

ASSOCIATIONS BETWEEN HYPERACTIVE-IMPULSIVE AND  
INATTENTIVE SYMPTOMS OF ADHD AND SELF-REPORT AND  
BEHAVIORAL MEASURES OF IMPULSIVITY.

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## THESIS ABSTRACT

Associations between Hyperactive-Impulsive and Inattentive Symptoms of  
ADHD and Self-Report and Behavioral Measures of Impulsivity.

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Those with Attention Deficit-Hyperactivity Disorder (ADHD) are diagnosed with one of three subtypes, Inattentive, Hyperactive/Impulsive, or the Combined subtype. Recent research has concluded that impulsive behavior is the product of multiple psychological traits instead of one impulsivity construct (Whiteside & Lynam, 2001). The strength of these different impulsivity sub-dimensions affect which type(s) of impulsive behavior an individual exhibits. This project examined the relationship between scores on self-report and behavioral measures of impulsivity constructs and scores on a measure of ADHD subtype symptoms. The secondary data used in this proposal was collected from 138 undergraduate students at Rutgers University – Camden. Participants were administered several behavioral measures of impulsivity (the Go-Stop and Immediate Memory Task), the Urgency Premeditation Perseverance Sensation Seeking Impulsive Behavior Subscales with the Positive Urgency Measure (UPPS-P) (a questionnaire measuring different impulsivity dimensions), and the

Adult ADHD Self-Report Scale (ASRS). Analyses were conducted to examine the associations between ADHD subtypes and impulsivity sub-dimensions. Throughout the tests conducted both subtypes were strongly associated with self-report measures of impulsivity and not associated with behavioral measures of impulsivity. These analyses revealed that generally symptoms of ADHD subtypes are not differently associated with measures of impulsivity. The one exception was the Inattentive subtype of ADHD's unique associations with a self-reported lack of Perseverance.

## **Introduction**

Attention Deficit Hyperactivity Disorder (ADHD) is a common neurodevelopmental disorder which affects approximately 5.9 – 7.1% of youth and 5% of adults (Willcutt, 2012). The American Psychiatric Association categorizes those with ADHD into one of three subtypes, determined by the type of behavior they exhibit (American Psychiatric Association, 1994). The Predominantly Inattentive subtype is characterized by behavior indicative of disorganization, carelessness, and a lack of sustained attention. The Predominantly Hyperactive/Impulsive subtype is characterized by behavior indicative of feelings of restlessness, impatience, and the compulsion to be active in all situations. The Combined subtype is diagnosable when behaviors indicative of both the Inattentive and Hyperactive/Impulsive subtypes are present. These symptoms cause significant impairment in social, academic, or occupational functioning, and are more frequent and severe than other individuals of the same developmental level (American Psychiatric Association, 1994).

Genetics research suggests that ADHD symptoms are extreme behaviors at the low functioning end of the normal behavior continuum (Larsson, Anckarsater, Rastam, Chang, & Lichtenstein, 2012). Typically ADHD is viewed as a discrete disorder, with individuals who meet the diagnostic criteria qualifying for one or both subtypes based on their symptoms. In 1997 the Australian Twin ADHD Project conducted a genetic analysis of monozygotic and dizygotic twin pairs to glean the heritability of the disorder. Results showed that the disorder was

highly heritable (approximately 75%) regardless of whether ADHD was diagnosed using a categorical or continuous measure (Levy, Hay, McStephen, Wood, & Waldman, 1997). These findings were later replicated in a 2012 study of 8,500 Swedish twin pairs. The analyses conducted for this study found the heritability of ADHD to be approximately 60% for both mild and severe forms of the disorder. This led the authors to postulate that, “ADHD is best viewed as the quantitative extreme of genetic and environmental factors operating dimensionally throughout the distribution of ADHD symptoms,” (Larsson, et. al., 2012, pp. 77-78). In other words the hyperactive/impulsive and inattentive behaviors characteristic of ADHD are exhibited in varying degrees of strength and frequency in all individuals. Only when these symptoms present in a maladaptive way are they regarded as pathological.

