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Examining The Relationship Between Technology Usage And Objective Assessments Of Impulsivity And Cognitive Performance In Young Adults

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EXAMINING THE RELATIONSHIP BETWEEN TECHNOLOGY USAGE AND OBJECTIVE ASSESSMENTS OF IMPULSIVITY AND COGNITIVE PERFORMANCE IN YOUNG ADULTS

by

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ABSTRACT

The present study examined objective measurements of cognitive performance in tasks a clinician may use when evaluating an adult for Attention Deficit Hyperactivity Disorder (ADHD) to determine if the cell phone behavior and self-reported text-message dependency and social media use accounted for the variance in scores. Seventy-four participants were included. in stepwise multiple regression analyses. Independent sample t-tests found age of first cell phone was significantly higher for men than women and reported significantly decreased sense of control over their social media use. Reported number of texting behavior (i.e. daily number of texts sent, received, and checked) were positively correlated with perceived excessive use measured by Self-Perception of Text Messaging Dependence Scale; however, increased anxiety, disappointment, and need to maintain relationships were not correlated which suggest a possible concrete evaluation of participant's dependence. Stepwise regression analyses included two remarkable findings of reported cell phone behavior in scores on Controlled Oral Word Association Task (COWAT) and Conners' Continuous Performance Test II (CPT-II) Omissions. Texts sent and received predicted lower scores on COWAT FAS and Animals, while length of cell phone ownership (i.e. age of first cell phone) predicted higher inattention scores on CPT-II Omissions. These two findings, therefore, warrant future research to examine if a causative effect of cell phone behavior is present in these two assessments which suggest clinician caution in interpretation between ADHD and learned behavior impulsivity.

CHAPTER I

INTRODUCTION

According to the American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, 2013, (DSM-5) impulsivity is defined as "acting on the spur of the moment in response to immediate stimuli, acting on a momentary basis without a plan or consideration of outcomes, difficulty establishing and following plans, a sense of urgency, and self-harming behavior under emotional distress" (p. 823). Symptoms of impulsivity along with hyperactivity and inattention form the basis for a diagnosis of Attention Deficit Hyperactivity Disorder (ADHD) (American Psychiatric Association, 2013). However, according to the most recent edition of the DSM, a certain number of impulsivity and/or hyperactivity symptoms must have been present prior to the age of 12 for a diagnosis to be rendered regardless of the age at the time a person seeks a professional diagnosis. Prevalence rates for ADHD in children and adolescents are considered to be 3 to 5% and 1 to 3% in adults (APA, 2013).

Adult Attention Deficit Hyperactivity Disorder

An estimated 50-60% of children diagnosed with ADHD will continue to have ADHD as an adult (Rapport, 2001; Goldstein, 2002). However, research suggests that using the DSM criteria for diagnosing adults may be problematic given that certain criteria may lack sensitivity in detecting ADHD in college students and adults since DSM definitions do not contain age appropriate terms (Barkley, Murphy, & Kwasnik, 1996; Heiligenstein, Conyers, Berns, Miller, & Smith, 1998). Prevalence rates for ADHD in college students are estimated between .5 and 8% (Weyandt, Linterman, & Rice, 1995). Additionally, according to Weyandt and Dupaul's review of 23 studies, prevalence rates for adults with ADHD have been estimated at a higher range of 2 to 8% (2006).

The DSM-5 age requirement may make proper diagnosing of ADHD in adulthood more difficult given that an individual may not have been assessed for ADHD prior to age 12. Often, self-report measures for these symptoms are used. Using solely based self-report measures have resulted in high rates of false positives (Mannuzza, Klein, Klein, Bessler, & Shrout, 2002). Therefore, clinicians typically use additional objective measures to rule out potential differential diagnoses such as learning disorders in addition to assessing for symptoms and criteria of ADHD including impulsivity and attention.

However, complicating the diagnostic picture, an adult or college student may attempt to malinger ADHD for external gains or incentives such as stimulant medication and/or special educational accommodations (Boone, 2007; Larrabee, 2007; Slick, Sherman, & Iverson, 1999). The issue is that while tests such as Test of Memory Malingering and Rey 15-item are available to detect possible memory malingering, no clearly established assessment is available to detect ADHD malingering (Osmon, Plambeck, Klein, & Mano, 2006). A diagnosis of ADHD for someone intentionally malingering ADHD may have dire health consequences if the diagnosis results in obtaining a prescription for stimulant medication which is often the first line pharmacological treatment.

Stimulant medications such as dextroamphetamines (brand names: Adderall, Dexedrine, Vyvanse, Benzedrine) and methylphenidates (brand names: Ritalin, Concerta) are classified as Schedule II stimulants by the U.S. Department of Justice Drug Enforcement

Administration under the Controlled Substances Act. As a Schedule II drug, these stimulants have high potential for abuse when used for nonmedical purposes as they produce euphoric feelings when consumed in large doses by snorting or injecting. In 2013, 1.4 million (0.5%) people age 12 and older used stimulants for nonmedical purposes as reported by Substance Abuse and Mental Health Services Administration's (SAMHSA) National Survey on Drug Use and Health: Summary of National Findings. These stimulants can develop drug tolerance as similarly strong as cocaine and methamphetamine. Chronic, repeated use of these stimulants for nonmedical purposes may result in aggression, agitation, hostility, panic, paranoia, suicidal, and homicidal tendencies. Additionally, high doses may produce psychosis including visual and auditory hallucinations possibly due to excessive dopamine levels. High doses may also cause cardiovascular failure, irregular heartbeat, seizures, and critically high body temperature. Sudden termination of chronic use may result in anxiety and depression. It has been noted that these effects are managed when taken for medical purposes such as ADHD by physicians prescribing them in low doses and gradually increasing them until a therapeutic effect is achieved (SAMHSA, 2014; United States, 2015).

Aside from seeking stimulant medication for euphoric effects, it may be possible that a person may not be intentionally malingering ADHD for medication but, rather, may have developed a potentially learned behavior that mimics the attentional and impulsivity symptoms indicative of someone with ADHD. Therefore, a person may believe they have ADHD for which a stimulant medication could be warranted therapeutically; however, their impulsivity may have been learned or created and, thus, behavioral therapy may be the appropriate avenue for treatment.

Assessing Attention Deficit Hyperactivity Disorder

Assessing for ADHD can prove challenging due to the heterogeneity of the disorder. A diagnosis of ADHD encompasses three subtypes or current presentations which are predominantly inattentive, predominantly hyperactive/impulsive, and combined presentations (APA, 2013).

In children, behavioral questionnaires completed by teachers and parents in addition to child observations by the clinician may be considered adequate, and arguments have been made that mainly behavioral criteria for diagnosis deems cognitive testing unnecessary (Pritchard, Nigro, Jacobson, & Mahone, 2012). However, cognitive assessment is generally employed for differential diagnosis as behavioral symptoms such as impulsivity may be related to normal personality (Eysenck & Eysenck, 1977) and other disorders (e.g. learning, mania, substance abuse, personality). Additionally, an individual's cognitive functioning is assessed to determine a person's individual strengths and weaknesses in order to form specific targeted therapeutic treatment of their developmental disorder. As such, no single or prototypical battery has been developed or agreed upon to assess for ADHD. In place are several options of tests to assess different domains (e.g. executive functioning, working memory, processing speed, attention, impulsivity) of cognitive functioning considered to differentiate individuals with and without ADHD.

Executive Functioning

Various definitions of executive functioning exist in the literature. In general, it may be considered an integration of several cognitive functions within but not exclusive to the prefrontal lobe of the cortex. Executive functioning is a complex process that includes planning, organization, decision making, problem solving, and judgment over cognitive functions based on environmental stimuli including emotions and behaviors as processed through working memory, attention, and processing speed. Executive functioning is most activated during novel problem solving (Gioia, Isquith, & Guy, 2001) and may not reflect a unitary construct (Baddeley, 1998; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). As basic tasks become more complex (e.g. verbal fluency vs. semantic fluency in Controlled Oral Word Association Test (COWAT)), increasing demand is placed on executive functioning. Miyake et al. differentiated three basic processes of executive functioning to include shifting, updating, and inhibition. The use of any or all of these processes is dependent on the type of task as well as the complexity of the task used to measure executive functioning (2000). Thus, it is important to consider use of more than one task to understand a person's executive functioning abilities. Additionally, working memory, in and of itself, also involves different processes which affect and are affected by executive functioning.

Working Memory

Working memory is the ability to hold auditory, visual, or tactile sensory input in short-term storage in order to perform mental operations. In addition to sensory input and working memory in the temporal lobes, information may be pulled from long-term memory. An example of this process may be observed in the WAIS-IV Digit Span (DS) subtest Backward and Sequencing tasks. Typical capacity for digit span is 7 ± 2 digits. DS Forward is a measure of repetition and attention ability as opposed to a measure of working memory. DS Forward tasks a person to repeat verbal numbers presented. DS Backward measures attention as well as working memory as it requires one to hold numbers briefly then perform a mental manipulation and repetition of verbal numbers in reverse order. DS

Sequencing is also a measure of working memory and attention with the addition of long-term retrieval. DS Sequencing requires more complex manipulation and pulls information from long-term memory as it requires not only recall of digits presented, it also requires one to recall the order in which numbers exist lowest to highest and manipulate the presented digits to form the correct response. Executive functioning may also be present as the task requires some inhibition of irrelevant digit information from long-term recall in addition to attention to the task at hand.

Processing Speed

Processing speed reflects a part of cognitive efficiency of a person's ability to complete automatic tasks with general accuracy. Processing speed has been shown to be related to working memory capacity as a person with faster processing speed is able to make efficient use of information in short-term memory (Baddeley, 1981, 1986). Processing speed and storage efficiency accounted for developmental variance of improvements in working memory performance (Case, Kurland, & Goldberg, 1982; Daneman & Carpenter, 1980; Dempster, 1981). This effect has been observed in lifespan studies showing intelligence increases with age were due to improvements in processing speed leading to increased working memory (Fry & Hale, 1996). Additionally, faster processing speed was suggested to effect short-term capacity efficiency related to item decay (Towse, Hitch, & Hutton, 1998). Also, Bayliss, Jarrold, Baddeley, Gunn, & Leigh found storage ability and working memory in addition to processing speed shared in contributing to higher levels of age-related cognition (2005). Processing speed as related to learning a new skill depends on the accuracy and speed of a person's skill performance (Lichtenberger & Kaufman, 2009). Paced Auditory Serial Addition Test (PASAT), COWAT verbal fluency task, and

Stroop Color and Word Test (Stroop) are tests considered to contain measurements of processing speed.

Attention

Attention is also a complex process involving the basic abilities of encoding capacity and sensory input along with working memory and executive functions to filter relevant verses irrelevant information, respond or inhibit a response, and maintain vigilance (Cohen, Sparling-Cohen, & O'Donnell, 1993). Due to the complexity of attention, it is difficult to solely measure attention as it is also dependent on processing speed and speed to respond in the requested manner (e.g. verbal, written). Tests of continuous performance such as Conners Continuous Performance Test-II (CPT-II) contains measures of vigilance, or sustained attention, which is one of the symptoms of ADHD.

