory driven method to decide what executive functioning measures represent specific factors, prior to examining the relationship between executive functioning and personality. Such an approach would enhance the construct validity on which this research rests. Additionally, this study employs a greater number of executive functioning assessments, so each factor will potentially be comprised of more than one measure, again enhancing construct validity. Further, a more robust measure of personality will be used, allowing for more thorough analysis of the relationship between executive functioning factors and sub-facets of the five-factor model.

A more global benefit of this study is the possibility to learn more about the specific factors that influence performance on executive functioning measures. For example, research has already concluded that individual factors such as age and education impact performance on neuropsychological tests (Davis et al., 2008; Hull et al.,

2008; Lam et al., 2013; Miyake et al., 2000), and should thereby be considered in the interpretation of test results. If personality has a similar effect on executive function test performance, the utility and interpretation of test results may improve if personality characteristics are considered. It is possible that the lack of ecological validity of executive functioning measures is, at least in part, the result of unconsidered factors. The investigation of other factors (i.e., personality), if appropriately considered, may give us additional insight into the variables that effect an individual's performance, thereby influencing test interpretation. Further, this may aid in enhancing the ecological validity, and therefore the utility, of neuropsychological assessments.

Although Murdock and colleagues (2013) used executive functioning to predict personality factors, the present study will use personality factors to predict executive functioning. The reason for inverting these relations is primarily heuristic; personality as a predictor of executive functioning is more heuristically appealing for several reasons. First, executive functioning measures are typically utilized when making decisions about an individual's level of functioning (e.g., neuropsychological evaluations, fit-for-work evaluations, forensic evaluations, living independently), whereas a measure of personality is not typically used. Thus, examining how a factor that is not usually considered in these types of 'real world' situations may be influencing test results seems to make intuitive sense. Second, we know that other factors (e.g., age, education) influence executive functioning, and executive functioning measures often have poor construct and ecological validity. Therefore, if we can identify ways in which personality may influence test performance, personality can potentially be integrated into neuropsychological case formulations. This said, researchers have also tested models in which personality

predicted executive functioning factors (Fleming et al., 2016). Finally, the cross-sectional nature of the previous research, and that I propose in the current study, makes this distinction of which variables predict and which are predicted by others primarily conceptual.

Research Questions & Hypotheses.

RQ1: What type of factor-structure will best fit executive functioning measures, including measures from the D-KEFS (i.e., trail making, verbal fluency, color-word interference) and the WCST?

Based on the previous literature (e.g., Fleming et al., 2016; Miyake et al., 2000; Murdock et al., 2013), I hypothesized that I would find a similar three-factor structure of executive functioning, represented broadly by updating, shifting, and inhibition.

RQ2: What specific relations between the executive functioning factors and personality emerge?

I hypothesized that personality traits will be significantly associated with performance on executive functioning tasks. Given the inconsistency within the prior literature, a specific directional hypothesis was not made; rather I examined the influence of each five personality measures on each executive functioning factor. Research in this area has revealed inconsistent relations; however, given the research that exists (e.g., Fleming et al., 2016; Murdock et al., 2013), I hypothesized that neuroticism, openness to experience, and conscientiousness will be significantly associated with one or more of the executive functioning factors.

CHAPTER II

Methods

Participants

The sample was comprised of 227 undergraduate students and was limited to students between the ages of 18 and 40. The age restriction was appropriate based on the literature suggesting that executive functioning scores of adolescents and older adults tend to yield a two-factor, rather than a three-factor structure, of executive functioning (Hull et al., 2008). Additionally, an undergraduate sample was best suited to compare the results to prior studies, which have primarily used undergraduates. To have a typically developing, neurologically intact sample, participants were asked about any potential neurological abnormalities on the demographics form, including premature birth, epilepsy, severe mental illness (e.g., bipolar disorder, schizophrenia), and previous brain injuries or concussions. These participants completed the study measures, but were excluded from the following analyses.

After select participants were excluded, the sample size consisted of 186 undergraduate students from a midsized university in Texas. Participants ranged in age from 18 to 34 (M = 20.0, SD = 2.1), 40.9% of participants identified as male and 59.1% of participants identified as female. Overall, the sample group was ethnically diverse with 35.5% Caucasian, 29.0% African American, 23.7% Hispanic/Latino(a), 7.5% Biracial, and the remainder was comprised of other minority individuals. Participants were distributed across academic classifications, with 33.3% Freshman, 19.9% Sophomore, 26.9% Junior, and 19.9% Senior. Additionally, the majority of participants

reported being unemployed (54.3%), 40.9% reported being employed part-time (i.e., less than 20 hours per week), and 4.8% reported being employed full time.

Measures

The present study utilized data collected for a larger study. For the present study, measures of intelligence, personality, and neuropsychological assessments typically used to test executive functioning were used.

NEO-PI-3. The NEO-PI-3 is a 240-item, pencil and paper, self-report measure assessing the Big Five personality traits; Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness (McCrae & Costa, 2010). Each personality domain is comprised of six facets, which provide a more detailed understanding of the overarching domain (McCrae & Costa, 2010). Participants respond to questions on a 1 (strongly disagree) to 5 (strongly agree) Likert scale. Previous studies have shown that the five scales have high reliability and have established the validity of the NEO-PI-3 as a measure of the Big Five personality traits (McCrae & Costa, 2010; Markon, Krueger, & Watson, 2005).

Delis-Kaplan Executive Functioning System (D-KEFS). The D-KEFS is a standardized "assessment of executive functions including flexibility of thinking, inhibition, problem solving, planning, impulse control, concept formation, abstract thinking and creativity" (Homack, Lee, & Riccio, 2005, p. 599). The D-KEFS is made up of nine tests, which are all scored independently of each other. For the current study three of the D-KEFS tests will be used:

Trail Making Test. The Trail Making Test will be used as a measure of Inhibition. Based on Latzman and Markon's (2010) factor analysis of the D-KEFS, the

Trail Making Test significantly loaded on an Inhibition factor in similarly aged samples as the one I propose recruiting, however Delis and colleagues (2001) propose that this test is a measure of cognitive flexibility (i.e., shifting). The Trail Making Test is comprised of five conditions, visual scanning, number sequencing, letter sequencing, number-letter switching, and motor speed (Delis, Kaplan, & Kramer, 2001). For the present study, two conditions will be administered: letter sequencing (i.e., connecting letters in alphabetic order) and number-letter switching (i.e., connecting number, letter, number, letter, etc. in sequential order). The test-retest reliability coefficient for the letter sequencing condition and number-letter switching condition within the normative sample group were 0.59 and 0.38, respectively (Delis et al., 2001).

Color-Word Interference Test. The Color-Word Interference Test is composed of four conditions, including word reading, color naming, inhibition, and inhibition/switching. Based on Latzman and Markon's (2010) factor structure analysis of the D-KEFS, the Color-Word Interference Test also significantly loaded onto Inhibition in similarly aged samples. The Inhibition condition on the Color-Word Test is similar to the Stroop test, and requires individuals to name the ink color rather than reading the word (i.e., the word blue is printed in green ink and the examinee must say green). Test-retest reliability coefficients for word reading, color naming, inhibition, and inhibition/switching within the normative sample were .76, .62, .75, and .65, respectively.

Verbal Fluency. The Verbal Fluency Test includes three conditions (i.e., letter fluency, category fluency, category switching) and yields four composite scores, including letter fluency, category fluency, category switching total correct, and category switching total switching. The examinee is asked to generate words beginning with a

specific letter, words belonging to a specific category, or switching between words belonging to two different categories (Delis et al., 2001). Based on Latzman and Markon's (2010) factor structure analysis of the D-KEFS, the Verbal Fluency Test loaded onto Monitoring (i.e., Updating). Test-retest reliability coefficients for letter fluency, category fluency, category switching total correct, and category switching total switching accuracy within the normative sample were .80, .79, .52, and .36, respectively (Delis et al., 2001).

Wisconsin Card Sorting Test (WCST). The WCST is typically used as a means of assessing cognitive flexibility and abstract reasoning and can be considered a measure of executive functioning (Heaton, Chelune, Talley, Kay, & Curtiss, 1993). It was originally designed to be used with normal adult populations, but is also used in clinical neuropsychological settings (Heaton et al., 1993). Similar to previous studies (e.g., Murdock et al., 2013), the present study will use the WCST as a measure of Shifting. Although the WSCT results in a variety of scores, two scores are being used in the current study: Percent Preservative Errors, which reflects the "concentration of perseverative errors in relation to overall test performance" (Heaton et al., 1993, p. 18) and is often used for clinical purposes, and Percent Nonperseverative Errors, which are primarily used to aid research investigations (Heaton et al., 1993). Demographically corrected norms were used for this study.

Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II). The WASI-II is a standardized measure of general cognitive ability (Wechsler, 2011). The Vocabulary and Matrix Reasoning subtests on the WASI-II can be used to calculate the Full Scale – IQ 2 Subtests (FSIQ-2). Raw scores on each subtest are converted to *T*-

scores (i.e., $M = 50$, $SD = 10$) and the composite score has mean of 100 and a standard deviation of 15. The average reliability coefficients in the adult normative sample for Vocabulary, Matrix Reasoning, and FSIQ-2 were .92, .90, and .94, respectively.

Procedures

The researcher recruited undergraduate participants from Sam Houston State University. Specifically, participants were recruited from an online system and in return for their participation they received three hours of course credit. At the onset of the testing session, participants were provided with an explanation of the study, including opportunities to ask questions. Each participant signed an informed consent document, and were given a copy of the informed consent to keep. After consent was obtained, participants completed a demographics questionnaire along with the NEO-PI-3, three D-KEFS tests (i.e., color-word interference test, trail making test, and verbal fluency test), the 2-Factor WASI-II subtests (i.e., vocabulary and matrix reasoning), and the WCST.