### *Impulsivity Traits and Inhibition*

Impulsive behavior is pervasive throughout all populations. No matter how much self-control or discipline an individual has, at some point everyone acts on their impulses. Despite being a ubiquitous human behavior, there is significant disagreement on how to define and measure impulsivity. Prior to the year 2000, impulsivity was conceptualized as a cluster of abstract overlapping traits such as, “sensation seeking, risk-taking, novelty seeking, boldness, adventuresomeness, boredom susceptibility, unreliability, and unorderliness” (Whiteside & Lynam, 2001, p. 670). This disagreement led to competing theories of impulsivity along with numerous constructs and measures of the trait.

One attempt to represent impulsivity based on dual-process models of cognition separates impulsivity into two parts. Dual-Process models of cognition postulate that people process experiences with two systems simultaneously. The Implicit system automatically and unconsciously processes information. It directs behavior in response to physiological needs and emotions related to the present moment or immediate context. The Explicit system must be deliberately activated and consciously processes information. It attempts to direct behavior strategically towards actions which will benefit the individual both in the present and future. These two systems sometimes compete with one another for cognitive resources when they attempt to direct behavior in contradictory directions (Carver, Johnson, & Joormann, 2009).

When this model is applied to impulsive behavior, the two systems take on the roles of impulse generator and impulse inhibitor. First the Implicit system creates an impulse: the desire to engage in some behavior based on emotions or physiological needs which could be detrimental to the individual in the long run. The Explicit system then attempts to inhibit the impulse by obtaining the most cognitive resources. If the Explicit system is successful, the behavior (or abstinence of a behavior) it has chosen can override the impulsive behavior selected by the Implicit system. Individual differences in the Implicit system and Explicit system's abilities to gather cognitive resources and select behaviors determine how successful one is at inhibiting impulses (Carver, Johnson, & Joormann, 2009; DeYoung, 2011).

Recent research has concluded that impulsive behavior is the product of multiple psychological traits instead of one overarching impulsivity construct (Whiteside & Lynam, 2001). Multiple competing theories on the nature and effects of these sub-dimensions exist in the literature (Marmorstein, 2013). Applying the dual-process model to the notion that impulsivity consists of multiple sub-dimensions, there may be several inhibition processes which work to override the various types of impulses that an individual experiences. Instead of a lone system attempting to inhibit all impulses, individual differences in the strength of these constructs determine what types of impulses one resists or succumbs to, and determines one's general tendency towards impulsivity.

#### *Impulsivity and the UPPS-P measure*

One study attempted to tackle the challenge of organizing the blanket term of impulsivity into several distinct traits. The authors used factor analysis to derive an empirically based set of sub-dimensions of impulsivity from pre-existing measures of impulsivity and personality. They found four distinct impulsivity factors within the items of the ten measures of impulsivity and personality examined. Negative Urgency is the tendency to engage in impulsive behavior under conditions of negative affect, such as sadness or anger. Sensation Seeking is the tendency to enjoy and pursue activities that are stimulating which may or may not be dangerous. Perseverance refers to an individual's ability to

remain focused on a task that may be boring or difficult. Premeditation is the tendency to think and reflect on the consequences of an act before engaging in that act (Whiteside & Lynam, 2001). These sub-dimensions do not reflect different iterations of the impulsivity trait, but rather, “discrete psychological processes that lead to impulsive-like behaviors” (Whiteside & Lynam, 2001, p.685).

After the items of each measure which did not reflect behavior indicative of only one sub-dimension or did not hold a high item-factor correlation pruned away the remaining items were used to construct a valid measure for the newly formed theory of impulsivity. The authors postulated that the fledgling Urgency, Premeditation, Perseverance, Sensation Seeking, Impulsive Behavior Subscale [UPPS Scale] could be used to supplement the diagnosis of psychological disorders characterized by impulsivity. In addition, they suggested that subscale scores on the UPPS scale could be used to discriminate between different pathologies and their subtypes. Later research building upon Whiteside and Lynam’s work produced a fifth factor, Positive Urgency, describing the tendency to engage in impulsive behavior under conditions of positive affect, such as joy or excitement [UPPS-P] (Cyders & Smith, 2008).