Impulsivity

Impulsivity is yet another multi-dimensional and complex process. As defined by the APA in the 2013 DSM-5, impulsivity is the active response to immediate stimuli without planning or outcome consideration with urgency and potential for self-harm (p. 823). Three distinct subtypes of impulsivity may be considered. Motor impulsivity refers to behavioral disinhibition or the inability to inhibit a response. CPT-II commissions is a measure of this response inhibition. Temporal impulsivity is considered the inability to consider delayed gratification or delay-discounting. Cognitive or reflexive impulsivity refers to risky decision making involving lack of planning and/or consideration of potential consequences. In addition to objective tasks of impulsivity such as CPT-II, impulsivity has also been assessed via self-report. Barratt's Impulsiveness Scale-11 (BIS-11) is a self-report measure of trait impulsivity. BIS-II identifies three subscales – attention, motor, and non-planning (Patton, Stanford, & Barratt, 1995). Despite the apparent overlay with the three factors of identified impulsivity construct, there was a suggested limited association of the BIS-II subscales and performance on certain tasks used to measure impulsivity (Caswell, Bond, Duka, & Morgan, 2015). Additionally, neuroimaging studies have found different pathways and networks involved dependent on the type of impulsivity under observation (Aron & Poldrack, 2005; Chambers, Garavan, & Bellgrove, 2009; Juan & Muggleton, 2012; Wilbertz et al., 2014; Peters & Büchel, 2011). Therefore, reliance on self-reported impulsivity may be problematic which suggests clinicians may want to consider both subjective and objective assessments when measuring impulsivity. However, objective assessment may also be problematic if a person attempts to simulate ADHD symptoms.

Malingering

Research studies have examined objective assessment differences between groups of control, ADHD diagnosed, and ADHD simulated conditions. Such studies have found participants who were requested to simulate someone with ADHD symptoms resulted in higher self-reports of attention symptoms, lower objective assessment of cognitive processing speed, and reduced attention than either the control or ADHD diagnosed groups. Booksh, Pella, Singh, & Gouvier (2010) compared control, ADHD diagnosed, and ADHD simulated groups and found that the ADHD simulated group scored significantly lower than either the control or ADHD diagnosed groups on Trails A, Trails B, WAIS-III subtests Digit Symbol Coding, Symbol Search, Digit Span, and Letter-Number Sequencing. Additionally, the ADHD simulated group scored significantly higher on Conners' Continuous Performance Test (CPT) measures. These results suggested that WAIS subtests may not differentiate between ADHD simulated and ADHD diagnosed as well as other measures requiring sustain attentional focus such as the CPT response inhibition, response consistency over time, and Trails A (Booksh et al., 2010).

Impulsivity and Technology

Impulsivity has not only been found to be a symptom of ADHD, but is also present in personality traits including urgency, lack of premeditation, lack of perseverance and sensation seeking (Whiteside & Lynam, 2001). DSM-5 specifically identifies impulsivity in criteria for Antisocial Personality Disorder and Borderline Personality Disorder (APA p. 659, and 663). Additionally, impulsivity is included in other psychopathological disorders including substance dependence and abuse (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Several researchers have found smoking, alcohol, drug use/addictions related to poor performance on objective measures of impulsivity (Bickel, Odum, & Madden, 1999; Fillmore & Rush, 2002; Lejuez et al., 2003; Madden, Petry, Badger, & Bickel, 1997; Mitchell, 1999; Petry & Casarella, 1999; Reynolds, Richards, Horn, & Karraker, 2004; Vuchinich & Simpson, 1998).

Internet and Social Media

More recently, investigation has been undertaken in a potentially new area of nonsubstance addiction reflecting repetitive behaviors. Despite lack of sufficient peer-reviewed evidence to include as a mental disorder at the time of publishing, DSM-5 defines nonsubstance/behavioral addiction as “not related to any substance of abuse that shares some features with substance-induced addiction” (p. 825). Behavioral addiction may be considered in the same light as a substance addiction in that the compulsion continues despite negative consequences (Griffiths, 1996). Griffiths further defined technology addictions as “non-chemical (behavioral) addictions involving human-machine interaction”

(1996). Young first used the term Internet Addiction Disorder to describe an "impulse-control" disorder not involving intoxication (1998). Young found functional impairment in students in which they were distracted from studying by surfing the Internet for irrelevant reasons (1998). Additional research supported the idea of problematic Internet use as an impulse-control disorder (Young & Case, 2004; Shapira et al., 2003; Kaltiala-Heino, Lintonen, & Rimpelä. 2004; Goldsmith & Shapira, 2006). Although not to be considered interchangeable, research has studied problematic Internet use in addition to possible Internet addiction. Problematic Internet use has been found to be prevalent and include distress and disability as may be found in other impulsive disorders (Goldsmith & Shapira, 2006).

Cell Phone

Researchers have also begun to suggest the concept of cell phone addiction with various definitions involving dependent and compulsive behavior in addition to problematic and excessive use. However, cell phone addiction is not a wide-spread accepted concept, and despite research using that term, others caution that while reinforced cell phone use may lead to problematic behavior, it does not necessarily suggest addiction (Bianchi & Phillips, 2005; Jenaro, Flores, Gómez-Vela, González-Gil, & Caballo, 2007). A smartphone is a specific type of cell phone with capability of accessing the Internet. Habitual use of a smartphone has been shown to contribute to addictive behavior (Van Deursen, Bolle, Hegner, & Kommers, 2015). Van Deursen et al. also found low self-regulation related to increased risk of addictive smartphone behavior. This corroborated prior research on self-regulation and media habits (LaRose & Eastin, 2004) and Internet use (Dawe & Loxton, 2004; Gámez-Guadix, Calvete, Orue, Las Hayas, 2015; Kubey, Lavin & Barrows, 2001;

LaRose, 2001; LaRose, Eastin, & Gregg, 2001; LaRose, Mastro, & Eastin, 2001; LaRose, Lin, & Eastin, 2003; LaRose & Eastin, 2004; Tokunaga, 2015). Research has also shown emotion regulation affects Internet use behaviors (Caplan, 2002, 2007, 2010; Casale, Caplan, & Fioravanti, 2016; Hormes, Kearns, & Timko, 2014; Yu, Kim, & Hay, 2013). Additionally, lower emotional intelligence has been shown to increase risk of Internet addiction (Beranuy, Oberst, Carbonell, & Chamarro, 2009; Engelberg & Sjöberg, 2004; Parker, Taylor, Eastabrook, Schell, & Wood, 2008) and smartphones (Beranuy et al., 2009; Kun & Demetrovics, 2010).

In 2007, Billieux et al. discovered a relationship between impulsivity and problematic cell phone use. Urgency and lack of perseverance which are dimensions of impulsivity were also found related to potential cell phone dependence (Billieux, Van der Linden, d'Acremont, Ceschi, & Zermatten, 2007) with urgency being the strongest predictor of problematic cell phone use (Billieux, Gay, Rochat, & Van der Linden, 2010). Length of time one owns a cell phone, in addition to impulsivity were related to higher self-attribution of addiction (Billieux & Van der Linden, & Rochat, 2008). Excessive cell phone use has been positively correlated with Internet addiction (Ha, Chin, Park, Ryu, & Yu, 2008).

Prevalence for minor text-messaging addiction was found to be 3.1% for men and 5.4% for women (Lu et al., 2011). Data also showed that while 28.6% of men were classified as heavy cell-phone users, 56.3% of women were classified as heavy users. (Jenaro et al., 2007). Impulsivity was an identified risk factor for addiction to Internet (Balodis et al., 2012; Mottram & Fleming, 2009) and social networking sites by smartphone users (Wu, Cheung, Ku, & Hung, 2013). In 2012, Billieux suggested an integrative model of problematic cell phone that included four pathways of impulsivity, relationship maintenance, extraversion, and cyber addiction (Billieux, 2012). Impulsivity and additional factors of weekend average usage hours and female gender were identified to predispose smartphone addiction (Kim et al., 2016).

As technology of the world advances so too does the ability to own technology. In 2012, 67% of young adults age 18-22, compared to 53% of all other ages of cell phone users, owned a smart phone. A smartphone is a cell phone capable of not only receiving and submitting text messages, but also searching the Internet. The world of technology, and all the information on the Internet, was now available instantaneously at the end of one's hand. In 2008, Turkle considered people to be "tethered" to their cell phones and stated they were "newly free in some ways, newly yoked in others" (Turkle, 2008). Despite being continuously available by cell phone, people considered that aspect to be cell phones' least favored quality (Ling & Baron, 2007; Baron, 2008). Nielsenwire found American adolescents age 13 to 17 were the largest consumers of text messaging by sending and receiving an average of 3,339 text messages per month (2010). In 2011, young adults were found to have received an average of 113 text messages and checked their phone an average of 60 times each day (Harman & Sato, 2011).

Cognitive Functioning

It has been suggested that smartphones create a continual source of attentional distraction (Thornton, Faires, Robbins, & Rollins, 2014). Attention as defined by the DSM-5 is "the ability to focus in a sustained manner on a particular stimulus or activity" (p. 818). Attention occurs through interaction of multiple brain network and systems (Cohen et al., 1993; Heilman, Watson, & Valenstein, 2003; Mesulam, 1992). It is a complex function in which stimuli are selected for processing and response. Executive functioning receives information from basic sensory inputs to process in order to decide whether to activate or inhibit a response. Neuroimaging studies confirmed activation in the dorsolateral prefrontal and posterior parietal cortex in those with Internet gaming disorder (Corbetta & Shulman, 2002). Ferraro et al. found negative associations between text messaging dependency and self-reported executive function most notably impulse control and strategic planning (2012).

Attention also includes emotional assessment from incoming stimuli that may influence one's response. Emotional regulation is the ability to change our emotional response either through immediate attention or cognitive reappraisal (Gross, 1998, 2008) while self-regulation is the ability to change based on goals and motivation in different situations. Failure of executive control over emotional responses are considered to contribute to psychopathology (Rottenberg & Gross, 2003; Rottenberg & Johnson, 2007), problematic Internet use (Caplan, 2010); Casale et al., 2016), and social networking sites (Hormes et al., 2014). Excessive use of a smartphone has been found to as a coping mechanism for negative emotion (Kim, Seo, & David, 2015). Removal of a person's smartphone has revealed increased discomfort and anxiety (Cheever, Rosen, Carrier, & Chavez, 2014; Shaffer, 1996; Young, 1999). Additionally, anxiety, heart rate and blood pressure increased when separated users heard their phone ring (Clayton, Leshner, & Almond, 2015). Increased social stress has been found to influence addictive smartphone behavior (Van Deursen et al., 2015). Women are more likely to experience negative interpersonal events and may experience higher social stress than men (Troisi, 2001). Additionally, women use smartphones more than men for social relationship maintenance (Jenaro et al., 2007). Van Deursen et al. concluded that women were more likely than men to develop addictive and habitual behaviors because of their use of smartphones for social relationships and stress (2015). Results from a study on imagined smartphone loss suggested increased capability of emotion regulation resulted in less reported depression, anxiety, and stress (Elhai, Hall, & Erwin, 2018). Gender differences have also been found in relation to emotion regulation wherein women have greater range of regulation strategies than men (Barrett, Lane, Sechrest, & Schwartz, 2000; Nolen-Hoeksema, 2012), however, they may be more likely than men to use social media (Duggan & Brenner, 2013).