Data Analysis

After the completion of data collection and entry, descriptive statistics were run to obtain means and standard deviations for each of the variables. Descriptive statistics were also used to examine sample characteristics, as is described in the participants section. Additionally, data was screened to check assumptions (e.g., range, skewness, kurtosis) to ensure the data satisfied the distributional assumptions of factor analysis and multiple regression. Bivariate correlations among the measures of executive functioning and the Big Five personality traits were then run to examine patterns of association between the scales.

Prior research has suggested that executive functioning may comprise factors of inhibition, shifting, and updating (i.e., Miyake et al., 2000; Murdock et al., 2013); however this research is not conclusive and findings have not been consistent (i.e., Latzman & Markon, 2010; Unsworth et al., 2009; Williams et al., 2010). Therefore, I conducted individual factor analyses using variables commonly used to measure the constructs of inhibition, shifting, and updating to determine if the conditions within the test reflected an underlying unitary construct. Following testing the series of one-factor models, I conducted a factor analysis of all measures simultaneously to investigate whether the measures when analyzed together would produce a three-factor structure.

An initial EFA was conducted using an orthogonal rotation to preserve simple structure if possible (Tabachnick & Fidell, 2006). Following the EFA conducted using an orthogonal rotation, researchers reran the EFA using an oblique rotation to compare factor structures. Some literature suggests that factor analyses provide more valuable information when factors are allowed to correlate (Farbrigar, Wegener, MacCullum, & Strahn, 1999). Although there were many similarities between the factor structures, the results obtained from the orthogonal rotation will be the primary factor structure discussed. This decision makes sense for several reasons. First, the use of an orthogonal rotation preserves simple structure (Tabachnick & Fidell, 2006; Woods, Tataryn, & Gorsuch, 1996). Using an orthogonal rotation does not change the correlations between variables, but instead rotates the matrix so that variables load onto a single factor. This process makes interpretation of individual factors more straightforward. Additionally, an orthogonal rotation is more in line with previous literature surrounding the factor structure of executive functioning, making the comparison between current and previous

results more coherent. Lastly, the use of an orthogonal rotation is more relevant when considering the clinical implications of the factor analysis as the results have been preserved by simple structure, thereby enhancing the interpretability of the factors.

Having settled on a suitable factor structure, I then saved factor scores for each of the underlying factors and conducted a multiple regression analysis in which factor scores were regressed on the personality variables. Prior to the regression, all continuous variables were centered by subtracting the mean from individual participant's scores to reduce potential multicollinerarity among the measurement scales. I then multiplied these variables together to create product interaction terms (i.e., Neuroticism by WASI-II, Extraversion by WASI-II, Openness by WASI-II, Agreeableness by WASI-II, and Conscientiousness by WASI-II). A second regression was conducted to test moderation by intelligence. Simple slopes were examined for all significant interactions. To test simple slopes, WASI-II scores were divided at 100, with scores below 100 being assigned to the low group and scores of 100 and above being the high group. This split is close to the median of the current sample and is convenient from a logical standpoint as the average WASI-II score within the normative sample group is 100. An independent samples *t*-test was conducted to determine if there were any differences in personality among participants assigned to the low IQ group and those assigned to the high IQ group. Significance will be reported at $p < .05$, however due to the exploratory nature of this study, results trending towards significance (i.e., $p < .1$) will also be discussed.

CHAPTER III

Results

Initial descriptive statistics for personality and executive functioning variables were run to look at sample characteristics (see Table 1). Overall, results yielded values consistent with values obtained in the normative sample group, suggesting that our sample group is not drastically different than the groups on which the tests were originally normed. Skewness and kurtosis values indicated most variables were normally distributed, however D-KEFS Trails Condition 4 and D-KEFS Color-Word Condition 2 tended to have a longer tail on the lower end of the distribution and were more sharply peaked than a normal distribution. Specifically, this indicates that fewer participants performed below average and there were more outliers on these two tests. Although these patterns emerged, they did not deviate enough from normality to warrant data transformation.

Table 1

Descriptive Statistics for Study Variables

Variable	*M*	*SD*	Range	Skewness	Kurtosis
Neuroticism	51.8	11.0	20-80	-0.04	-0.37
Extraversion	50.1	12.7	20-78	-0.08	-0.38
Openness to Experience	54.1	12.3	24-80	0.01	-0.41
Agreeableness	51.0	10.6	20-80	0.09	0.5
Conscientiousness	53.1	11.0	22-80	-0.03	-0.09
D-KEFS Trails Condition 3	8.5	3.2	1-15	-0.61	-0.03

(continued)

D-KEFS Trails Condition 4	9.1	2.4	1-14	-0.98	1.44
D-KEFS Verbal Fluency Condition 1	11.0	2.8	3-19	0.2	0.3
D-KEFS Verbal Fluency Condition 2	11.5	3.2	4-19	0.46	-0.13
D-KEFS Verbal Fluency Condition 4	11.0	2.9	1-19	-0.07	0.48
D-KEFS Color-Word Condition 1	10.0	2.7	1-15	-0.79	0.88
D-KEFS Color-Word Condition 2	10.5	2.7	1-15	-1.25	2.63
D-KEFS Color-Word Condition 3	10.7	2.7	3-17	-0.59	0.45
D-KEFS Color-Word Condition 4	10.5	2.5	2-15	-0.85	0.84
WCST Perseverative Errors	52.8	13.3	20-80	-0.9	-0.06
WCST Nonperseverative Errors	51.3	9.2	22-71	-0.68	-0.02
WASI FSIQ-2	98.9	9.9	65-129	0.73	0.36

Note. D-KEFS = Delis-Kaplan Executive Functioning System; WCST = Wisconsin Card Sort Test; Color-Word = Color-Word Interference; WASI FSIQ-2 = Wechsler Abbreviated Scale of Intelligence, Second Edition, Two-Factor Full Scale Intelligence Quotient

Correlations Between Study Variables

Correlations were run between personality factors and individual executive functioning tests (see Table 2). Between personality variables, Neuroticism was significantly and negatively correlated with Agreeableness and Conscientiousness, and Openness to Experience was significantly and positively correlated with Extraversion. These patterns are consistent with the extant literature surrounding the Big Five personality traits (McCrae & Costa, 2010). Additionally, Openness to Experience was significantly and positively correlated with WASI-II FSIQ-2 scores, which is consistent with literature suggesting that individuals with higher levels of Openness to Experience tend to have higher levels of intelligence (DeYoung et al., 2005; DeYoung, Quilty, Peterson, & Gray, 2014).

Table 2

Pearson Correlations Across Personality and Executive Functioning Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Neuroticism	-	**-.16**	.09	***-.22***	***-.55***	-.08	.01	-.12	<.00	-.02	-.08	.07	.06	.02	-.02	-.11	-.11	-.11	-.10	-.02
2. Extraversion		-	***.32***	**.16**	**.15**	.08	.10	.14	.07	.06	.03	.06	.10	.02	-.03	-.03	-.04	-.04	-.02	.02
3. Openness to Experience			-	.07	**-.17**	-.04	.10	**.15**	**.15**	.03	-.03	.20	-.02	.07	.02	<.00	-.04	-.02	.02	***.34***
4. Agreeableness				-	***.36***	<.00	-.03	.03	.04	-.03	-.02	-.09	-.02	.03	.01	.09	.10	.11	.05	.02
5. Conscientiousness					-	.06	-.04	.01	-.09	-.02	-.01	-.10	-.04	-.05	-.04	-.06	-.07	-.05	-.06	-.09
6. D-KEFS Trails 3						-	***.49***	.14	**.16**	***.30***	***.31***	***.35***	***.30***	***.27***	***.32***	.09	.09	***.09***	***.08***	***.23***
7. D-KEFS Trails 4							-	***.38***	***.25***	***.29***	***.26***	***.36***	***.26***	***.43***	***.34***	***.24***	***.22***	***.23***	***.23***	***.23***
8. D-KEFS Verbal Flu. 1								-	***.47***	**.19**	***.15***	***.38***	***.40***	***.31***	***.19***	*.13*	.11	*.12*	.12	**.15**
9. D-KEFS Verbal Flu. 2									-	***.42***	***.35***	***.27***	**.28**	***.19***	***.19***	.07	.05	.05	.08	**.17**
10. D-KEFS Verbal Flu. 3										-	***.94***	***.24***	***.20***	***.27***	***.25***	.03	.01	.01	.04	**.19**
11. D-KEFS Verbal Flu. 4											-	***.19***	***.18***	***.28***	***.27***	.07	.03	.04	.07	**.19**
12. D-KEFS Color-Word 1												-	***.70***	***.60***	***.49***	<.00	-.02	-.01	.02	**.18**
13. D-KEFS Color-Word 2													-	***.50***	***.41***	-.09	-.05	-.05	-.09	.08
14. D-KEFS Color-Word 3														-	***.59***	.10	.11	.11	.05	***.30***
15. D-KEFS Color-Word 4															-	.07	*.13*	*.14*	-.01	**.19**
16. WCST Total Err.																-	***.86***	***.87***	***.94***	***.26***
17. WCST Persev. Resp.																	-	***.99***	***.65***	**.18**
18. WCST Persev. Errors																		-	***.67***	***.20***
19. WCST Nonpersev. Err.																			-	***.25***
20. WASI-II FSIQ-2																				-