#### *The Self-Regulation Model of ADHD, a cognitive approach to Inhibition*

The Self-Regulation model of ADHD put forth by Russell Barkley conceptualizes ADHD symptomatology as the expression of severely impaired inhibition. In his model Barkley defines inhibition as, “performance on cognitive and behavioral tasks that require withholding of responding, delayed responding,



cessation of ongoing responses, and resisting distraction or disruption by competing events,” (Barkley, 1997, p. 68).

Three cognitive mechanisms which regulate an individual’s predisposition to respond to stimuli impulsively were isolated and conceptualized as the basis of inhibition (Barkley, 1997). *Inhibition of a prepotent response* (a.k.a. the dominant response) is the cognitive mechanism which stops an individual from instantly responding when a stimulus offering immediate reinforcement is presented. When an appealing stimulus is presented to an individual, this mechanism creates a brief cognitive delay before their response, allowing the individual to make a decision on whether to respond and how to respond instead of merely reacting to the stimulus. The *interruption of an ongoing response* occurs during the aforementioned cognitive delay or during the enactment of a response. This mechanism evaluates the efficiency of the chosen response from environmental stimuli. If new information reveals that the desired results will not or cannot be obtained utilizing the current response, the ineffective behavior ceases. *Interference control* is the mechanism which inhibits irrelevant stimuli from entering consciousness during the cognitive delay, and during the execution of the chosen response. This third mechanism acts as a filter, protecting executive functioning from derailment by distracting stimuli. Barkley posits that the efficiency of these three cognitive processes can be conceptualized as a single trait, Response Inhibition (Barkley, 2011). The three mechanisms of Response Inhibition work in tandem to select and enact behavior towards the achievement of specific long term goals.

In order to better clarify what the three processes of Response Inhibition do, consider the environment individuals with ADHD seem to struggle with the most, a classroom. As a student attempts to follow the lesson they are also subjected to a variety of impulses (the desire to daydream, get up and stretch, check their cellphone, etc.). If the student is in a class they find boring, gazing out the window may be preferable or more stimulating than focusing on the teacher. The brief delay created by the *inhibition of a prepotent response* decouples the stimulus of the window from the student's response. This decoupling allows the student to make a quick choice between refocusing attention on the window or maintaining attention on the lecture instead of immediately responding to the most interesting stimulus. Presumably the student will use this delay to choose the response which matches their long term goals, which in this case is receiving an education. Let's say that the student gives into their impulse and begins to gaze out the window. The mechanism *interruption of an ongoing response* monitors the student's behavior and, noticing gazing out the window is doing nothing to further their education, prompts the student to "snap out of" their current behavior. This prompt once again gives the student the opportunity to re-evaluate their current behavior. Even if the student is actively maintaining their focus on the teacher, irrelevant stimuli (the view out the window again, other students talking, bodily sensations such as a rumbling stomach, etc.) are still competing for their attention. *Interference control* tunes out these distractions allowing the student to focus only on the stimuli relevant to learning the material (Barkley, 1997).

When the speed and frequency of the mechanisms of Response Inhibition occur below optimal levels, cognition becomes overburdened by an unfiltered stream of stimuli and less capable of self-regulating the way it responds to said stimuli. Deficits in Response Inhibition lead to an individual's behavior being influenced more by external stimuli than internally based motivation (Barkley, 1997). In other words, "one cannot direct actions or behavior towards [a goal] if one has already responded impulsively to an immediate event. They are mutually exclusive events," (Barkley, 2011, p. 554). The degree to which one is capable of resisting stimuli irrelevant to their current goal is defined as persistence. The weaker the cognitive mechanisms of one's Response Inhibition, the less persistent they are in their tasks, resulting in the hyperactive/impulsive and inattentive behavior characteristic of ADHD.