In addition to emotion regulation and attention with respect to executive functioning, working memory is also involved as it is required in order for a person to hold irrelevant and/or neutral information during distraction in order to decrease negative affect (Fennell, Teasdale, Jones, & Damlé, 1987; Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Teasdale & Rezin, 1978). Siemer further suggested that reaching working memory capacity with incongruent mood prevents congruent mood thoughts access to resources of attention (2005).

Present Study

Deficits in cognitive functioning including executive functioning, impulsivity, processing speed, and working memory have been found in not only adults with ADHD but also those with substance use and addiction disorders (Seidman, 2006, Crews & Boettiger, 2009). With overlaps in impulsivity between ADHD, behavioral addictions, and smartphone use in addition to emotion regulation, attention, and working memory, the present study sought to examine objective measurements of cognitive performance used in adult ADHD evaluations to determine the relationship between objective performance, cell phone usage, and text-message dependency. Specifically of interest was whether these assessments might benefit clinicians in determining impulsivity as a learned behavior stemming from overuse, dependence, or possible behavioral addiction to cell phone use verses impulsivity as observed in adults with ADHD.

The following hypotheses are considered:

1. Given prior research's reported differences between women and men with regard to emotional type of smartphone use, it is anticipated that women will score higher on measures of social media use and text-message dependency than men.

2. Reported cell phone usage will be positively correlated with text-message dependence.

3. The contribution of text-message dependence, cell phone usage, self-reported symptoms, and self-reported impulsivity as predictors of cognitive functioning will be examined. If significant contributors, it is anticipated that higher scores on those measures will result in lower scores of executive functioning, working memory, and processing speed. Additionally, higher GPA, state mindfulness, and trait mindfulness scores will account for higher scores of executive functioning, working memory, and processing speed.

4. The contribution of text-message dependence, cell phone usage, self-reported ADHD symptoms, and self-reported impulsivity as predictors of attention and impulsivity will also be examined. If significant contributors, it is anticipated that higher scores on those measures will result in higher scores of inattention and impulsivity. Additionally, higher GPA, state mindfulness, and trait mindfulness scores will account for lower scores of inattention and impulsivity.

CHAPTER II

METHOD

Participants

The number of participants was chosen a priori by entering desired information into GPower3 for a linear multiple regression, fixed model, using $\alpha = .15$ to achieve a medium effect size of .15 with power of .95 (Faul, Erdfelder, Lang, & Buchner, 2007). GPower3 indicated 75 participants were needed, thus a total of 79 participants age 18 – 22 were recruited through the University of North Dakota's Psychology Department Sona System (Sona Systems, 2018). Students received up to three hours of credit toward a psychology course.

Measures

Background Information

Participants were asked basic background information which included their age, gender, race, household income, education level, GPA, relationship status, current occupation, current and/or past psychological diagnoses, and current medications. Participants were asked to provide the estimated number of times they check their cell phone for text messages every day, the average number of hours they spend, and the average number of text messages they send and receive every day.

Self-Perception of Text-Message Dependency Scale

The Revised Self-Perception of Text-Message Dependency Scale (STMDS) is a 15-item self-report construct validated scale measuring participant's perceived text message usage along with their attitudes regarding compulsive text messaging in interpersonal relationships. (Igarashi, Motoyoshi, Takai, & Yoshida, 2005). In 2008, Igarashi et al. conducted reliability analysis which revealed three subscales, negative emotional response (Emotional Reaction), excessive amounts of time spent on text messages (Excessive Use), and withdrawal from face-to-face communication (Relationship Maintenance) (Igarashi et al., 2005, 2008). Cronbach's alpha reliabilities for each of these three subscales were found to be .81, .85, and .78 respectively (Igarashi et al., 2008).

Toronto Mindfulness Scale

The Toronto Mindfulness Scale (TMS) is a 13-item self-report scale measuring participant's current state mindfulness. This construct and criterion validated scale contains two subscales, Curiosity (α=.93) and Decentering (α=.91) (Lau et al, 2006). Lau defined the Curiosity subscale as awareness of present moment experience with a quality of curiosity. Lau credited the definition of the Decentering subscale to Teasdale et al.'s 2002 definition of decentering as awareness of one's experience with some distance and disindentification rather than being carried away by one's thoughts and feelings (Teasdale et al., 2002).

Five Facet Mindfulness Questionnaire

The Five Facet Mindfulness Questionnaire (FFMQ) is a 39-item self-report construct validated scale measuring participant's trait mindfulness. The scale contains five subscales, attending to internal and external experiences (Observe), labeling internal experiences with words (Describe), attending to current activities and avoiding automatic pilot (Act with

Awareness), not evaluating thoughts and feelings (Nonjudge), and allow thoughts to come and go without reaction (Nonreact). Cronbach's alpha reliabilities for each of these five subscales were found to be .83, .91, .87, .87, and .75 respectively (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006).

Social Media Use Questionnaire

The Social Media Use Questionnaire (SMUQ) is a 9-item self-report construct validated scale measuring participant's various social media usage. The scale contains two subscales, avoidance of places without Internet access or enduring them with increased anxiety and anger (Withdrawal) and decreased sense of control (Compulsion). Cronbach's alpha reliabilities for Withdrawal was α=.83 and Compulsion α=.82 (Xanidis & Brignell, 2016).

Barkley Adult ADHD Rating Scale-IV

Barkley Adult ADHD Rating Scale-IV (BAARS-IV) is a self-report measure for current as well as recalled childhood symptoms of ADHD. The current symptom form requests frequency ratings for 9 symptoms of inattention and 9 symptoms of hyperactivity/impulsivity experienced during the past 6 months. The childhood symptom form requests frequency ratings for 9 symptoms of inattention and 9 symptoms of hyperactivity/impulsivity experienced between the ages of 5 and 12. Clinical significance of either inattention or hyperactivity/impulsivity is reached on scores above the 93rd percentile based on norms according to the person's age (Barkley, 1997). Internal consistency is α=.92 for current symptoms and α=.95 for childhood symptoms with test-retest reliability of .75 current symptoms and .79 childhood symptoms (Barkley, 2011).

Barratt Impulsiveness Scale-11

Barratt Impulsiveness Scale-11 (BIS-11) is a 30-item self-report likert-style measure of impulsive personality traits revised by Patton, Stanford, & Barratt in 1995 from the BIS originally developed by Dr. Ernest Barratt in 1959. Patton's study, which included undergraduate students in the United States, revealed Cronbach's α=.82. The scale contains six first order factors, focusing on the task at hand (Attention), thought insertions and racing thoughts (Cognitive Instability), acting on the spur of the moment (Motor Impulsiveness), a consistent life style (Perseverance), planning and thinking carefully (Self-Control), and enjoy challenging mental tasks (Cognitive Complexity) (Patton et al., 1995).

Conners' Continuous Performance Test II

Conners' Continuous Performance Test II (CPT-II) is a 14-minute test in which the individual is asked to respond as quickly as possible to a target stimulus, but to abstain from responding to a more rarely occurring non-target stimulus. The target stimulus, an "X" is presented for 10% of the trials while other letters are presented on 90% of the trials. Each stimulus is presented for 250 milliseconds. CPT-II consists of 18 blocks of 20 trials in each block. Each block uses a different inter-stimulus interval of 1-second, 2-seconds, or 4-seconds. The primary dependent variables in this task are listed below along with T-scores, percentile scores, and interpretive guidelines from the Conners test. A T-score has a mean of 50 and a standard deviation of 10 (Conners, Epstein, Angold, & Klaric, 2003).

Wechsler Adult Intelligence Scale – Fourth Edition

The WAIS-IV is a standardized norm-referenced battery consisting of 15-subtests assessing an array of cognitive abilities. Individual subtest scores have a mean of 10 and standard deviation of 3.

The Digit Span (DS) subtest is considered to measure short-term auditory memory, working memory, attention, sequential processing, and concentration (Kaufman & Lichtenberger, 2006; Lichtenberger & Kaufman, 1999; Sattler & Ryan, 2009). During the DS task, participants are presented with a series of number sequences orally. They then must repeat the numbers verbatim for Digits Forward, in reverse for Digits Backward, and sequentially for Digits Sequencing. Working memory requires the ability to temporarily retain information in memory, perform some mental operation on, or manipulation of, it and produce a result. Working memory involves attention, concentration, mental control, and reasoning. Working memory is an essential component of other higher order cognitive processes (Buehner, Krumm, Ziegler, & Pluecken, 2006; de Ribaupierre & Lecerf, 2006; Salthouse & Pink, 2008; Unsworth & Engle, 2007). Factors that may be related to an individual's score include ability to self-monitor, auditory acuity and discrimination, ability to use encoding strategies, and ability to use rehearsal strategies (Sattler, 2008).

The Processing Speed Index (PSI) is a measure of ability to quickly and correctly scan, sequence, or discriminate simple visual information. PSI contains the subtests Symbol Search (SS) and Coding (CD). The PSI measures short-term visual memory, attention, and visual-motor coordination (Groth-Marnat & Baker, 2003; Kaufman & Lichtenberger, 1999, 2006; Lichtenberger & Kaufman, 2009; Sattler, 2008). Research indicates a significant correlation between processing speed and cognitive ability (Jenkinson, 1983; Kail, 2000; Kail & Salthouse, 1994) and the sensitivity of processing speed measures to clinical conditions such as ADHD, learning disabilities, TBI, and dementia. Research suggests that declines in processing speed ability are associated with age-related declines in performance on other measures of cognitive ability (Lindenberger, Mayr, & Kliegl, 1993; Salthouse, 1996; Salthouse & Czaja, 2000; Salthouse & Ferrer-Caja, 2003). Factors that may be related to an individual's score include rate of motor activity, motivation and persistence, visual acuity, and ability to work under time pressure (Sattler, 2008).

Paced Auditory Serial Addition Test

The Paced Auditory Serial Addition Test (PASAT) is a test measuring auditory information, processing speed, working memory/cognitive flexibility, divided attention, and calculation ability. Participants perform tasks of serial addition with numbers presented every 3 seconds in the first trial, and every 2 seconds in the second trial. Norms are provided for age and education level.

Trail Making Test

The Trail Making Test (TMT) is used to assess motor speed and visual search. The test is composed of two separate parts. Part A measures simple attention, visual motor speed, visual search ability, cognitive flexibility and requires the individual to draw lines to connect 25 consecutive numbers (i.e., 1-2-3….). Part B measures an individual's ability to divide attention, processing speed, visual scanning ability, and involves drawing lines between numbers and letters (i.e., 1-A, 2-B, 3-C…). The time for participant to complete each part is the primary measure of interest. In 1987, TMT was given to young adults and reliability for Trail A was .5 and Trail B was .75 (Bornstein, Baker, & Douglass, 1987).