Note. Values in *italics,* $p < .1$; values in **bold**, $p < .05$; values in ***italics and bold***, $p < .01$; D-KEFS = Delis-Kaplan Executive Functioning System; Flu. = Fluency; WCST = Wisconsin Card Sort Test; Err. = Errors; Persev. = Perseverative; Nonpersev. = Nonperseverative; WASI-II FSIQ-2 = Wechsler Abbreviated Scale of Intelligence, Second Edition, Full Scale Intelligence Quotient - Two Factor

In regards to executive functioning variables, tests from the D-KEFS were all significantly and positively correlated with one another, with one exception. D-KEFS Trails Condition 3 (i.e., letter sequencing) was not significantly correlated with D-KEFS Verbal Fluency Condition 1 (i.e., letter fluency) or D-KEFS Verbal Fluency Condition 2 (i.e., category fluency). Variables from the WCST were not significantly related to D-KEFS variables, with the exception of being significantly and positively correlated with D-KEFS Trails Condition 4 (i.e., letter-number switching). Scores from the WASI-II FSIQ-2 were significantly and positively correlated with all of the executive functioning variables except D-KEFS Color-Word Condition 2 (i.e., color naming). Overall, the significant correlations between executive functioning variables are consistent with previous literature (Delis et al., 2001; Homack et al., 2005; Latzman & Markon 2010). Between personality and executive functioning variables, the only significant correlations yielded were between Openness to Experience and D-KEFS Verbal Fluency Condition 1 (i.e., letter fluency), as well as Openness to Experience and D-KEFS Verbal Fluency Condition 2 (i.e., category fluency), which is consistent with findings from Murdock and colleagues (2013).

Results of the Factor Analyses

The two subtests from the D-KEFS Trails Test yielded a single-factor structure, suggesting that the subtests measure a unitary construct. Specifically, Trails Condition 3 and Trails Condition 4 yielded a single underlying factor with an eigenvalue of 1.49, accounting for 74.3% of the variance underlying the individual scales. Additionally, the four subtests from the D-KEFS Color-Word Interference Test yielded a single-factor structure. The D-KEFS Color-Word Interference subtests (i.e., Word Reading, Color

Naming, Inhibition, and Inhibition/Switching) yielded a single underlying factor with an eigenvalue of 2.65, accounting for 66.3% of the variance underlying the individual scales. Using the four scores from the D-KEFS Verbal Fluency Test, an initial factor analysis was conducted to ensure the variables reflected a unitary construct. The factor analysis yielded a two-factor structure. Upon investigation, Verbal Fluency Condition 3 and Verbal Fluency Condition 4 were too highly correlated ($\alpha = .94$), indicating that one of the two variables could be deleted. As these two variables are derived from the same Verbal Fluency subtest (i.e., Condition 3 = total items correct, Condition 4 = accuracy in switching categories), it was decided that Condition 3 would be excluded from the factor analysis. A second factor analysis, using Verbal Fluency Conditions 1, 2, and 4, yielded a single underlying factor with an eigenvalue of 1.66, accounting for 55.4% of the variance underlying the individual scales. Using the four variables from the WCST, an initial factor analysis was conducted to confirm a single underlying construct. Although a single-factor model was found, it was decided to eliminate two variables to reduce the significant amount of covariance between variables. Specifically, the correlation between WCST Total Errors and WCST Nonperseverative errors ($\alpha = .94$) and the correlation between WCST Perseverative Responses and WCST Perseverative Errors ($\alpha = .99$) were too high to warrant all four variables being included in the factor analysis. WCST Perseverative Errors and WCST Nonperseverative Errors were retained as the variables to comprise this unitary construct. A second factor analysis, using WCST Perseverative Errors and WCST Nonperseverative Errors, was conducted and yielded a single underlying factor with an eigenvalue of 1.67, accounting for 83.6% of the variance underlying the individual scales.

An exploratory factor analysis (EFA) using an orthogonal rotation was conducted using all executive functioning variables deemed appropriate from the initial factor analyses (i.e., D-KEFS Trails Condition 3, D-KEFS Trails Condition 4, D-KEFS Verbal Fluency Condition 1, D-KEFS Verbal Fluency Condition 2, D-KEFS Verbal Fluency Condition 4, D-KEFS Color Word Interference Condition 1, D-KEFS Color Word Interference Condition 2, D-KEFS Color Word Interference Condition 3, D-KEFS Color Word Interference Condition 4, WCST Perseverative Errors, and WCST Nonperseverative Errors). Principal component analysis was used to identify and compute composite scores for the factors that underlie executive functioning tests. Both eigenvalues and the scree plot (see Figure 1) indicated that a four-factor model was the best fit.

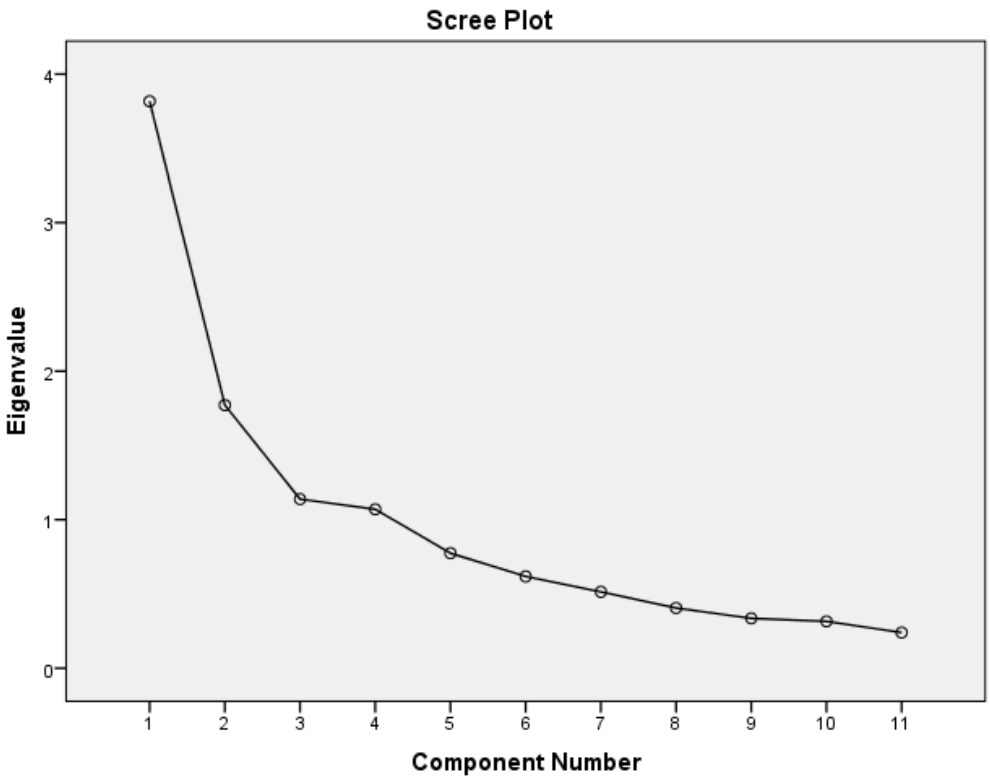

Figure 1. Exploratory factor analysis scree plot for executive functioning factors.

Factor 1 yielded an eigenvalue of 3.82 and accounted for 34.7% of the variance. Factor 2 yielded an eigenvalue of 1.77 and accounted for 16.1% of the variance. Factor 3 yielded an eigenvalue of 1.14 and accounted for 10.3% of the variance. Factor 4 yielded an eigenvalue of 1.07 and accounted for 9.7% of the variance. Overall, the four-factor solution explained 71% of the total variance. The factor loadings for each of the four factors are shown in Table 3.

Table 3

Rotated Component Matrix Factor Loadings for Executive Functioning Tests Using Orthogonal Rotation

	Factor Loadings			
	Factor 1: Inhibition	Factor 2: Cognitive Flexibility	Factor 3: Shifting	Factor 4: Updating
D-KEFS Verbal Fluency 1	.32	.14	-.02	**.80**
D-KEFS Verbal Fluency 2	.05	-.00	.29	**.82**
D-KEFS Verbal Fluency 4	.03	-.04	**.80**	.22
D-KEFS Trails 3	.34	.07	**.72**	-.03
D-KEFS Trails 4	.40	.33	**.49**	.21
D-KEFS Color-Word 1	**.84**	-.03	.09	.23
D-KEFS Color-Word 2	**.76**	-.15	.03	.32
D-KEFS Color-Word 3	**.80**	.10	.19	.07
D-KEFS Color-Word 4	**.71**	.06	.31	-.05
WCST Perseverative Errors	.05	**.90**	.03	.01
WCST Nonperseverative Errors	-.06	**.89**	.05	.08

Note. D-KEFS = Delis-Kaplan Executive Functioning System; WCST = Wisconsin Card Sorting Test

Following the EFA conducted using an orthogonal rotation, researchers reran the EFA using an oblique rotation to compare factor structures. Overall, the factor structure

obtained using an oblique rotation was fairly similar to the factor structure obtained in the orthogonal rotation. The most notable difference was almost all variables cross-loaded onto the Inhibition factor, which may indicate that many tests of executive functioning require some inhibitory processes.

Multiple Regression of Executive Functioning Factors with Personality Variables

Prior to running the regression, bivariate correlations were run between the four factors, personality, and intelligence (See Table 4). The only significant correlation between factors and personality variables was between Updating and Openness to Experience. Inhibition, Cognitive Flexibility, and Shifting were significantly and positively correlated with intelligence.