## **Rationale & Hypothesis**

Throughout the literature explored, theories on the underlying roots of impulsive behavior and ADHD symptomology parallel one another. Both are unproductive but normal forms of human behavior which can become maladaptive in extreme cases (Larsson, Anckarsater, Rastam, Chang, & Lichtenstein, 2012). Both symptoms of ADHD and impulsive behavior are considered the product of a failure in multiple cognitive mechanisms responsible for regulating behavior (Barkley, 1997; Carver, Johnson, & Joormann, 2009; Whiteside & Lynam, 2001). Perhaps ADHD subtype symptoms and some types of impulsive behaviors stem from weaknesses in the same or similar inhibition constructs. Examining the associations between symptoms of ADHD subtypes and measures of impulsivity would help us to better understand the links between these two closely related groups of behaviors.

Some of the impulsivity traits detailed in Whiteside and Lynam's UPPS-P model of impulsivity (2001) share similar features with the characteristic symptoms of ADHD subtypes. Both the impulsivity trait (Lack of) Perseverance and symptoms of the Predominantly Inattentive subtype revolve around an individual's inherent inability to sustain attention. (Lack of) Premeditation and symptoms of the Predominantly Hyperactive/Impulsive subtype are both characterized by a failure to consider the consequences of one's behavior for an adequate amount of time before acting. Sensation Seeking and symptoms of the Predominantly Hyperactive/Impulsive subtype are both associated with the

pursuit of stimulation or arousal in a maladaptive way or in inappropriate situations (Whiteside & Lynam, 2001; American Psychiatric Association, 1994).

The UPPS-P measure offers a way to examine impulsivity in broader terms by quantifying participants' tendency to engage in different groups of impulsive behaviors. Other measures are needed to reflect the cognitive oriented theories such as the Dual-Processing model of impulsivity and the Self-Regulation model of ADHD. The Immediate Memory Task (IMT) is a computerized continuous performance task measuring an individual's ability to discriminate between correct stimuli and decoy stimuli (refer to page 13 for a detailed description of the measure). It was designed to measure working memory and impulsivity in high functioning populations (Dougherty, Marsh, & Mathias, 2002). A participant commits a commission error on the IMT when they respond to a decoy stimulus (which superficially resembles the stimulus that precedes it). Commission errors and liberal responding to all types of stimuli are representative of an inability or unwillingness to take the time to adequately assess the stimulus before responding. Similar impatient behaviors are characteristic of the Predominantly Hyperactive/Impulsive subtype of ADHD (Dougherty, et. al., 2002).

The Go/Stop Impulsivity Paradigm (Go/Stop Task) is another computerized task designed to measure an individual's "capacity to inhibit an already initiated response," (Dougherty, Mathias, Marsh, & Jagar, 2005, p. 84). The stimuli presented in this measure have the potential to change without warning and at different intervals (Refer to Page 14 for a detailed description of

this measure.) Participants who frequently respond to these stimuli incorrectly are demonstrating a deficit in their ability to monitor stimuli and quickly inhibit ineffective behavior. Deficits in one's ability to monitor fluctuating stimuli are similar to the deficits in sustained attention experienced by those with the Predominantly Inattentive subtype of ADHD.

The disadvantages incurred by those who express the impatient behavior characteristic of the Primarily Hyperactive/Impulsive subtype would not affect performance on the Go/Stop Task. The Go/Stop task is not is not purely a measure of reaction time but of the speed and efficiency of one's inhibition. Signals in the Stop Trial are presented so close together that participants receive the abstain signal at roughly the same time they finish processing the initial signal. This rapid fire presentation of the signals does not give participants adequate time to deliberate on their response, so a deficit in the ability to stop and think before acting would not matter.

Previous studies have shown there are group differences between those diagnosed with ADHD and control groups in scores on the UPPS-P (Whiteside, Lynam, Miller, & Reynolds, 2005), IMT (Dougherty, Bjork, et.al., 2003), and Go/Stop task (Oosterlaan, Logan, & Sergeant, 1998). The following analyses looked at whether these previously observed differences between groups were indicative of associations between these different forms of impulsivity and behavior representative of both ADHD subtypes. In other words, this study sought whether symptoms of ADHD and impulsive behaviors continue to occur together when these symptoms occur in a normal or subclinical way.