Controlled Oral Word Association Test

The purpose of the Controlled Oral Word Association Test (COWAT) is to assess an individual's ability to automatically produce words starting with a given letter or given class within a specified time period to assess verbal association fluency. In this version of the test, the participant was given one minute to name as many words or items possible from each of the following categories: words beginning with the letter F; words beginning with the letter A; words beginning with the letter S; and names of different animals. Internal consistency for FAS was r=.83 with test-retest reliability of .74 (Tombaugh, Kozak, & Rees, 1999).

Stroop Color and Word Test

The Stroop Color and Word Test (Stroop) is a measure of executive function, including selective attention, processing speed, and inhibition (Stroop, 1935). Test-retest reliability of .88, .79, .71 was found with university student participants (Jensen, 1965). The participant completes three tasks: reading the words of three colors (red, green, and blue; “Word”) printed in black ink; naming the color of ink of Xs (“Color”); and naming the color of the ink of color words (e.g., the word “green” presented in blue ink; “Color-Word”). The raw score is the number of items completed in 45 seconds. Then, a score is predicted based on the examinee’s age or education. The difference between the raw and predicted scores results in a residual score.

California Verbal Learning Test, Second Edition

The California Verbal Learning Test, Second Edition (CVLT-II) measures recall and recognition of a list of 16 words over five immediate recall trials, a short delay free-recall trial (30 seconds), a free and cued long-delay trial (10 minutes), a yes/no recognition trial, and a forced choice recognition trial. Each word comprises one of three semantically related categories. CVLT-II manual reports split-half reliability of trials 1-5 of r=.94 for the normative sample. Additionally, they found r=.82 for list A four categories and r=.79 split-half for immediate recall (Delis, Kramer, Kaplan, & Ober, 2000).

Procedure

Participants for the present study were recruited through Sona Systems, a cloud-based software for participant pool management, during fall 2016 and spring 2017 semester (Sona Systems, 2018). Assessment sessions were scheduled for three hours and conducted in room 419 on fourth floor of Corwin-Larimore Hall on the University of North Dakota campus except for CPT-II which was performed in room 424 of Corwin-Larimore Hall. Undergraduate students trained in proper procedures and test administration conducted all assessments. Upon review and signature of the consent form, participants completed general background information questions then participated in the following self-report measures and neurocognitive assessments as follows: CVLT-II immediate and short delay, CPT, FFMQ, Digit Span, Symbol Search, Coding, CVLT-II delay, PASAT, Trail Making Test, COWAT, STROOP, STMDS, SMUQ, Barkley, BIS-11, and Toronto. After completion of all assessments, participants were provided a debriefing page including number of credit hours they would receive, contact information for researchers, and contact information for potential adverse reaction(s). All participants completed their sessions within two hours.

CHAPTER III

RESULTS

Participant Exclusions

A review of the data collected from 79 participants revealed that 5 participants reported diagnoses of ADHD, ADD and/or current stimulant medication use. As decided a priori, these participants were excluded, and analyses were, therefore, conducted on 74 participants *(n*=14 men, *n*=60 women) age 18-22 (*M*=19.08, *SD*=1.13). Of the 74 participants included, 70 identified as White (95%), 1 as Asian, 1 as Black, 1 as American Indian, and 1 as Native Hawaiian. Relationship status was reported as 42 single, 30 dating, and 2 cohabitating. Average age of first cell phone use was 13.08 years (*SD*=1.65 years) ranging from 7 to 16 years old. All 74 participants reported unlimited monthly text-message cell phone plans. Participants reported sending and receiving a range of 8 to 500 text messages in addition to checking text messages 5 to 960 times per day. Additionally, they reported spending 2.26 hours (*SD*=1.81) hours per day texting. Average GPA of participants was 3.51 (*SD*=.38) out of 4.0. Number of credits take by participants ranged from 3 to 107. Seven participants reported income level under $20,000; 3 were $20,000-30,000; 4 were $30,000-40,000; 7 were $40,000-50,000; 10 were $50,000-60,000; 8 were $60,000-70,000, 14 were $70,000-100,000, 19 were over $100,000; and 2 did not answer. In response to highest education completed, 26 reported a high school diploma, 46 reported some college, 1 reported trade/technical or community college, and 1 reported a bachelor's degree.

Data Preparation

Prior to analyses, all assessments were scored according to standardized scoring recommendations. T scores were calculated for Digit Span, Symbol Search, PASAT, TMT, COWAT, Stroop, and CPT. Standard Scores were used for CVLT-II. Subscales for all self-report measures were calculated such that the following were used as independent variables: SMUQ (Compulsion, Withdrawal), STMDS (Excessive Use, Relationship, Emotion Reaction), BIS (Attention, Cognitive Instability, Motor, Perseverance, Self-Control, Cognitive Complexity), FFMQ (Nonjudge, Describe, Observe, Act Awareness, Nonreact), Toronto (Decentering, Curiosity), and Barkley (Current Total, Current Hyperactivity, Current Inattention, Childhood Total, Childhood Hyperactivity, Childhood Inattention). Cronbach's alpha analyses were conducted on SMUQ, Toronto, STMDS, FFMQ, and BIS-11 total scales and their subscales. Mean, standard deviation, and Cronbach's alpha are presented in Table 1. Actual reported gender and numbers were used for Age of First Cell Phone, GPA, Texts Sent, Texts Received, and Times Checked. A series of stepwise linear regression analyses were then conducted on the following dependent variables: Digit Span Backward, Digit Span Forward, Digit Span Sequence, Digit Span total, Symbol Search total, PASAT 2 seconds total, PASAT 3 seconds total, TMT A, TMT B, TMT B-A difference, COWAT FAS, COWAT Animals, Stroop Word, Stroop Color, Stroop Color Word, Stroop Interference, CPT-II Clinical Confidence Percentage, CPT-II Omissions, CPT-II Commissions, CPT-II Hit RT, and CVLT-II Trials 1-5, Short Delay Free Recall, Short Delay Cued Recall, Long Delay Free Recall, and Long Delay Cued Recall.

Table 1. Reliability of Self-Report Measures

	Cronbach's α	*Mean*	*Standard Deviation*
SMUQ	.81	14.15	4.99
Withdrawal	.71	6.47	2.97
Compulsion	.64	7.69	2.52
Toronto Mindfulness	.84	36.81	7.50
Curiosity	.87	18.14	4.80
Decentering	.60	18.68	3.60
STMDS	.51	39.70	8.80
Emotional	.46	12.02	5.03
Excessive	.53	18.79	5.30
Relationship	.52	8.90	3.80
FFMQ	.80	127.42	12.08
Observe	.67	24.30	4.35
Describe	.83	26.79	4.32
Aware	.87	26.74	5.43
Nonjudge	.87	27.85	5.36
Nonreact	.60	21.74	3.27
BIS-11	.82	60.07	9.34
Attention	.65	10.55	2.55
Cognition	.57	5.55	1.61
Motor	.70	14.04	3.44
Perseverance	.36	6.68	1.52
Self-Control	.74	11.58	3.03
Cognitive Complexity	.48	11.74	2.40

Main Analyses

Gender

Independent sample t-tests were conducted to test differences between men and women with regard to age they first obtained a cell phone and scores on social media use and text-message dependence scales. Two significant differences were found with regard to age of first cell phone and SMUQ compulsion. Nonsignificant differences are reported in Table 2. Age of first cell phone was significantly higher for men (M = 27.0, SD = 7.21) than for women (M = 24.2, SD = 7.69), $t(31) = 3.21$, $p < .01$. Levene's test indicated unequal variances ($F = 4.157$, $p = .045$), so degrees of freedom were adjusted from 72 to 31. Scores on SMUQ subscale compulsion were higher for women (M = 7.97, SD = 2.32) than for men (M = 6.50, SD = 3.03), $t(72) = 2.01$, $p < .05$.

Table 2. Gender Differences

	Men *M*	Men *SD*	Women *M*	Women *SD*	*t*	*p*	*df*
SMUQ Withdrawal	8.50	1.23	8.07	1.16	1.24	.218	72
STMDS Excessive Use	16.14	7.56	19.40	4.49	1.55*	.142	15
STMDS Relationship	8.42	3.80	9.00	3.83	.504	.616	72
STMDS Emotional	11.00	5.14	12.27	5.02	.846	.400	72

Note. Men *N*=14, Women *N*=60. *Equal variances not assumed.

Cell Phone Usage and Text Message Dependence

Pearson bivariate correlations were conducted to determine if reported numbers of texts sent, received, checked were associated with the three subscales (i.e. excessive use, relationship, emotional) of STMDS. There was a significant positive correlation between texts sent daily and STMDS Excessive Use, $r=.243$, $n=74$, $p<.05$. Additionally, there was a significant positive correlation between texts received daily and STMDS Excessive Use, $r=.270$, $n=74$, $p<.05$. Nonsignificant results reported in Table 3.

Table 3. Cell Phone Usage and Dependence

	Pearson *r*	*n*	*p*
Texts Sent and STMDS Relationship	-.024	74	.838
Texts Sent and STMDS Emotional Reaction	-.034	74	.589

Table 3. cont.

	Pearson *r*	*n*	*p*
Texts Received and STMDS Relationship	.009	74	.937
Texts Received and STMDS Emotional Reaction	-.095	74	.419
Texts Checked and STMDS Relationship	.185	74	.115
Texts Checked and STMDS Emotional Reaction	-.055	74	.639

Executive Functioning

TMT. Regression results for TMT A, B, and B-A each had only one predictor entered into the models. BIS Cognitive Complexity significantly predicted variance in scores for TMT A [R^2 = .286, R^2adj = .069, F(1, 72) = 6.412, p<.05] as well as TMT B [R^2 = .245, R^2adj = .047, F(1, 72) = 4.616, p<.05]. While GPA significantly predicted variance in scores for TMT B-A [R^2 = .260, R^2adj = .054, F(1, 72) = 5.206, p<.05].

Stroop. Regression results for Stroop Word and Interference had one predictor each entered into the models. Neither Stroop Color nor Stroop Color-Word had any predictors entered. Barkley Current Attention significantly predicted variance in scores for Stroop Word [$R^2 = .067$, $R^2_{adj} = .054$, $F(1, 72) = 5.169$, $p<.05$]. GPA significantly predicted variance in scores for Stroop Interference [$R^2 = .073$, $R^2_{adj} = .061$, $F(1, 72) = 5.711$, $p<.05$].

COWAT. Regression results for COWAT FAS indicated an overall model of two predictors (Texts Checked and FFMQ Observe) that significantly predicted variance in scores [$R^2 = .147$, $R^2_{adj} = .123$, $F(2, 71) = 6.106$, $p<.01$]. Regression results for COWAT Animals indicated on overall model of two predictors (Texts Received, FFMQ Describe) that significantly predicted variance in scores [$R^2 = .113$, $R^2_{adj} = .088$, $F(2, 71) = 4.521$, $p<.05$]. Full results for COWAT are presented in Tables 4, 5, 6, and 7.