Table 4

Pearson Correlations Across Executive Functioning Factors and Personality

	1	2	3	4	5	6	7	8	9	10
1. Factor 1: Inhibition	-	<.00	<.00	<.00	.06	.05	.05	-.03	-.06	**.17**
2. Factor 2: Cognitive Flexibility		-	<.00	<.00	-.11	-.03	.02	.08	-.06	***.23***
3. Factor 3: Shifting			-	<.00	-.07	.05	-.02	-.02	*.03*	***.22***
4. Factor 4: Updating				-	-.04	*.13*	**.18**	.04	-.02	.11
5. Neuroticism					-	**-.16**	.09	***-.22***	***-.55***	-.02
6. Extraversion						-	***.32***	**.16**	**.15**	.02
7. Openness to Experience							-	.07	**-.17**	***.34***
8. Agreeableness								-	***.36***	.02
9. Conscientiousness									-	-.09
10. WASI FSIQ-2										-

Note. WASI FSIQ-2 = Wechsler Abbreviated Scale of Intelligence, Full Scale Intelligence Quotient, Two-Factor

Personality variables together did not significantly predict Inhibition, F (5, 176) = .35, p = .88, accounting for only 1% of the variance. Additionally, no individual personality variables significantly predicted Inhibition scores. Personality variables together were not a significant predictor of Cognitive Flexibility, F (5, 176) = 1.69, p = .14, accounting for only 4.6% of the variance. However, among individual personality variables, Neuroticism (β = -.21, t = -2.34, p = .02) and Conscientiousness (β = -.21, t = -2.18, p = .03) were significant predictors of Cognitive Flexibility. Collectively, personality variables did not significantly predict Shifting, F (5, 176) = .34, p = .89, accounting for less than 1% of the variance. Furthermore, individual personality variables were not significant predictors of Shifting. Personality variables together did not significantly predict Updating, F (5, 176) = 1.50, p = .19, accounting for 4.1% of the variance. Among individual predictors, Openness to Experience predicting Updating was marginally significant, (β = .15, t = 1.83, p = .07).

Intelligence as a Moderator of the Relationship Between Personality and Executive Functioning

In regards to Inhibition, interactions between personality variables and WASI-II scores accounted for an additional 7.4% of the variance, but the results were still nonsignificant F (10, 171) = 1.56, p = .12 (see Table 5). However, among individual predictors the interaction between Openness and WASI-II scores was significant, (β = .21, t = 2.39, p = .02) and the interaction between Agreeableness and WASI-II scores trended towards significance, (β = -.15, t = -1.83, p = .07). Simple slopes indicated among participants with low WASI-II scores, Openness and Agreeableness together did not significantly predict Inhibition, F (2, 92) = 1.12, p = .33, accounting for only 2.4% of

the variance. Additionally, neither Openness, (β = -.14, *t* = -1.33, *p* = .19), or Agreeableness (β = .08, *t* = .79, *p* = .44) were significant predictors of Inhibition among participants with low WASI-II scores. Simple slopes indicated among participants with high WASI-II scores, Openness and Agreeableness together did not significantly predict Inhibition, *F* (2, 84) = 1.49, *p* = .23, accounting for 3.4% of the variance. Within the high WASI-II group, the relationship between Openness, (β = .12, *t* = 1.14, *p* = .26) and Agreeableness (β = -.15, *t* = -1.37, *p* = .18) were again nonsignificant predictors of Inhibition but the relationship was in the opposite direction as those with low WASI-II scores, which produced the significant interaction.

Table 5

Multiple Regression Analysis Predicting Inhibition

	B	*t*	*p*
Neuroticism	.04	0.41	.68
Extraversion	.06	0.78	.44
Openness to Experience	.02	0.21	.83
Agreeableness	-.02	-0.25	.80
Conscientiousness	-.04	-0.44	.66
Neuroticism x IQ	.11	1.26	.21
Extraversion x IQ	.02	0.23	.82
Openness to Experience x IQ	.21	2.39	.02
Agreeableness x IQ	-.15	-1.83	.07
Conscientiousness x IQ	.10	1.06	.29

Note. IQ = Wechsler Abbreviated Scale of Intelligence, Second Edition, Two-Factor Full Scale Intelligence Quotient

In regards to Cognitive Flexibility, interactions between personality variables and WASI-II scores accounted for an additional 6.4% of the variance, but the results were still nonsignificant, F (10, 171) = 1.17, p = .32 (see Table 6). The interaction between Openness to Experience and WASI-II scores in predicting Cognitive Flexibility was beginning to trend towards significance, (β = -.15, t = -1.63, p = .11).

Table 6

Multiple Regression Analysis Predicting Cognitive Flexibility

	B	*t*	*p*
Neuroticism	-.21	-2.34	.02
Extraversion	-.06	-0.69	.49
Openness to Experience	.01	0.10	.92
Agreeableness	.11	1.39	.17
Conscientiousness	-.21	-2.18	.03
Neuroticism x IQ	.08	0.88	.38
Extraversion x IQ	.05	0.53	.60
Openness to Experience x IQ	-.15	-1.63	.11
Agreeableness x IQ	.03	0.38	.70
Conscientiousness x IQ	-.05	-0.52	.60

Note. IQ = Wechsler Abbreviated Scale of Intelligence, Second Edition, Two-Factor Full Scale Intelligence Quotient

In regards to Shifting, interactions between personality variables and WASI-II scores accounted for an additional 3% of the variance but the results were still nonsignificant, F (10, 171) = .53, p = .87 (See Table 7). The interaction between Agreeableness and WASI-II trended towards significance, (β = -.14, t = -1.71, p = .09). Simple slopes indicated among participants with high WASI-II scores, the relationship between Agreeableness and Shifting was again nonsignificant, (β = -.13, t = -1.21, p =

.23), but in the opposite direction as those with low WASI-II scores, (β = .10, *t* = .95, *p* = .34), which produced the trending significant interaction.

Table 7

Multiple Regression Analysis Predicting Shifting

	B	*t*	*p*
Neuroticism	-.09	-0.93	.36
Extraversion	.05	0.63	.53
Openness to Experience	-.03	-0.39	.70
Agreeableness	-.04	-0.46	.65
Conscientiousness	-.03	-0.26	.80
Neuroticism x IQ	-.07	-0.73	.46
Extraversion x IQ	-.04	-0.51	.61
Openness to Experience x IQ	.07	0.81	.42
Agreeableness x IQ	-.14	-1.71	.09
Conscientiousness x IQ	.07	0.77	.45

Note. IQ = Wechsler Abbreviated Scale of Intelligence, Second Edition, Two-Factor Full Scale Intelligence Quotient

In regards to Updating, interactions between personality variables and WASI-II scores accounted for an additional 7.2% of the variance but the results were still nonsignificant, *F* (10, 171) = 1.33, *p* = .22 (See Table 8). The interaction between Neuroticism and WASI-II scores trended towards significance, (β = -.15, *t* = -1.69, *p* = .09). Simple slopes yielded results indicating that among participants with high WASI-II scores, the relationship between Neuroticism and Updating was again nonsignificant, (β = -.13, *t* = -1.24, *p* = .22), but in the opposite direction as those with low WASI-II scores, (β = .03, *t* = .30, *p* = .77), which produced the trending significant interaction.

Table 8

Multiple Regression Analysis Predicting Updating

	B	*t*	*p*
Neuroticism	-.07	-0.82	.41
Extraversion	.08	0.94	.35
Openness to Experience	.15	1.83	.07
Agreeableness	.02	0.24	.81
Conscientiousness	-.06	-0.62	.54
Neuroticism x IQ	-.15	-1.69	.09
Extraversion x IQ	-.05	-0.58	.57
Openness to Experience x IQ	-.02	-0.23	.82
Agreeableness x IQ	.10	1.19	.24
Conscientiousness x IQ	-.06	-0.69	.49

Note. IQ = Wechsler Abbreviated Scale of Intelligence, Second Edition, Two-Factor Full Scale Intelligence Quotient

When examining potential group differences between level of intelligence and personality, no significant differences were found between groups for Neuroticism, Extraversion, or Agreeableness. The mean score for Openness to Experience among participants in the high IQ group was significantly higher than the low IQ group (t = -3.93, $p < .001$). The mean score for Conscientiousness among participants in the high IQ group was significantly lower than the low IQ group (t = 1.94, p = .05). Further, based on histograms and scatter plots examining personality and factor scores divided by intelligence groups (i.e., low IQ, high IQ) it appears the distribution of scores overlap; therefore, the interactions found are not likely the result of spurious correlations.

CHAPTER IV

Discussion

The current study provides a thorough examination of the factor structure of executive functioning based on a selection of commonly used neuropsychological tests. The literature surrounding this topic is mixed, with support for one- (see Williams et al., 2010), two- (see Huizinga et al., 2006; Hull et al., 2008), three- (see Miyake et al., 2000), four- (see Unsworth et al., 2009), and five- (see Levin et al., 1996) factor models of executive functioning. The range of results produced by the literature in the surrounding area is likely, at least in part, contributable to the highly complex nature of the neurological processes that make up executive functioning and the inconsistent taxonomy used within the research surrounding it. Furthermore, individual differences including age (Huizinga et al., 2006; Hull et al., 2008), education (Davis et al., 2008), stress regulation (Williams et al., 2010), and personality (Fleming et al., 2016; Murdock et al., 2013), all contribute to executive functioning performance, which contribute to the measurement challenges. The significant amount of variability in results from studies examining executive functioning challenges researchers to interpret findings in a manner that adds to our understanding of specific neurological processes. Despite these challenges, results from the current study furthers the literature surrounding the factor structure of executive functioning, and offers additional insights into the relationship between executive functioning and personality.

A Four-Factor Model of Executive Functioning

Four commonly used neuropsychological tests of executive functioning, including the D-KEFS Trail Making Test (Conditions 3 and 4), D-KEFS Verbal Fluency Test, D-

KEFS Color-Word Interference Test, as well as the WCST, were used in an exploratory factor analysis to discern if the commonly used three-factor model of executive functioning (i.e., updating, shifting, inhibition) was supported. Results instead yielded a four-factor model. The first factor, which we named Inhibition, is reflected in all four scores from the D-KEFS Color-Word Interference Test: Word Reading, Color Naming, Inhibition, and Inhibition/Switching. This is consistent with literature surrounding Inhibition, as the 'Stroop Test,' which is essentially the same test as the D-KEFS Color-Word Inhibition Condition, is the prototypical test to assess for Inhibition (Miyake et al., 2000). Previous studies have either used the traditional Stroop task (e.g., Fleming et al., 2016) or have only used two conditions from the Color-Word Interference Test - Inhibition and Inhibition/Switching (e.g., Latzman & Markon, 2010; Murdock et al., 2013; Savla et al., 2012). Interestingly, albeit unintuitive, the present study indicated that all four Color-Word Interference Conditions loaded appropriately onto the Inhibition factor. One might presume that the Word Reading condition would load onto a separate factor (e.g., with verbal fluency tasks), as it does not inherently seem like measure of Inhibition, however this factor loading may simply be the result of shared test variance within the Color-Word Interference test. Additionally, although the Color Naming condition does not initially seem like a measure of Inhibition, there is some literature to suggest that similar color naming tasks are related to inhibitory control (Friedman & Miyake, 2004; Heij & Boelens, 2010).

The second factor, which we named Cognitive Flexibility, is reflected in two variables from the WCST: Perseverative Errors and Nonperseverative Errors. These factor loadings are consistent with previous findings (Campbell et al., 2011; Fisk &

Sharp, 2004; Murdock et al., 2013), although one study has found the WCST to load onto a factor with fluency related tasks, such as verbal fluency and design fluency (Levin et al., 1996). It is possible the WCST is in fact a measure of multiple executive functioning domains and is not able to be accurately conceptualized as a single construct. Furthermore, Miyake and colleagues (2000) used the WCST as a 'complex executive task' in their confirmatory factor analysis, instead of including it as part of one of the three traditional factors (i.e., inhibition, shifting, updating), which supports the notion that the WCST is a more difficult task than other common tasks of executive functioning.

The third factor, which we named Shifting, is reflected in one variable from the D-KEFS Verbal Fluency Test, Condition 4 - Category Switching Accuracy, and two variables from the D-KEFS Trails Test, Condition 3 – Letter Sequencing and Condition 4 – Number/Letter Switching. Previous literature using a theoretical approach to assign specific tests to factors have included similar tasks (i.e., category switching, number/letter switching) as measures of shifting (Fleming et al., 2016). In contrast, previous exploratory factor analyses have found D-KEFS Verbal Fluency Category Switching Accuracy and D-KEFS Trail Making Test Letter/Number Switching to load onto separate factors (Latzman & Markon, 2010). Specifically, Category Switching Accuracy loaded onto Monitoring/Updating, whereas Number/Letter Switching loaded onto Inhibition (Latzman & Markon, 2010).

The fourth factor, which we named Updating, is reflected in two D-KEFS Verbal Fluency Test scores: Letter Fluency and Category Fluency. These two subtests comprising a factor is consistent with previous literature, despite the inconsistent ways in which these factors have been derived. For example, one study assigned these two

variables as a measure of Updating/Monitoring based on a theoretical framework (Murdock et al., 2013); an exploratory factor analysis found these two variables to load onto a single factor, which they named Monitoring (Latzman & Markon, 2010); and yet another study using latent variable analysis found these variables to comprise a single factor, which they named Fluency (Unsworth et al., 2009).

Results of the Current Factor Structure Compared to Previous Studies

The four-factor model of executive functioning found in the present studies shares some similarities with a previous study that found a four-factor model using latent variable analysis (Unsworth et al., 2009). Unsworth and colleagues (2009) identified four factors (i.e., working memory, fluency, response inhibition, and vigilance) to be derived from seven measures of executive functioning. Although there was no overlap in measures between the present study and the study done by Unsworth and colleagues (2009), their fluency factor consisted of scores from similar tasks (i.e., semantic/category fluency and letter fluency) that loaded on our Updating factor. Although the names of these factors differ, and one could easily argue that 'fluency' is a better descriptor of the abilities being measured, 'updating' or "updating/monitoring' seem to be the most commonly used terms to describe letter fluency and category fluency (see Latzman & Markon, 2010; Murdock et al, 2013). It is difficult to compare the remaining three factors (i.e., working memory, response inhibition, vigilance) found by Unsworth and colleagues (2009) with the remaining three factors (i.e., inhibition, cognitive flexibility, shifting) in the present study due to the significant differences in measures between studies. Although the names of the factors are similar, and appear intuitively to be measuring the same construct, the factors are derived from tests that are challenging to

compare. For example, Response Inhibition was comprised of Antisaccade (i.e., participants stare at a fixation point on a computer screen and identify letters flashed onto the screen) and Arrow Flankers (i.e., participants stare at a fixation point on a computer screen and identify the direction of an arrow flashed on the screen; Unsworth et al., 2009). In the present study, Inhibition was comprised of the four conditions from the D-KEFS Color-Word Interference Test. While it is fair to presume these two factors are both measuring skills associated with cognitive inhibitory control, the tests are not necessarily comparable. However, although the measures used between studies were vastly different, the fact that a similar factor structure was still found using tests that do not appear on the surface to be comparable may be relevant in conceptualizing inhibition as an independent construct. Another difference to consider is Unsworth and colleagues (2009) allowed their factors to correlate with one another, whereas the present study used an orthogonal rotation to preserve simple structure (Tabachnick & Fidell, 2006).

It is also worth considering how the present findings are consistent and inconsistent from the two recent studies (Fleming et al., 2016; Murdock et al., 2013) that largely guided the hypotheses and research methodology for the current study. A three-factor model of executive functioning has been widely supported in the literature, and was used as a theoretical basis by both Fleming and colleagues (2016) and Murdock and colleagues (2013) to assign specific measures to factors. Although a three-factor model consisting of inhibition, shifting, and updating was proposed by Fleming and colleagues (2016), latent variable analyses found the model best suited to their measures to be a three-factor structure comprised of included shifting, updating, and a common executive functioning factor. Out of the nine executive functioning tasks used by Fleming and

colleagues (2016), the only measure to overlap with the present study was the Stroop task, which is analogous to the D-KEFS Color-Word Interference Test. Previous results found the Stroop task to fall under a common executive functioning factor, rather than inhibition (Fleming et al., 2016). This is particularly intriguing as the Stroop task has been considered the prototypical measure for inhibition since its development in 1935 (Miyake et al., 2000; Stroop, 1935). Further, Fleming and colleagues (2016) used all computerized measures of executive functioning, whereas the present study used examiner administered tests. The differences in factor structure and measures used makes comparison across studies challenging. The present study has more similarities to the work done by Murdock and colleagues (2013) in terms of measures used. Specifically, both studies used the D-KEFS Verbal Fluency Test, D-KEFS Color-Word Interference Test, and the WCST; however, Murdock and colleagues (2013) assigned these measures to factors based on theory, whereas the current study conducted an EFA to determine the appropriate factor loadings. Despite these differences, there were consistencies between factor structures. Specifically, scores from the WCST were a single factor, Cognitive Flexibility, and scores from the Color-Word Interference Test were a single factor, Inhibition. The current study used an additional measure of executive functioning, two conditions from the D-KEFS Trail Making Test, which likely accounts for the fourth factor found. However, previous studies examining the factor structure of the D-KEFS tests found scores from the Trail Making Test to load onto the same factor as scores from the Color-Word Interference Test (Latzman & Markon, 2010). This contradictory finding may be at least partially explained by the difference in sample groups used. Specifically Latzman and Markon (2010) used the normative sample group

from the D-KEFS technical manual, which was geographically diverse and included 1,750 participants between the ages of 8- and 89-years-old, whereas the present study had a sample group of 186 participants between the ages of 18- and 34-years-old from a single geographic location.

Clearly, there is great variability in how executive functioning measures are being conceptualized and great inconsistency among factor analyses with measures of executive functioning. While the results of the current study are inconsistent with a three-factor model of executive functioning, they provide further evidence as to the level of complexity and overlap among such measures. Moreover, the present study expands upon the previous literature by including tests that have been excluded from similar studies (i.e., D-KEFS Trail, Making Test, conditions 1 and 2 from the D-KEFS Color-Word Interference Test). Another contribution from the present study is the implication that these commonly used measures of executive functioning are correlated with one another and appear to form distinct clusters. Neuropsychological tests were originally designed to detect and diagnose brain damage, not assess an individual's level of executive functioning, however these tests were quickly reframed to be used as such with minimal validation studies, leaving clinicians with little empirical guidance on which to base their use of and interpretation of neuropsychological measures. While these tests are often administered and/or interpreted individually, it may be more meaningful to instead focus on interpreting the tests that fall within a single factor collectively. This is a practice that is already widely used in cognitive and academic achievement psychological assessments. For example, the Wechsler Adult Intelligence Scale, Fourth Edition (WAIS-IV; Wechsler, 2008) yields an overall intelligence quotient, as well as four index

scores, in addition to the ten subtest scores. It is common practice to interpret the index scores as opposed to the subtests scores, as the index score is assumed to provide a more accurate picture of an individual's abilities within that area. Similarly, with executive functioning tests, it may be wise to administer and interpret multiple tests that fall within the same domain rather than to arbitrarily pick and interpret individual tests. By creating neuropsychological test instruments that include domains of executive functioning comprised of multiple tests, clinicians may be able to provide more accurate information about an individual's level of functioning and it may help to reduce the inconsistencies that are currently abundant within the literature.