Table 4. COWAT FAS Model Summary

Step	*R*	R^2	R^2_{adj}	ΔR^2	F_{chg}	*p*	df_1	df_2
1. Texts Checked	.300	.090	.078	.090	7.137	<.05	1	72
2. FFMQ Observe	.383	.147	.123	.057	4.707	<.05	1	71

Table 5. COWAT FAS Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
Texts Checked	-.014	.005	-2.588***	-.300	-.294
FFMQ Observe	.429	.198	2.170***	.257	.249

Note. *** Indicates significance at p <.05

Table 6. COWAT Animals Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	*p*	df_1	df_2
1. Texts Received	.241	.058	.045	.058	4.426	<.05	1	72
2. FFMQ Describe	.336	.113	.088	.055	4.406	<.05	1	71

Table 7. COWAT Animals Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
Texts Received	-.027	-.283	-2.488***	-.241	-.283
FFMQ Describe	.384	.238	2.099***	.189	.242

Note. *** Indicates significance at p <.05

CVLT-II. CVLT-II Trials 1 – 5 did not have any predictors entered. Regression results for CVLT-II Short Delay Free Recall indicated an overall model of three predictors (Barkley Current Inattention, FFMQ Nonjudge, and STMDS Relationship Maintenance) that significantly predicted variance in scores [$R^2 = .201$, $R^2_{adj} = .116$, $F(3, 70) = 5.857$, $p<.001$]. Regression results for CVLT-II Short Delay Cued Recall indicated on overall model of two predictors (Barkley Current Inattention and FFMQ Nonjudge) that significantly predicted variance in scores [$R^2 = .123$, $R^2_{adj} = .098$, $F(2, 71) = 4.965$, $p<.01$]. CVLT-II Long Delay Free Recall had no predictors entered. Regression results for CVLT-II Long Delay Cued

Recall indicated on overall model of two predictors (Barkley Current Inattention and FFMQ Nonjudge) that significantly predicted variance in scores [R^2 = .177, R^2_{adj} = .154, F(2, 71) = 7.634, p<.01]. Full results for CVLT-II are presented in Tables 8, 9, 10, 11, 12, and 13.

Table 8. CVLT-II Short Delay Free Recall Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. Barkley Current Inattention	.247	.061	.048	.061	4.663	<.05	1	72
2. FFMQ Nonjudge	.375	.141	.117	.080	6.602	<.01	1	71
3. STMDS Relationship Maintenance	.448	.201	.166	.060	5.249	<.001	1	70

Table 9. CVLT-II Short Delay Free Recall Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
Barkley Current Inattention	-.043	-.369	-3.272**	-.247	-.364
FFMQ Nonjudge	-.049	-.278	-2.489***	-.200	-.285
STMDS Relationship Maintenance	.061	.249	2.291***	.217	.264

Note. ** Indicates significance at p <.01
Note. *** Indicates significance at p <.05

Table 10. CVLT-II Short Delay Cued Recall Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. Barkley Current Inattention	.249	.062	.049	.062	4.766	<.01	1	72
2. FFMQ Nonjudge	.350	.123	.098	.061	4.905	<.05	1	71

Table 11. CVLT-II Short Delay Cued Recall Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
Barkley Current Inattention	-.038	-.323	-2.785**	-.249	-.310
FFMQ Nonjudge	-.045	-.257	-2.215***	-.164	-.246

Note. ** Indicates significance at p <.01
Note. *** Indicates significance at p <.05

Table 12. CVLT-II Long Delay Cued Recall Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. Barkley Current Inattention	.255	.065	.052	.065	4.990	<.01	1	72
2. FFMQ Nonjudge	.421	.177	.154	.112	9.676	<.01	1	71

Table 13. CVLT-II Long Delay Cued Recall Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
Barkley Current Inattention	-.045	-.355	-3.161**	-.255	-.351
FFMQ Nonjudge	-.066	-.350	-3.111**	-.247	-.346

Note. ** Indicates significance at p <.01

Working Memory

Digit Span. Regression results for Digit Span Forward indicated an overall model of two predictors (FFMQ Nonjudge and GPA) that significantly predicted variance in scores [R^2 = .143, R^2_{adj} = .119, F(2, 71) = 5.945, p<.01]. Regression results for Digit Span Backward indicated on overall model of three predictors (GPA, Barkley Childhood Hyperactivity, and Texts Sent) that significantly predicted variance in scores [R^2 = .550, R^2_{adj} = .273, F(83 70) = 10.122, p<.001]. Regression results for Digit Span Sequence indicated on overall model of two predictors (BIS Cognitive Complexity and BIS Attention) that significantly predicted variance in scores [R^2 = .153, R^2_{adj} = .128, F(2, 71) = 6.352, p<.01]. Regression results for Digit Span Total indicated an overall model of eight predictors (FFMQ Nonjudge, BIS Cognitive Complexity, BIS Perseverance, Toronto Curiosity, STMDS Excessive Use, Barkley Childhood Inattention, Gender, and GPA) that significantly predicted variance in scores [R^2 = .495, R^2_{adj} = .433, F(8, 65) = 7.956, p<.001]. Full results for Digit Span are presented in Tables 14, 15, 16, 17, 18, 19, 20, and 21.

Table 14. Digit Span Forward Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	*p*	df_1	df_2
1. FFMQ Nonjudge	.307	.094	.081	.094	7.474	<.01	1	72
3. GPA	.379	.143	.119	.049	4.095	<.01	1	71

Table 15. Digit Span Forward Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
FFMQ Nonjudge	-.527	-.308	-2.808**	-.307	-.308
GPA	5.383	.222	2.024**	.220	.222

Note. ** Indicates significance at p <.01

Table 16. Digit Span Backward Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	*p*	df_1	df_2
1. GPA	.421	.177	.166	.177	15.507	<.001	1	72
2. Barkley Childhood Hyperactivity	.492	.242	.221	.065	6.110	<.001	1	71
3. Texts Sent	.550	.303	.273	.060	6.037	<.001	1	70

Table 17. Digit Span Backward Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
GPA	10.006	.447	4.449*	.421	.444
Barkley Childhood Hyperactivity	.268	.266	2.650**	.208	.264
Texts Sent	.029	.245	2.457***	.241	.245

Note. * Indicates significance at p <.001
Note. ** Indicates significance at p <.01
Note. *** Indicates significance at p <.05

Table 18. Digit Span Sequence Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	*p*	df_1	df_2
1. BIS Cognitive Complexity	.244	.060	.046	.060	4.557	<.05	1	72
1. BIS Attention	.390	.152	.128	.092	7.721	<.01	1	71

Table 19. Digit Span Sequence Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
BIS Cognitive Complexity	-1.414	-.406	-3.277**	-.244	-.358
BIS Attention	1.126	.344	2.779**	.153	.304

Note. ** Indicates significance at p <.01

Table 20. Digit Span Total Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. FFMQ Nonjudge	.323	.104	.092	.104	8.398	<.05	1	72
2. BIS Cognitive Complexity	.445	.198	.175	.093	8.271	<.001	1	71
3. GPA	.510	.260	.228	.062	5.881	<.001	1	70
4. Barkley Childhood Inattention	.555	.308	.268	.048	4.785	<.001	1	69
5. Gender	.623	.389	.344	.081	8.969	<.01	1	68
6. Toronto Curiosity	.651	.424	.373	.036	4.145	<.05	1	67
7. BIS Perseverance	.680	.462	.405	.038	4.624	<.05	1	66
8. STMDS Excessive Use	.703	.495	.433	.033	4.216	<.05	1	65

Table 21. Digit Span Total Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
FFMQ Nonjudge	-.324	-.203	-2.147***	-.323	-.257
BIS Cognitive Complexity	-1.401	-.391	-4.132*	-.273	-.456
GPA	7.107	.313	3.445*	.296	.393
Barkley Childhood Inattention	.517	.425	3.879*	.259	.434
Gender	-7.130	-.327	-3.286**	-.165	-.377
Toronto Curiosity	-.386	-.217	-2.231***	-.040	-.267
BIS Perseverance	1.335	.236	2.501***	.112	.296
STMDS Excessive Use	.314	.194	2.053***	.158	.247

Note. * Indicates significance at p <.001
Note. ** Indicates significance at p <.01
Note. *** Indicates significance at p <.05

PASAT. Regression results for PASAT 3 Seconds indicated on overall model of five predictors (GPA, BIS Perseverance, BIS Cognitive Complexity, Texts Received, and

Gender) that significantly predicted variance in scores [$R^2 = .308$, $R^2_{adj} = .257$, $F(5, 68) = 6.051$, $p<.001$]. Regression results for PASAT 2" indicated on overall model of four predictors (Age of First Cell Phone, BIS Cognitive Complexity, Gender and GPA) that significantly predicted variance in scores [$R^2 = .334$, $R^2_{adj} = .295$, $F(4, 69) = 8.639$, $p<.001$]. Full results for PASAT are presented in Tables 22, 23, 24, and 25.

Table 22. PASAT 3 Seconds Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. GPA	.300	.090	.077	.090	7.131	<.01	1	72
2. BIS Perseverance	.395	.156	.133	.066	5.571	<.01	1	71
3. Texts Received	.462	.214	.180	.057	5.093	<.001	1	70
4. BIS Cognitive Complexity	.516	.266	.224	.053	4.981	<.001	1	69
5. Gender	.555	.308	.257	.041	4.071	<.001	1	68

Table 23. PASAT 3 Seconds Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
GPA	5.740	.276	2.670**	.300	.308
BIS Perseverance	1.786	.344	3.190**	.259	.361
Texts Received	.029	.265	2.564*	.185	.297
BIS Cognitive Complexity	-.826	-.251	-2.363*	-.190	-.275
Gender	-4.151	-.208	-2.018*	-.190	-.238

Note. * Indicates significance at p <.001
Note. ** Indicates significance at p <.01

Table 24. PASAT 2 Seconds Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. Age of First Cell Phone	.380	.144	.132	.144	12.127	<.001	1	72
2. BIS Cognitive Complexity	.481	.231	.209	.087	8.033	<.01	1	71
3. GPA	.537	.289	.258	.058	5.680	<.05	1	70
4. Gender	.578	.334	.295	.045	4.643	<.05	1	69

Table 25. PASAT 2 Seconds Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
Age of First Cell Phone	1.527	.279	2.693***	.280	.265
BIS Cognitive Complexity	-1.014	-.270	-2.699**	-.302	-.265
GPA	6.585	.277	2.725*	.333	.268
Gender	-5.104	-.223	-2.155*	-.241	-.212

Note. * Indicates significance at p <.001
Note. ** Indicates significance at p <.01
Note. *** Indicates significance at p <.05

Processing Speed

Coding. Coding did not have any predictors entered.

Symbol Search. Regression results for Symbol Search indicated on overall model of two predictors (Barkley Current Hyperactivity and BIS Attention) that significantly predicted variance in scores [R^2 = .158, R^2_{adj} = .134, F(2, 71) = 6.660, p<.01]. Full results for Symbol Search are presented in Tables 26 and 27.

Table 26. Symbol Search Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. Barkley Current Hyperactivity	.258	.066	.053	.066	5.119	<.001	1	72
2. BIS Attention	.397	.158	.134	.092	7.723	<.01	1	71

Table 27. Symbol Search Coefficients for Final Model

	B	*β*	*t*	Bivariate *r*	Partial *r*
Barkley Current Hyperactivity	.581	.432	3.438*	.258	.378
BIS Attention	-1.237	-.349	-2.779**	-.133	-.313

Note. * Indicates significance at p <.001
Note. ** Indicates significance at p <.01

Attention

Regression results for CPT-II Omissions indicated on overall model of two predictors (BIS Motor and Age of First Cell Phone) that significantly predicted variance in scores [R^2 = .167, R^2_{adj} = .143, $F(2, 71)$ = 7.097, p<.01]. Full results for CPT-II Omissions are presented in Tables 28 and 29.