Executive Functioning and Personality

Similar to the research surrounding the factor structure of executive functioning, the research examining the relationship between executive functioning and personality has significant variability. The present results yielded few significant relationships between executive functioning factors and individual personality variables. Updating was significantly and positively correlated Openness to Experience. Although statistical significance was not reached, there was a trend for Openness to Experience to predict Updating performance. As such, individuals with higher levels of Openness to Experience tend to perform better on Updating tasks. These findings are consistent with previous literature suggesting that Openness has a significant and positive relationship with Updating (DeYoung et al., 2005; Murdock et al., 2013; Unsworth et al., 2009), and appears to be one of the most consistent findings in the literature surrounding executive functioning and personality. Present results indicated Neuroticism to be a significant predictor of Cognitive Flexibility. It should be noted that the two scores underlying

Cognitive Flexibility represent errors made on the WCST, where higher scores reflect a higher number of perseverative and/or nonperseverative errors. Specifically, the relationship found between Neuroticism and Cognitive Flexibility was negative, such that higher levels of Neuroticism predicted fewer errors on Cognitive Flexibility tasks. Similarly, Conscientiousness significantly predicted Cognitive Flexibility, such that higher levels of Conscientiousness predicted fewer errors on Cognitive Flexibility tasks. Related to recent literature, one of the primary findings from Fleming and colleagues (2016) was the association between Conscientiousness and Shifting, suggesting that Conscientiousness may be better understood as a trait related to rule learning and cognitive agility. This idea has been proposed in prior literature that found Conscientiousness to be a strong predictor of 'effortful control,' as measured by the WCST (Jensen-Campbell et al., 2002). Notably, the present study found Conscientiousness to be a significant predictor of Cognitive Flexibility, which is comprised of two WCST scores. Despite the vast differences in nomenclature, it appears that when investigated more thoroughly, Conscientiousness has a meaningful relationship with cognitive skills associated with flexibility/agility, sorting principles, and rule learning. None of the Big Five personality traits independently were significant predictors of Inhibition or Shifting. The lack of findings related to Inhibition is surprising given the research supporting a relationship between Neuroticism and Inhibition (Thake & Zelenski, 2013; Vreeke & Muris, 2012), as well as Conscientiousness and Inhibition (DeYoung, 2010; Eisenberg, Duckworth, Spinrad, & Valiente, 2014). Additionally, previous literature provides support for a relationship between Extraversion and Shifting (Campbell et al., 2011). The inconsistencies in

findings across studies is likely best accounted for by the difference in research designs and executive functioning measures.

Using intelligence as a moderator between personality and executive functioning yielded few significant findings, which to our knowledge, has not been accounted for in previous research. Although previous studies have examined the relationship between intelligence and executive functioning (Unsworth et al., 2009; Van Aken, Kessels, Wingbermühle, Van der Veld, & Egger, 2016), examining moderation effects seems to be a novel approach, thereby adding valuable insight to the current literature in the surrounding area. Specifically, intelligence appears to moderate the relationship between Openness to Experience and Inhibition. Interestingly, while not significant, the direction of the relationship between Openness to Experience and Inhibition is opposite for individuals scoring high on the WASI-II compared to those scoring low on the WASI-II. Among those who score low on the WASI-II the relationship between Openness to Experience and Inhibition was negative, whereas high WASI-II scores yielded a positive relationship between Openness to Experience and Inhibition. This pattern was seen throughout all interactions trending towards significance. Specifically, trends suggest intelligence may moderate the relationship between Agreeableness and Inhibition, Agreeableness and Shifting, as well as Neuroticism and Updating.

Theoretical and Clinical Implications

Neuropsychological assessments utilizing measures of executive functioning are becoming increasingly common practice for a multitude of referral questions. The finding of a four-factor model of executive functioning is relevant in order to better understand what cognitive skills we are assessing when using common measures such as

the D-KEFS and the WCST, and to appreciate the other variables that may influence test performance. The history and use of neuropsychological assessments has been the topic of skepticism by many clinicians and researchers because of the unconventional way in which they came to be used (Chan et al., 2008; Lezak et al., 2012). Conducting more thorough research, including validation studies, factor analyses, and examining potential latent variables, may help to increase the ecologically validity and clinical usefulness of neuropsychological assessments. Specifically, if neuropsychological test batteries are made to look more similar to other psychological assessments (e.g., with cluster, domain, or index scores), clinicians may be able to make more accurate conclusions about an individual's level of functioning. Specifically, adopting an approach to neurological assessments that tests skills by domains, rather than individual tests, will help increase construct validity. The use of multiple tests to determine an individual's ability level within a specific domain lends itself to greater accuracy when interpreting scores. Additionally, better understanding how neurologically intact populations perform on executive functioning tasks will help clinicians interpret test results, as these tests have been traditionally used with neurologically impaired populations.

Limitations and Future Directions

Noteworthy considerations were found within the factor structure of executive functioning, in addition to the personality/executive functioning relationship, however the present study has limitations that need to be recognized. The study was conducted using an undergraduate sample at a single university, which decreases the ability to generalize the results to a greater population. In terms of neuropsychological tests, it must be acknowledged that these tests were originally intended to detect neurological dysfunction

and may lack sufficient sensitivity to accurately assess executive functioning among neurologically intact populations (Suchy, 2009; Williams et al., 2009). Additionally, although this study used a more robust measure of personality compared to some previous studies, intelligence scores were derived from two subtests of the WASI-II. While the WASI-II is shown to be an adequate screener of intelligence, it is not a comprehensive measure of intelligence. Furthermore, one of the greatest limitations may be the inherent difficulty in interpreting factors derived from using an orthogonal rotation technique, as the factors are not allowed to correlate with one another and the executive functioning tests used may in fact be measuring multiple domains of executive functioning (Miyake et al., 2000). This may also be the reason why the literature surrounding the factor structure of executive functioning is so varied and inconsistent.

Future directions should include a replication of this study using a more diverse sample group (e.g., wider age range, multiple geographic locations). Obtaining data from a broader range of individuals may offer greater insight into the factor structure of executive functioning, as well as its relationship with personality. Further, replication of this study using a neurologically impaired population may provide valuable information to be applied clinically, with a population that more closely resembles those individuals who are referred for neuropsychological evaluations in the community. Additionally, based on previous literature, working memory may be more accurately represented as a factor of executive functioning as opposed to intelligence (Fleming et al., 2016; Miyake et al., 2000; Unsworth et al., 2009). Future studies may benefit from the inclusion of additional working memory tasks. Due to the inconsistencies in the literature, it may be of benefit to conduct a study utilizing the same measures that have

been used not only in this study, but previous similar studies (e.g., Fleming et al., 2016; Murdock et al., 2013; Unsworth et al., 2019; Williams et al., 2010). As such, a study using multiple previously used measures would allow researchers to conduct a confirmatory factor analysis to better determine what factor structure truly represents executive functioning. Further, a meta-analysis of the previous studies may provide a better understanding of the underlying factor structure of executive functioning. Given the significant findings of intelligence moderating the relationship between personality and executive functioning, future research may benefit from using a more comprehensive measure of intelligence. It may also be worthwhile for future research to intentionally sample at the low and high end of intelligence to get a larger spread of IQ scores and to be able to break intelligence down into low, average, and high categories rather than simply splitting intelligence at the mean. Lastly, the neuropsychological assessment field would likely benefit from the development of specific executive functioning measures designed to be used with neurologically intact populations, as the usage of these types of instruments becomes more routinely included in psychological assessments.

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APPENDIX

Sam Houston State University
Department of Psychology and Philosophy

Informed Consent to Participate in Research

You are being asked to participate in a research study. This form provides you with information about the study. Please read the information below and ask questions about anything you do not understand before deciding whether or not to take part in the study. Your participation is entirely voluntary and you can refuse to participate without penalty.

Title of Research: Personality's Influence on Neurocognitive Functioning

Principal Investigator: Charlotte R. Pennington, M.A.
Faculty Sponsor: Adam T. Schmidt, Ph.D.

Purpose of this study: We are interested in learning more about the relationship between personality and cognitive skills such as memory, problem solving, attention, etc. We are especially interested in how psychological tests can be predicted from other factors.

Time: Completing this study will take **approximately THREE hours** of your time.

Your role: If you decide to participate in this study, you will be asked to complete a series of questionnaires. First, you will provide demographic information and beliefs/ratings of yourself on several questionnaires. You will then be asked to complete a series of performance tests that evaluate skills such as problem solving, fluency (how fast you can do something), verbal skills, and how you make decisions. A brief (approximately 5 minutes) audio recording will be taken during one task. This is entirely for scoring purposes to ensure that the researcher correctly scores the task. The audio recording will be listened to immediately after the conclusion of testing and then destroyed. After the assessment you will be able to ask questions about the study and have a chance to provide your e-mail so the researchers can send you a final copy of any publications that result from the study. Due to the experimental nature of the research, no specific information regarding your performance will be available.