Table 28. CPT-II Omissions Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. BIS Motor	.273	.074	.062	.074	5.795	<.05	1	72
2. Age of First Cell Phone	.408	.167	.143	.092	7.847	<.05	1	71

Table 29. CPT-II Omissions Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
BIS Motor	-.493	-.343	-3.086***	-.273	-.334
Age of First Cell Phone	-.936	-.312	-2.801***	-.234	-.304

Note. *** Indicates significance at p <.05

Impulsivity

Regression results for CPT-II Clinical Confidence Percentage indicated on overall model of four predictors (FFMQ Describe, BIS Motor, FFMQ Nonjudge, and Gender) that significantly predicted variance in scores [R^2 = .348, R^2_{adj} = .310, $F(4, 69)$ = 9.215, p<.001]. Regression results for CPT-II Commissions indicated on overall model of two predictors (BIS Cognitive Complexity and STMDS Excessive Use) that significantly predicted variance in scores [R^2 = .123, R^2_{adj} = .099, $F(2, 71)$ = 4.988, p<.01]. Regression results for CPT-II Hit RT indicated on overall model of four predictors (BIS Cognitive Complexity, BIS Motor, Barkley Childhood Hyperactivity, and SMUQ Withdrawal) that significantly predicted variance in scores [R^2 = .256, R^2_{adj} = .213, $F(4, 69)$ = 5.936, p<.001]. Full results for PASAT are presented in Tables 30, 31, 32, 33, 34, and 35.

Table 30. CPT-II Clinical Confidence Percentage Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. FFMQ Describe	.331	.110	.097	.110	8.861	<.001	1	72
2. BIS Motor	.449	.202	.179	.092	8.218	<.01	1	71
3. FFMQ Nonjudge	.538	.289	.259	.087	8.570	<.01	1	70
4. Gender	.590	.348	.310	.059	6.267	<.05	1	69

Table 31. CPT-II Clinical Confidence Percentage Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
FFMQ Describe	-1.361	-.365	-3.472*	-.331	-.386
BIS Motor	1.500	.322	3.188**	.224	.358
FFMQ Nonjudge	.971	.324	3.276**	.217	.367
Gender	-10.468	-.257	-2.503***	-.330	-.289

Note. * Indicates significance at p <.001
Note. ** Indicates significance at p <.01
Note. *** Indicates significance at p <.05

Table 32. CPT-II Commissions Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. BIS Cognitive Complexity	.254	.064	.051	.064	4.953	<.05	1	72
2. STMDS Excessive Use	.351	.123	.099	.059	4.764	<.05	1	71

Table 33. CPT-II Commissions Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
BIS Cognitive Complexity	1.025	.256	2.307***	.254	.240
STMDS Excessive Use	.439	.243	2.183***	.240	.251

Note. *** Indicates significance at p <.05

Table 34. CPT-II Hit RT Model Summary

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
1. BIS Cognitive Complexity	.234	.055	.042	.055	4.169	<.01	1	72
2. BIS Motor	.362	.131	.106	.076	6.212	<.001	1	71
3. Barkley Childhood Hyperactivity	.449	.202	.168	.071	6.244	<.05	1	70

Table 34. cont.

	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	df_1	df_2
4. SMUQ Withdrawal	.506	.256	.213	.054	5.012	<.05	1	69

Table 35. CPT-II Hit RT Coefficients for Final Model

	B	β	t	Bivariate r	Partial r
BIS Cognitive Complexity	-.859	-.345	-3.219**	-.234	-.361
BIS Motor	.753	.434	3.701*	.231	.407
Barkley Childhood Hyperactivity	-.204	-.287	-2.498***	-.121	-.288
SMUQ Withdrawal	-1.201	-.237	-2.239***	-.169	-.260

Note. * Indicates significance at p <.001
Note. ** Indicates significance at p <.01
Note. *** Indicates significance at p <.05

CHAPTER IV

DISCUSSION

The purpose of the present study was to examine objective measurements of cognitive performance in tasks a clinician may use when evaluating an adult for ADHD. An adult evaluation such as this can, at times, be complicated as the DSM-5 requires a certain number of impulsivity and/or hyperactivity symptoms to have been present prior to the age of 12 for a diagnosis to be rendered regardless of the age at the time a person seeks a professional diagnosis. The issue that a clinician may encounter is that a person may have not received a professional diagnosis as a child due to a number of factors such as lack of access to providers and high cost of assessment. Additionally, even though an assessment may have been completed, clinicians and/or clients may not have access to those records to confirm the exact diagnosis rendered. Because of these issues, clinicians may need to rely on self-reported diagnoses, self-reported measures of childhood symptoms, and parental confirmation if a client is willing to sign a release of information. The problem of relying on self-report is that a client may attempt to malinger symptoms of ADHD in order to receive a diagnosis in efforts to obtain stimulant medication prescriptions and/or special educational accommodations. Therefore, clinicians may also decide to give a client additional cognitive tests to rule out differential diagnoses such as a specific learning disorder, hearing or vision difficulties, or other developmental disorders of communication or cognitive functioning. When other possible diagnoses are ruled out, a clinician must continue to rely on their clinician judgment based on assessment data and clinical interview. For example, a person may appear to have dementia, when in fact they have a urinary tract infection causing abrupt pseudodementia symptoms. This example is rather quick to assess as a simple urinary analysis may provide the needed information to determine the differential diagnosis. However, the same is not available when diagnosing ADHD. Another example is a client may endorse symptoms such as psychomotor agitation, slowness, and difficulty concentrating. These may appear to be related to ADHD; however, these symptoms are also related to depression which a clinician has hopefully considered and further assessed for in their evaluation. These examples highlight the importance of considering available alternative explanations and, therefore, differential diagnoses than ADHD. The author, while evaluating a client who presented with reported symptoms of ADHD including inability to focus, pay attention in class, daydream, and concentrate, considered the possibility of cell phone distraction as the client viewed their phone between every test and subtest administered. Having not considered a differential of overuse, distraction, or dependence on a cell phone as accounting for the client's reported symptoms, the author reviewed current research to determine what impact may be observed on cognitive functioning assessment data. Unfortunately, most research found relied on self-reported cognition rather than the objective tests used with this client.

Further investigation of research to offer insight for future adult ADHD evaluations revealed different measures for cell phone overuse, dependence, and even addiction. Reviewing behavioral addiction research and cognitive functioning was somewhat fruitful in that it has been linked to executive functioning, working memory, processing speed, impulsivity, and emotional regulation. However, as cell phone addiction has not been accepted as a definitive behavioral addiction, assuming prior research with cognitive functioning equated to cell phone overuse or dependence was premature. Therefore, the author sought to investigate the overlap between ADHD and cell phone use with regard to those cognitive functions.

Hypothesis 1 – Gender Differences

First, differences between men and women were assessed with regard to age of first cell phone, social media use, and text-message dependency to determine if this study's data fit with prior research. Women reported significantly decreased sense of control over their social media use such as losing track of time and staying on social media longer than intended. This result is in line with prior research that women use smartphones for social relationship maintenance more than men (Duggan & Brenner, 2013; Jenaro et al., 2007) and may be at greater risk of developing habitual behaviors by using smartphones for social relationships (Van Deursen et al., 2015). Present study results also suggest that in addition to type of use (i.e. social relationship maintenance), the length of time a person owns a cell phone may also influence problematic use as women reported significantly younger ages they received their first cell phone than men. This fits with prior research suggesting length of cell phone ownership was related to higher self-attribution of addiction (Billieux et al., 2008).

Hypothesis 2 – Cell Phone Usage and Text Message Dependence

It was hypothesized that reported cell phone usage would be positively correlated with text-message dependence. Participants did perceive higher excessive use in accordance with higher numbers of reported daily texts sent and received. However, they did not report increased anxiety, disappointment or need to maintain relationships. Interestingly, this suggests that participants of the current study may have taken a more concrete thought approach to their responses on text-message dependence. In other words, they acknowledged and equated cell phone usage numbers to excessive use; however, they did not consider usage to be related to abstract concepts such as anxiety and emotional needs of relationship maintenance. The present study did not manipulate loss or perceived loss of cell phone which could account for the lack of correlation between cell phone usage and anxiety or disappointment as found in prior research (Cheever et al., 2014; Clayton et al., 2015; Elhai et al., 2018; Shaffer, 1996; Young, 1999). An additional consideration is that the reliability of the STMDS with this study's participants was poor (α=.46, .53, and .52) which is in contrast to measure developers' reported reliabilities of α=.81, .85, and .78.

Hypothesis 3 – Cognitive Functioning

The contribution of text-message dependence, cell phone usage, self-reported ADHD symptoms, and self-reported impulsivity as predictors of cognitive functioning were examined. For purposes of explanation and in accordance with typical clinician consideration, cognitive functioning has been divided into executive functioning, working memory, and processing speed.

Executive Functioning

The Trail Making Test is considered to be a measure of motor speed, visual search/scanning, divided attention, and processing speed. It may be used to assess a person's ability to switch between tasks which is thought to take place in the thalamus which plays a role in executive functioning and attention (Van der Werf et al., 2003). Results of the present study indicated GPA was the only significant predictor of switching which is measured by subtracting the time to complete Trails B (connecting 1-A-2-B-3-C…) from Trails A (connecting 1-2-3…).

Stroop is considered a measure of executive functioning tasks of selective attention, processing speed, and inhibition. As was observed with results of TMT, GPA was the only significant predictor of participants' ability to inhibit irrelevant information as measured by the Stroop Inference score.

Together, results from TMT and Stroop suggest that either there is no relation or contribution of text-message dependence, cell phone usage, self-report ADHD symptoms, or self-report impulsivity to cognitive functioning; or TMT B-A and Stroop Interference were not good measures for these executive functions.

COWAT, as a measure of phonemic and semantic fluency, may be used to assess the extent to which a person's speed of processing information between cortical and subcortical regions. The FAS task involves subcortical regions while Animal, or category, involves the cortical region. Examining the difference between these two scores gives clinician an idea of a person's strengths or weaknesses between these two brain areas. A person who exhibits deficits in the Animals task and, therefore, cortical deficit may have experienced stroke, traumatic brain injury, or dementia of the Alzheimer's type. Whereas, a person with deficits in the FAS task is more indicative of someone with a subcortical stroke or traumatic brain injury. Additionally, deficits in subcortical vs. cortical suggest potential ADHD processing difficulties as more processing time (i.e. slow processing speed) is required for them to switch between these brain regions to extract information. The present study found texts checked and texts received to predict scores on FAS and Animals, respectively. This appears to suggest that the more a person engages in texting behavior, the lower there scores may be. Additionally, self-reported mindfulness trait FFMQ Observe which is considered to measure the ability to express inner experiences in words predicted better scores on both FAS and Animals. Therefore, participants who perceive themselves with trait observational mindfulness did better on the COWAT.

CVLT-II not only measures memory, it is also a measure of learning. Present study results did not find any predictors with regard to learning as measured by Trials 1-5. However, participants who self-reported current inattention difficulties, as measured by BAARS Current Inattention, performed worse on short-term free recall but not long-term recall. A clinician may interpret a person who performs better on long-term recall than short-term recall to potentially have attention difficulties. Although it appears self-reported attention may relate to objective measure of attention, this result is not consistent in the present study.

With regard to the hypothesis, the only task that suggests a relationship with cell phone behavior in the present study is COWAT. A clinician who uses this measure as part of an adult ADHD evaluation may want to also consider the person's cell phone behavior in light of these results.

Working Memory

Examination of the different tasks involved in WAIS-IV Digit Span may be used to determine an individual's working memory abilities. Although number of daily texts sent was found as a significant predictor of Digit Span Backward which measures working memory in addition to repetition ability and attention, it appears that more texts sent were related to higher scores. This might suggest that a person's working memory abilities may be enhanced by repeated practice of typing and sending texts. Additionally, participants who indicated symptoms of childhood hyperactivity also scored better which would be in contrast to clinician interpretations that hyperactivity in ADHD would impact objective measures of working memory. This highlights the potential problem with relying on retrospective self-report of childhood symptoms.

Gender differences and cognitive impulsivity were significant predictors of PASAT scores across both three and two second trials. This indicates that participants who consider themselves to be impulsive insofar as they view themselves as nonplanners, experience boredom with complex thought problems, and instant gratification seekers, performed worse on this task. This self-assessment tends to fit the idea of lack of motivation to engage in divided attention and focused cognitive flexibility that the task requires. Therefore, a clinician may want to consider low scores on PASAT as a potential reflection of motivation in addition to cognitive deficits.

Processing Speed

Slow processing speed is considered to be a potential indication of ADHD as low activity in subcortical regions are combined with high activity in cortical regions. As self-reported current hyperactivity symptom scores increased, so too did processing speed scores as measured by WAIS-IV Symbol Search. However, as participants' attention difficulty symptoms increased, their processing speed was slower. This suggests that clinicians may want to consider self-report symptoms on BIS-11 as opposed to BAARS related more to actual current attention functioning and processing speed.

Hypothesis 4 – Attention and Impulsivity

The contribution of text-message dependence, cell phone usage, self-reported ADHD symptoms, and self-reported impulsivity as predictors of attention and impulsivity were examined. The present study results on CPT-II Omissions, which is considered a measure of attention, revealed that the age participants received their first cell phone predicted their scores. Scores on inattention were higher the longer a participant owned a cell phone. This is similar to results from Billieux et al.'s findings that length of cell phone ownership was related to higher self-attribution of addiction (2008). Interestingly, however, self-reported motoric impulsivity also predicted attention as measured by CPT-II Omissions. This runs contradictory to predictions because as participant's self-rated impulsivity increased, their Omission scores decreased which would suggest that motoric impulsivity enhanced attention.

Results revealed self-rated excessive use of text-messaging dependence predicted impulsivity scores on CPT-II Commissions. As ratings of excessive use increased, so did the number of Commissions. This suggests that as a self-report measure, STMDS Excessive Use subscale appears to relate to actual poor performance on this measure. Therefore, clinicians may consider this measure to possibly accurately reflect how a person may perform on objective measures of impulsivity. However, it is limited in that no report of actual cell phone use (i.e. texts received, sent, or checked) were included in the predictor model. This does appear to support the main focus of this study in that the author was interested in whether cell phone overuse would impact objective measures of impulsivity. This is also interesting in that self-report ADHD symptoms did not significantly predict impulsivity scores. Motivation may have been a factor as the model included BIS Cognitive Complexity as a predictor. This subscale of impulsivity reflects a lack of motivation to engage in divided attention.

In comparison to the impulsivity measure of Commissions on CPT-II, the Clinical Confidence Percentage, which is an overall measure of possible ADHD symptoms, did not include any actual or self-reported cell phone behaviors. Self-perceived trait mindfulness, FFMQ Describe and Nonjudge, were significant predictors; however, the direction of their impact was contradictory. Results are, therefore, mixed as to whether or not trait mindfulness buffered these scores. Self-assessed motoric impulsivity significantly predicted scores such that higher perceived motoric impulsivity resulted in higher overall measure of possible ADHD. This indicates that clinicians may consider self-reported motor impulsivity as measured by BIS Motor subscale to reflect objective measurement of overall CPT-II Clinical Confidence Percentage.

CPT-II Hit RT is a measure of inattention as well as impulsivity. Participant results revealed self-reported motoric impulsivity predicted inattention in that as symptoms of motoric impulsivity increased, Hit RT also increased which suggests inattention. With regard to impulsivity, low scores on Hit RT were significantly predicted by self-reported lack of motivation and childhood symptoms of hyperactivity. Additionally, self-reported SMUQ Withdrawal predicted impulsivity. This result is somewhat in line with research on emotional regulation contributing to Internet use, social networking sites, and psychopathology (Caplan, 2010; Casale et al., 2016; Hormes et al., 2014; Rottenberg & Gross, 2003; Rottenberg & Johnson, 2007). However, emotional regulation is thought to affect attention (Gross, 1998, 2008) which would be contradictory to the present study results as self-reported avoidance of places without Internet or enduring them with anxiety suggested impulsivity rather than inattention.

Summary

Given advancements in technology access and current ongoing and beginning research in the effects of cell phone and social media use behaviors, the present study provided a start in examining the variance on objective measures of cognitive performance. When evaluating for ADHD after any potential other diagnoses have been ruled out, a clinician may examine the results of a person's executive functioning, working memory, processing speed, attention, and impulsivity. The general consensus is that in addition to attention and impulsivity deficits, a person with ADHD may show slower processing speed which impacts working memory and executive functioning. As discussed above, some self-report measures predicted score variances. Again, as prior research has shown, this is problematic as it may not reflect actual behaviors and increase false positive diagnoses of ADHD. However, two particular findings were remarkable.

First, actual numbers of reported texting behavior predicted COWAT scores. This observation warrants further investigation as variance in scores in both FAS and Animals which represent subcortical and cortical functioning were predicted by reported texting behavior. A clinician may consider the differential between FAS and Animals when deciding, based on their clinical judgment, that an ADHD deficit of processing speed is present.

Another area that warrants further investigation is CPT-II Omissions as age of first cell phone was a predictor of inattention. This suggests that the longer a person owns a cell phone, the greater change they may have to develop inattention behaviors. This could impact a clinician's interpretation of CPT-II Omissions as it is a scale a clinician may consider when evaluating a person for ADHD.

Limitations

Generalizability of the present study is rather limited. The majority of participants were White women age 18-22 enrolled in introductory level psychology courses in a mid-size upper Midwest university. Participants who reported currently taking stimulant medications and/or prior ADHD diagnoses were excluded from analyses. Assessment of participants with and without ADHD could provide additional clarity and wider breadth of score variations as impulsivity is found in individuals with ADHD and other psychological disorders throughout the lifespan. It is possible that individuals with difficulties in impulsivity have either decided not to attend college, not to attend this particular college, may not be enrolled in a psychology course, or were not accepted to a university due to impulsivity and/or other learning or cognitive disorders.

While objective measures were conducted, several measures including text messaging continued to rely on self-report data. Estimates of text message usage may have been different than actual usage. Self-report measures rely on a person's insight and awareness. Participants could have also lacked motivation to fully consider their responses as they were incentivized by time and credit rather than concern for diagnoses as would be reflected in someone seeking official clinical evaluation. Additionally, self-report measures of childhood ADHD symptoms rely on retrospective consideration. This, in addiction to self-reported current ADHD symptoms have been shown to result in high rates of false positives (Mannuzza et al., 2002).

Self-report measures used in the present study were chosen with consideration for their good reliability and construct validation. However, construct validation measures contain their own inherent limitations as they rely on prior researchers' constructs of the psychological phenomena and abstract concepts attempted to be measured. Reliability of self-report measures (SMUQ, Toronto, STMDS, FFMQ, BIS-11) of social media use, text-messaging dependence, impulsivity, and state/trait mindfulness as used in the present study did not reveal the same levels of reliability as reported in prior research. Present study reliabilities as measured by Cronbach's α ranged from good to poor (.87 to .36). This greatly limited the present study results as these measures do not appear to adequately measures the constructs as intended.

A number of objective assessments have been used by past researchers and clinicians to assess the cognitive functioning examined in this study (i.e. executive functioning, working memory, processing speed, attention, and impulsivity). The present study examined only a handful of possible tasks. Others may be found to have elicited greater variance in the variables under examination.

The present study attempted to recruit 75-100 participants as initial power analysis indicated a sample size of 75 needed under t-tests, linear multiple regression: fixed model, single regression coefficient. The author used stepwise regression to conserve degrees of freedom; however, post hoc analysis indicated a sample size of 79 needed to detect a medium effect with 3 or more independent variables. However, the present study did have enough participants to detect large effect sizes with power equal to .80.

Clinical Implications/Future Directions

Given increasing stimulant use for nonmedical purposes (SAMHSA, 2014), proper diagnosis of impulsivity in young adults is important in order to direct future therapeutic interventions. Interventions for an ADHD diagnosis may range from medication to psychotherapy, while impulsivity from use, dependence, or addiction to cell phone or other technology would warrant psychological therapy directed to behavior modification and treatment for potential dependence and/or addiction. Future studies may want to replicate the current study to include individuals with prior diagnosis of ADHD. They may find alternative measures with higher internal reliability especially with respect to technology dependence and/or addiction as this is a fairly new area of research with new measures being developed. Additionally, as impulsivity is a multi-dimensional and complex process, neuroimaging studies may be beneficial to consider in addition to neuropsychology assessments to determine if different pathways are involved in cell phone behavior as opposed to ADHD that result in different observations on objective assessments.