Possible discomfort or risk: The questionnaire asks you to provide information about your beliefs. If these questions make you feel uncomfortable, you may withdraw from participation at any time. Some of the cognitive tasks can be long and sometimes boring. If you get tired or bored, ask the researcher and you can take a break. There are no additional foreseeable risks to you. If you wish to discuss the information above or any other risks you may experience, you may ask questions now or contact the principal investigator listed above.

Benefits: If you participate in this study and are recruited from the PeRP system, you will receive three hours' worth of research credit to satisfy your course requirements, either for research or extra credit depending on the class. If you participate in this study and are recruited from campus organizations or classes, you will receive three hours of community service. You may also gain insight into some of the tests used in neuropsychological research and practice.

Options available should you decide not to participate: Participation in this study is entirely voluntary. You are free to refuse to be in the study, and your refusal will not influence current or future relationships with Sam Houston State University, the College of Humanities and Social Sciences, or the Department of Psychology and Philosophy.

You are free to withdraw your consent and stop participation in this research study at any time without penalty.

If you have questions about your rights as a research participant, please contact Donna Desforges, Ph.D., Chair, Protection of Human Subjects Committee, Sam Houston State University at (936) 294-1178 or psy_dmd@shsu.edu.

If you have any questions about the details of this research study, contact Adam T. Schmidt, Ph.D. at (936) 294-1177 or ats013@shsu.edu.

Privacy and confidentiality: Consent forms, anonymously coded questionnaires, and scored protocols will be kept separately, all in locked files in the Neuropsychology Lab at Sam Houston State University. In this way, your name or identifying information cannot be traced back to your responses. Also, nobody beyond the research team will have access to your data. The brief audio recording will be deleted immediately after the testing session and no further records of it will be maintained.

Authorized persons from Sam Houston State University and members of the Protection of Human Subjects Committee have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by law. Your research records will not be released without your consent unless required by law or a court order.

If the results of this research are published or presented at scientific meetings, your identity will not be disclosed. All results will be presented in aggregate (i.e., your results will be combined with those from other participants), which will further reduce identification of specific individuals.

Who should I contact if I have questions?: The researcher conducting this study is Charlotte Pennington. You may ask any questions you have now. If you have questions later, you may contact the researcher at: Phone: 936-294-2458 or Email: crp007@shsu.edu

Researcher Supervisor:
Dr. Adam T. Schmidt
Department of Psychology & Philosophy
ats013@shsu.edu
936-294-1177

Rights as a research subject: If you feel you have not been treated according to the descriptions in this form, or you have any questions about your rights as a research participant, you may call the Office of Research and Sponsored Programs – Sharla Miles at 936-294-4875 or e-mail ORSP at sharla_miles@shsu.edu.

You may choose not to participate or to stop your participation in this research at any time. Your decision whether or not to participate will not affect your current or future relations with the University.

If you are a student, this will not affect your class standing or grades at SHSU. The investigator may also end your participation in the research. If this happens, your class standing or grades will not be affected and you will still be given credit for all three hours of participation.

Consent: I have read and understand the above information, and I willingly consent to participate in this study. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I agree to participate in this research. I have received a copy of this consent form.

_____

Printed Name of Participant

_____

Signature of Participant Date

_____

Signature of Principal Investigator Date

VITA

Charlotte Renée Pennington

EDUCATION

August 2013 – Present — ***Doctor of Philosophy in Clinical Psychology***
Sam Houston State University
Huntsville, Texas
Dissertation: A four-factor model of executive functioning: The relationship between personality, intelligence, and executive functioning (defended 05/2017)

May 2013 — ***Master of Arts in Clinical Psychology***
Sam Houston State University
Huntsville, Texas
Thesis: An examination of clinical moderators of psychopathy and suicidal ideation in a correctional sample (defended 10/2012)

December 2010 — ***Bachelor of Science in Psychology, Cum Laude***
Sam Houston State University
Huntsville, Texas
Minor: Human Services

CLINICAL EXPERIENCE

August 2016 – February 2017 — ***University of Texas – Harris County Psychiatric Center***
Houston, Texas

Setting: Secure Inpatient Facility

Population: Primarily low income, multi-ethnic children, adolescents, and adults

Responsibilities:

- Provide group therapy; topics include emotional processing, interpersonal effectiveness, mindfulness, and basic psychological skills (e.g., behavioral activation, adaptive coping skills, cognitive restructuring, etc.).
- Provide individual therapy using empirically-supported treatments (e.g., CBT, MI, elements of DBT, etc.) to adolescents on acute and justice-related units.
- Maintain a long-term therapy caseload of at least four adolescent offenders and offer short-term therapy to children and adolescents on the acute care unit.
- Complete assessments using diagnostic, intellectual, achievement, personality, and neuropsychological measures.

- Participate in weekly consultation and collaboration with treatment teams, and juvenile justice personnel.
- Attend and present in weekly case conferences.

Supervisors: Elaheh Ashtari, Psy.D. Madvi Reddy, Ph.D., Ana Ugueto, Ph.D., & Margaret Wardle, Ph.D.

August 2015 – July 2016 ***Harris County Juvenile Probation Department***
Houston, Texas

Setting: Juvenile Justice Intake and Detention Facility

Population: Primarily low income, multi-ethnic justice-involved adolescents

Responsibilities:
- Conducted mental health screenings and integrated psychological assessments (i.e., intelligence, achievement, and personality testing).
- Authored integrated assessment reports for juvenile courts.
- Provided treatment and placement recommendations.
- Co-facilitated psychoeducational groups (communication skills, stress management, healthy relationships) for adjudicated females in a 30-day treatment program.
- Maintained a caseload of short- and long-term individual therapy clients.
- Co-facilitated a group for adolescent sex offenders.

Supervisors: Uche Chibueze, Psy.D., ABPP, & Nicole Dorsey, Ph.D.

November 2014 – October 2015 ***Psychological Services Center***
Sam Houston State University
Huntsville, Texas

Setting: Community Mental Health Clinic; Texas Department of Corrections

Population:
- Justice-involved juveniles and adults

Responsibilities:
- Conducted court-ordered evaluations of competency to stand trial and mental state at time of alleged offense under direct supervision
- Co-authored reports providing diagnostic opinions, psycholegal formulations, and recommendations.
- Conducted and reported diagnostic evaluations for juvenile probation departments and provided placement and treatment recommendations.

Supervisors: Mary Alice Conroy, Ph.D., ABPP, & Darryl Johnson, Ph.D.

September 2013 – May 2017 ***Psychological Services Center***
Sam Houston State University
Huntsville, Texas

Setting: Community Mental Health Outpatient Clinic

Population: Primarily low income, multi-ethnic children, adolescents, and adults

Responsibilities:

- Conducted comprehensive psychodiagnostic, psychoeducational and neuropsychological evaluations.
- Authored integrated reports, including diagnostic opinions and recommendations.
- Delivered in-person evaluation feedback
- Provided individual psychotherapy to adults and adolescents with emphasis on empirically supported treatments (e.g., CBT, DBT, MI, IPT, ACT, TF-CBT, etc.).
- Engaged in treatment planning, discharge planning, and suicide risk management.
- Attended and presented case conferences.
- Attended weekly clinic meetings to staff and discuss new and existing assessment and therapy cases.

Supervisors: Darryl Johnson, Ph.D., David Nelson, Ph.D. ABPP, Adam Schmidt, Ph.D, & Lisa Kan, Ph.D.; Jorge G. Varela, Ph.D.

August 2012- December 2012 *Touchstone Neurorecovery Center*
Conroe, Texas

Setting: Post-Acute Neurorehabilitation Residential Center

Population: Adults with brain injuries and/or spinal cord injuries

Responsibilities:

- Provided individual therapy to persons with traumatic brain injuries and spinal cord injuries.
- Co-facilitated cognitive therapy and relaxation groups.
- Attended and participated in treatment team meetings.
- Administered, scored, and interpreted neuropsychological, cognitive, and personality assessments.
- Documented interactions with patients and wrote clinical notes for each individual and group therapy session.

Supervisor: Cynthia Bailey, Ph.D.

RESEARCH POSITIONS

June 2016 – Present ***Exercise and Health Behaviors Laboratory***
Sam Houston State University
Huntsville, Texas

Title: Research Assistant

Responsibilities:
- Participate in bi-weekly research team meetings to discuss current research projects and grant proposals.
- Conduct literature reviews and help write grant proposals.

Supervisor: Craig E. Henderson, Ph.D.

August 2013 – May 2016 ***Resilience and Social Cognition Laboratory***
Sam Houston State University
Huntsville, Texas

Title: Research Project Coordinator

Responsibilities:
- Administered a battery of cognitive, neuropsychological, and personality assessments to undergraduate research participants.
- Database construction and input.
- Data analysis.
- Authored two conference presentations and journal manuscript (in preparation)

Title: Research Assistant

Responsibilities:
- Conducted literature reviews.
- Co-Authored book chapter.

Supervisor: Adam T. Schmidt, Ph.D.

August 2012- May 2013 ***Personality, Diversity, and the Law Laboratory***
Sam Houston State University
Huntsville, Texas

Title: Research Assistant

Responsibilities:
- Conducted literature reviews, input data, and assisted in data analysis.
- Assisted writing the initial draft of a manuscript, edited final manuscript and drafted revision letters.
- Supervised and mentored an undergraduate research assistant.

Supervisor: Robert J. Cramer, Ph.D.

January 2012-August 2012	***Laboratory for the Study of Self-Perception and Other-Attribution in Context*** **Sam Houston State University** **Huntsville, Texas**
Title:	Research Assistant
Responsibilities:	• Conducted literature reviews and input data into SPSS. • Responsible for managing group administered data collection sessions.
Supervisor:	Audrey Miller, Ph.D.