APPENDICES

Appendix A

Self-Perception of Text-Message Dependency Scale (STMDS)

1. After sending a text message, I check my mailbox repeatedly to see if I had received a response

   _____ Yes _____ No

2. I feel disappointed if I don't get a reply to my message immediately

   _____ Yes _____ No

3. I feel anxious when people don't immediately reply to my text message

   _____ Yes _____ No

4. I often check my mailbox to see if I had a new text message

   _____ Yes _____ No

5. I feel disappointed if I don't receive any text-messages

   _____ Yes _____ No

6. I sometimes send text-messages while engaging in a conversation with another person

   _____ Yes _____ No

7. I sometimes spend many hours on text-messages

   _____ Yes _____ No

8. I often exchange many text-messages in a short period of time

   _____ Yes _____ No

9. I use text-messages even while I am talking with friends

   _____ Yes _____ No

10. I consider myself a quick-typist on mobile phones

_____ Yes _____ No

11. I cannot maintain new friendships without text-messages

_____ Yes _____ No

12. I can't form any new relationships without using text messages

_____ Yes _____ No

13. I think my relationships would fall apart without text messages

_____ Yes _____ No

14. Without text-messages, I would not be able to contact friends whom I cannot meet on a daily basis

_____ Yes _____ No

15. Without using text-messages, I can't say what is on my mind

_____ Yes _____ No

Appendix B

Background Information

1. Age: ________

2. Gender: □ Male □ Female

3. Race:
   - □ Asian
   - □ Black/African American
   - □ Latino/Hispanic
   - □ Native American/Alaskan Native
   - □ Native Hawaiian/Other Pacific Islander
   - □ Non-Hispanic White/Caucasian
   - □ Other (please specify) _____________

4. Yearly household income
   - □ under 20,000
   - □ 20,000-30,000
   - □ 30,000-40,000
   - □ 40,000-50,000
   - □ 50,000-60,000
   - □ 60,000-70,000
   - □ 70,000-100,000
   - □ 100,000 +

5. Highest education completed
   - □ Some high school
   - □ High school diploma
   - □ Some trade/technical school or community college
   - □ Some college
   - □ Associate Degree
   - □ Bachelor Degree
   - □ Masters Degree
   - □ PhD, MD, or other professional degree
   - □ Other (describe)______________

6. Relationship Status
   - □ Single
   - □ Dating
   - □ Engaged
   - □ Married
   - □ Divorced/Separated
   - □ Cohabiting
   - □ Widowed
   - □ Other (describe)______________

7. Current Occupation: ____

8. Current and/or past psychological diagnoses:______________________________
____

9. Current medications (include vitamins and supplements):_________________
____

10. At what age did you begin using a cell phone for the purpose of sending or receiving a text message? __________

11. How many text messages do you send in an average day? _____

12. How many text messages do you receive in an average day? _____

13. How many hours do you spend sending or receiving text messages in an average day? ______

14. Do you have an unlimited text message cell phone plan? ____. If no, please explain (e.g. pay for each individual message or a limited number of texts allowed per month)

____

15. How many times per day to do check your cell phone for text messages? _______

16. Current GPA _____

17. Current number of credits taken _____ (do not include credits in progress).

Appendix C

Consent Form

Examining the Relationship Between Technology Usage and Objective Assessments of Impulsivity and Cognitive Performance in Young Adults

This study is being conducted as part of a doctoral dissertation in the psychology department at the University of North Dakota (UND). Please take your time in reading through this document. If you choose to continue with this research study, please indicate your acceptance to participate by signing and dating this form.

Study

100 participants age 18 – 24 will be recruited through UND's SONA during Fall 2016 and Spring 2017 semesters as necessary. You will be asked to fill out a few questionnaires today, and complete hands-on, interactive cognitive tests. This study is expected to take no more than four hours. Students will receive up to four hours of credit that may be used toward psychology classes at UND.

Participation

Participation is completely voluntary. If a student, your academic standing within UND will not be affected by your participation or lack thereof. At any time you wish end the study, you may decide to stop. Your data will not be entered into the research and you will not be adversely penalized.

Confidentiality

You will receive a copy of this consent form for your personal records. All information that you provide on this consent form as well as any information you provide on the subsequent data forms will be kept confidential and anonymous. Consent forms will be stored separate from any data forms and kept in a locked room in Corwin/Larimore Hall. All data forms will be kept in a separate locked room in Corwin/Larimore Hall. Forms will be retained for three (3) years. After that time, all documents will be destroyed. Dr. F. Richard Ferraro, Sheryl Holter Vogel, and IRB auditors are the only individuals who will have access to locked files.

Risk

No physical or financial risk is anticipated during your participation in this study. While participating, you may feel mild anxiety and/or lowered self-esteem. If you experience any discomfort or distress, please contact your local mental health provider. UND students may contact University Counseling Center (701) 777-2127, Psychological Services Center (701) 777-3691, University Crisis Coordination Team (701) 777-3491. Any costs associated with counseling due to anxiety, distress or other adverse reaction will be the responsibility of the participant.

If you have any questions or concerns about this research study, please contact Sheryl Holter Vogel at (218) 791-3688 sheryl.holter@und.edu or Dr. F. Richard Ferraro at (701) 777-2414 f.richard.ferraro@email.und.edu. This research study has been reviewed by the University of North Dakota Institutional Review Board (IRB). If you have any questions about your rights as a participant, concerns, or complaints, the IRB may be reached at (701) 777-4279.

Your signature below indicates your consent to participate in this study. Thank you.

Date	Signature of Participant
Date	Signature of Researcher

Appendix D

Barrett Impulsivity Scale-11 (BIS-11)

Directions: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and circle the appropriate number on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly. Circle one.

	Rarely	Occasionally	Often	Almost Always/ Always
1. I plan tasks carefully.	1	2	3	4
2. I do things without thinking.	1	2	3	4
3. I make up my mind quickly.	1	2	3	4
4. I am happy-go-lucky.	1	2	3	4
5. I don't "pay attention".	1	2	3	4
6. I have "racing" thoughts.	1	2	3	4
7. I plan trips well ahead of time.	1	2	3	4
8. I am self-controlled.	1	2	3	4
9. I concentrate easily.	1	2	3	4
10. I save regularly.	1	2	3	4
11. I "squirm" at plays or lectures.	1	2	3	4
12. I am a careful thinker.	1	2	3	4
13. I plan for job security.	1	2	3	4
14. I say things without thinking.	1	2	3	4
15. I like to think about complex problems.	1	2	3	4
16. I change jobs.	1	2	3	4
17. I act "on impulse".	1	2	3	4
18. I get easily bored when solving thought problems.	1	2	3	4
19. I act on the spur of the moment.	1	2	3	4
20. I am a steady thinker.	1	2	3	4
21. I change residences.	1	2	3	4
22. I buy things on impulse.	1	2	3	4
23. I can only think about one thing at a time.	1	2	3	4
24. I change hobbies.	1	2	3	4
25. I spend or charge more than I earn.	1	2	3	4
26. I often have extraneous thoughts when thinking.	1	2	3	4
27. I am more interested in the present than the future.	1	2	3	4
28. I am restless at the theater or lectures.	1	2	3	4
29. I like puzzles.	1	2	3	4
30. I am future oriented.	1	2	3	4

Appendix E

Toronto Mindfulness Scale

Instructions: We are interested in what you just experienced. Below is a list of things that people sometimes experience. Please read each statement. Next to each statement are five choices: “not at all”, “a little”, moderately”, “quite a bit”, and “very much”. Please indicate the extent to which you agree with each statement. In other words, how well does the statement describe what you just experienced, just now?

	Not at all	A little	Moderately	Quite a bit	Very much
1. I experienced myself as separate from my changing thoughts and feelings.					
2. I was more concerned with being open to my experiences than controlling or changing them.					
3. I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings or sensations.					
4. I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things “really” are.					
5. I was curious to see what my mind was up to from moment to moment.					
6. I was curious about each of the thoughts and feelings that I was having.					
7. I was receptive to observing unpleasant thoughts and feelings without interfering with them.					
8. I was more invested in just watching my experiences as they arose, than in figuring out what they could mean.					
9. I approached each experience by trying to accept it, no matter whether it was pleasant or unpleasant.					
10. I remained curious about the nature of each experience as it arose.					
11. I was aware of my thoughts and feelings without overidentifying with them.					
12. I was curious about my reactions to things.					
13. I was curious about what I might learn about myself by just taking notice of what my attention gets drawn to.					

Appendix F

Five Facet Mindfulness Questionnaire

Directions: Please rate each of the following statements using the scale provided. Circle the number that best describes your own opinion of what is generally true for you.

	Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true
1. When I'm walking, I deliberately notice the sensations of my body moving.	1	2	3	4	5
2. I'm good at finding words to describe my feelings	1	2	3	4	5
3. I criticize myself for having irrational or inappropriate emotions.	1	2	3	4	5
4. I perceive my feelings and emotions without having to react to them.	1	2	3	4	5
5. When I do things, my mind wanders off and I'm easily distracted.	1	2	3	4	5
6. When I take a shower or bath, I stay alert to the sensations of water on my body.	1	2	3	4	5
7. I can easily put my beliefs, opinions, and expectations into words.	1	2	3	4	5
8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.	1	2	3	4	5
9. I watch my feelings without getting lost in them.	1	2	3	4	5
10. I tell myself I shouldn't be feeling the way I'm feeling.	1	2	3	4	5
11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.	1	2	3	4	5
12. It's hard for me to find the words to describe what I'm thinking.	1	2	3	4	5
13. I am easily distracted.	1	2	3	4	5
14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.	1	2	3	4	5
15. I pay attention to sensations, such as the wind in my hair or sun on my face.	1	2	3	4	5
16. I have trouble thinking of the right words to express how I feel about things.	1	2	3	4	5

17. I make judgments about whether my thoughts are good or bad.	1	2	3	4	5
18. I find it difficult to stay focused on what's happening in the present.	1	2	3	4	5
19. When I have distressing thoughts or images, I "step back" and am aware of the thoughts or image without getting taken over by it.	1	2	3	4	5
20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.	1	2	3	4	5
21. In difficult situations, I can pause without immediately reacting.	1	2	3	4	5
22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.	1	2	3	4	5
23. It seems I am "running on automatic" without much awareness of what I'm doing.	1	2	3	4	5
24. When I have distressing thoughts or images, I feel calm soon after.	1	2	3	4	5
25. I tell myself that I shouldn't be thinking the way I'm thinking.	1	2	3	4	5
26. I notice the smells and aromas of things.	1	2	3	4	5
27. Even when I'm feeling terribly upset, I can find a way to put it into words.	1	2	3	4	5
28. I rush through activities without being really attentive to them.	1	2	3	4	5
29. When I have distressing thoughts or images I am able just to notice them without reacting.	1	2	3	4	5
30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.	1	2	3	4	5
31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.	1	2	3	4	5
32. My natural tendency is to put my experiences into words.	1	2	3	4	5
33. When I have distressing thoughts or images, I just notice them and let them go.	1	2	3	4	5
34. I do jobs or tasks automatically without being aware of what I'm doing.	1	2	3	4	5
35. When I have distressing thoughts or images, I judge myself as good or bad,	1	2	3	4	5

depending what the thought/image is about.					
36. I pay attention to how my emotions affect my thoughts and behavior.	1	2	3	4	5
37. I can usually describe how I feel at the moment in considerable detail.	1	2	3	4	5
38. I find myself doing things without paying attention.	1	2	3	4	5
39. I disapprove of myself when I have irrational ideas.	1	2	3	4	5

Appendix G

Social Media Use Questionnaire

Directions: Please rate each of the following statements using the scale provided. Circle the number that best describes your own opinion of what is generally true for you.

	Never	Rarely	Sometimes	Often	Always
1. I struggle to stay in places where I won't be able to access social network sites.	0	1	2	3	4
2. I feel angry when I am not able to access my social network account.	0	1	2	3	4
3. My relatives and friends complain that I spend too much time using social network sites.	0	1	2	3	4
4. I lose track of time when using social network sites.	0	1	2	3	4
5. I use social network sites when I am in the company of friends.	0	1	2	3	4
6. I feel anxious when I am not able to check my social network account.	0	1	2	3	4
7. I stay online longer than initially intended.	0	1	2	3	4
8. I spend a large proportion of my day using social network sites.	0	1	2	3	4
9. I feel guilty about the time that I spend on social network sites.	0	1	2	3	4

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