August 2011-May 2012	***Personality, Diversity, and the Law Laboratory*** **Sam Houston State University** **Huntsville, Texas**
Title:	Research Assistant
Responsibilities:	• Attended jury selection at local courts to recruit research participants. • Responsible for managing group administered data collection sessions. • Conducted literature reviews. • Entered and verified data.

PUBLICATIONS

Pennington, C. R., Cramer, R. J., Miller, H. A., & Anastasi, J. S. (2015). Psychopathy, depression, and anxiety as predictors of suicidal ideation in offenders, *Death Studies, 39*, 288-295. doi: 10.1080/07481187.2014.991953

Cramer, R.J., Kehn, A., **Pennington, C.R.,** Wechsler, H.J., Clark, J.W., & Nagle, J. (2013). An examination of sexual orientation- and transgender-based hate crimes in the post-Matthew Shepard era. *Psychology, Public Policy, and Law,* 19, 355-368. doi: 10.1037/a0031404

BOOK CHAPTERS

Schmidt, A., Ridge, B., & **Pennington, C R.** (2015). An overview of facial affect recognition deficits following traumatic brain injury in children and adults. In A. Freitas-Magalhães,

Emotional Expression: The brain and face (Vol. 6, pp. 307-350). Porto, Portugal: Edições Universidade Fernando Pessoa

CONFERENCE PRESENTATIONS

Vera, L. M., Boccaccini, M. T., Laxton, K. L., Bryson, C. N., **Pennington, C.R.,** Ridge, B. E. (2017, March). *Evaluator empathy in psychopathy interviews.* Poster presented at the Annual Conference of the American Psychology-Law Society (Seattle, Washington).

Pennington, C. R., Marshall, K. K., Bryson, C. N., McCallum, K. E., Ridge, B. E., Cheiffetz, R. T., Stanford-Galloway, P., & Schmidt, A. T. (2016, February). *The role of executive functions in externally-valid decision-making processes.* Poster presented at the Annual Meeting of the International Neuropsychological Society (Boston, Massachusetts).

Ridge, B. E., **Pennington, C. R.,** Bryson, C. N., McCallum, K. E., Marshall, K. K., & Schmidt, A. T. (2016, February). *Connecting the dots: Relating executive dysfunction to the externalizing spectrum of psychopathology.* Poster presented at the Annual Meeting of the International Neuropsychological Society (Boston, Massachusetts).

Pennington, C. R., Schmidt, A. T., McCallum, K. E., Ridge, B. E., Bryson, C. N., Marshall, K. K., & Cheiffetz, R. T. (2015, February). *Personality traits influence processing speed performance in a neurologically intact population.* Poster presented at the Annual Meeting of the International Neuropsychological Society (Denver, Colorado).

Pennington, C. R., Cramer, R. J., Miller, H. A., & Anastasi, J. S. (2013, March). *An examination of clinical moderators of psychopathy and suicidal ideation in a correctional sample.* Poster presented at the Annual Conference of the American Psychology-Law Society (Portland, Oregon).

Rodriguez, D., Miller, A.K., **Pennington, C.R.,** & Pennington, J.N. (2013, March). *Reasoning insanity: Examining the relative influences of preexisting attitudes, trial factors, and*

intuitive explanations. Poster presented at the Annual Conference of the American Psychology-Law Society (Portland, Oregon).

Miller, A. K., Duncan, J. M., Taslitz, A.E., Gardner, B. O., **Pennington, C. R.,** Kline, S.A., Burks, A. C., Pennington, J.N., Duhon, D. A., Rodriguez, D., Stein, M. L., Gemberling, T. M., & Laxton, K. L. (2013, March). *A personality-and-attitude-change model of jury NGRI verdicts: The pivotal role of perspective taking.* Poster presented at the Annual Conference of the American Psychology-Law Society (Portland, Oregon).

Cramer, R. J., Clark, J. W., **Pennington, C. R.,** Kehn, A., Harris, P. N., Sanders-Guerrero, J., & Stroud, C. H. (2012, March). *Juror perceptions of hate crimes against sexual and gender minorities: Policy compliance and the role of juror need for cognition.* Poster presented at the Annual Conference of the American Psychology-Law Society (San Juan, Puerto Rico).

INVITED PRESENTATIONS

Pennington, C. R. (2016). *Distress tolerance and emotion regulation skills with justice-involved youth.* Case conference presentation at the University of Texas – Harris County Psychiatric Center, Houston, Texas.

Pennington, C. R. (2016). *Psychotherapy with gang-involved youth.* Case conference presentation at the University of Texas – Harris County Psychiatric Center, Houston, Texas.

Pennington, C. R. (2014). *Ecological Validity of Neuropsychological Assessments and the Influence of Personality Traits.* Research presentation at the Sam Houston State University Annual Graduate Research Exchange, Huntsville, Texas.

SUPERVISORY EXPERIENCE

January 2016 – April 2016 ***Doctoral Practicum II***
Sam Houston State University
Huntsville, Texas

Position: Peer Supervisor

Responsibilities:
- Assisted faculty member in providing feedback to a second year doctoral student on psychological assessments and report writing.

TEACHING EXPERIENCE

August 2015 – May 2016 ***Introduction to Psychology***
Sam Houston State University
Huntsville, Texas

Position: Instructor

Responsibilities:
- Created lectures and exams that broadly covered all aspects of psychology.
- Provided tutoring to students who needed additional assistance.

January 2015 – May 2015 ***Introduction to Collegiate Studies***
Sam Houston State University
Huntsville, Texas

Position: Instructor

Responsibilities:
- Created lesson plans; created and graded exams and written assignments
- Topics included: management of time, stress, and money; physical and mental health; test taking strategies; and career planning.
- Provided tutoring to students who needed additional assistance.

August 2014- December 2014 ***Introduction to Collegiate Studies***
Sam Houston State University
Huntsville, Texas

Position: Teaching Assistant

Responsibilities:
- Created lectures, graded written assignments, and provided feedback to students.

January 2013 – May 2013 ***Psychopharmacology***
Sam Houston State University

Huntsville, Texas

Position: Instructor

Responsibilities:
- Taught an online undergraduate psychopharmacology class.
- Prepared class material, assigned readings, created and monitored online discussions.
- Created and graded tests, and assisted students as needed.

January 2012 – December 2012 ***Psychopharmacology***
Sam Houston State University
Huntsville, Texas

Position: Teaching Assistant (online class)

Responsibilities:
- Moderated online class discussions.
- Created tests and graded assignments.
- Provided feedback to students.

PROFESSIONAL DEVELOPMENT

November 2016 Getting it Wrong About Miranda Rights: Research on our Myths and Misconceptions

Speaker: Richard Rogers, Ph.D.

April 2016 Risk-Need-Responsivity (RNR): A Simulation Tool

Speaker: Faye Taxman, Ph.D.

April 2015 Callous Unemotional Traits in Children and the Treatment of Conduct Disorder in Juvenile Settings

Speaker: Paul Frick, Ph.D.

October 2014 The Role of Forensic Psychologists in Family Law Matters

Speaker: Michael Gottlieb, Ph.D.

January 2014 Clinical Conceptual Problems in the Attribution of Malingering in Forensic Evaluations

Speaker: Richard Frederick, Ph.D.

August 2013 – Supervision Seminar

May 2014 *Sam Houston State University;* Huntsville, Texas

- Didactic seminar series on clinical supervision in order to learn about evidenced-based supervision practices and ethical considerations
- *Supervisors:* Mary Alice Conroy, Ph.D., ABPP & Jorge G. Varela, Ph.D.

April 2013 International Perspectives on Preventative Detention and Mental Disability Law

Speaker: John Petrila, J.D.

ADDITIONAL EXPERIENCE

June 2014-
December 2014

Student Success Initiatives/First Year Experience
Sam Houston State University
Huntsville, Texas

Position: Graduate Assistant

Responsibilities:
- Assisted in data collection and data entry on FORWARD (former foster children, orphans, and wards of the court) students.
- Advised and mentored incoming students during summer orientations.

June 2013-
July 2013

Neuroimaging Summer Seminar
Baylor College of Medicine
Houston, Texas

Position: Project Intern

Description:
- Learned the basics of neuroimaging (including MRI, DTI, fMRI) and how to use brain imaging software.
- Attended lectures on alternative scanning techniques.
- Attended lectures on statistics and research methods related to traumatic brain injury research.

January 2011 –
October 2011

SAAFE House Shelter for Women and Children
Huntsville, Texas

Position: Shelter Advocate

Responsibilities
- Conducted intake interviews and paperwork.
- Answered a crisis hotline for victims of domestic violence or sexual abuse.
- Aided women and children in crisis.
- 141 total volunteer hours.

HONORS AND AWARDS

2010	Most Outstanding Psychology Student award, Sam Houston State University
2010-2011	Member of Psi Chi (Psychology Honor Society)
2008	Member of Alpha Lambda Delta (Freshman Honor Society)
2007-2009	Dean's list (4 semesters)

SPECIALIZED COURSEWORK

Practicum in Group Counseling

Empirically Supported Treatments

Multicultural Psychology

Human Neuropsychology

Suicide Risk Assessment

Forensic Assessment I

Forensic Assessment II

Psychopharmacology Clinical Applications

PROFESSIONAL ASSOCIATION MEMBERSHIPS

American Psychological Association

Society of Clinical Psychology (APA Division 12)

Society for Clinical Neuropsychology (APA Division 40)

American Psychology-Law Society (APA Division 41)

Association for Psychological Science