I hypothesized unique associations would be found between the prevalence of ADHD subtype symptoms exhibited and impulsive behaviors which are attributed to a common theoretical deficit. Perseverance scores on the UPPS-P and Performance on the Go/Stop Impulsivity Paradigm was expected to be associated with Inattentive scores but not Hyperactive/Impulsive scores. Premeditation and Sensation Seeking scores on the UPPS - P as well as performance on the Immediate Memory Task was expected to be associated with Hyperactive/Impulsive scores but not Inattentive scores. No specific predictions for the variables Positive Urgency and Negative Urgency on the UPPS-P measure were made. Analyses of associations with these variables were exploratory in nature.

### *Potential Implications*

Identifying which types of impulsive behaviors are associated with which subtype's symptoms would help to refine our understanding of impulsivity's relationship to ADHD. If differences are found in the way Inattentive symptoms and Hyperactive/Impulsive symptoms associate with various impulsive behaviors, it could imply that these behavior groups may be caused by the same or similar underlying deficit. Furthermore it would show that the effect of this common deficit between one ADHD subtype and impulsive behavior(s) are observable at both the severe and high functioning ends of the ADHD continuum.

The results of this study have the potential to better inform us on which problematic impulsive behaviors are associated with ADHD subtype symptoms. From 2003 to 2011 the reported prevalence of ADHD among children increased by 42% (Visser et. al., 2013). In addition to medication, targeted behavioral therapy will be needed to address the increasing number of individuals who are seeking treatment for childhood and adult ADHD. By knowing what subtype symptoms are associated with which impulsive behaviors, it would allow therapists to devise targeted therapies or treatment plans which work best for the individual needs of their clients.



## Methods

### *Participants*

The secondary data used in this proposal was collected from 194 undergraduate students at Rutgers University – Camden. As part of the initial study on actions, feelings, and behavior, participants were given a battery of various cognitive and psychological tests. Of the 194 participants, 138 had taken the Adult ADHD Self-Report Scale (which was not administered to the first 56 participants, due to lack of time in the initial study), Immediate Memory Task, Go-Stop Impulsivity Paradigm, and UPPS-P. These participants were between the ages of 17 and 45, with a mean age of 19.81(SD = 3.4, median = 19), and consisted of 67 females. Fifty two percent of the participants self-identified as Caucasian, nineteen percent as African American, fifteen percent as Hispanic or Latino, nine percent as Asian, and five percent as other. Demographic information was kept separate from participants' scores on the various measures and were not hypothesized to affect the associations examined in this project, therefore they were not used as part of the analysis.

### *Measures*

The Urgency, Premeditation, Perseverance, Sensation Seeking, Impulsive Behavior Subscales and Positive Urgency Measure (UPPS-P) (Whiteside & Lynam, 2001; Cyders & Smith, 2008): The UPPS-P is a 59-item measure which combines the items of the UPPS Impulsive Behavior Subscale and Positive Urgency Measure. It consists of five subscales measuring Negative Urgency (-

URG;  $\alpha = 0.89$ , 12 items), Positive Urgency (+URG;  $\alpha = 0.92$ , 14 items), Premeditation (PRE;  $\alpha = 0.83$ , 11 items), Perseverance (PSV;  $\alpha = 0.85$ , 10 items), and Sensation Seeking (SS;  $\alpha = 0.88$ , 12 items). Each item is phrased as a statement describing thoughts or actions related to one of five subscales of Impulsivity. Participants are asked to rate how much they agree with the statements from 1 (agree strongly) to 4 (disagree strongly). Negative Urgency is the tendency to experience strong impulses under conditions of negative affect, such as sadness or anger (“When I feel bad, I will often do things I later regret in order to make myself feel better now”). Positive Urgency is the tendency to experience strong impulses under conditions of positive affect, such as joy or excitement (“I tend to lose control when I am in a great mood”). Sensation Seeking is the tendency to enjoy and pursue activities that are stimulating which may or may not be dangerous (“I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional”). Perseverance refers to an individual's ability to remain focused on a task that may be boring or difficult (“I am able to pace myself so as to get things done on time”). Premeditation is the tendency to think and reflect on the consequences of an act before engaging in that act (“I am not one of those people who blurt out things without thinking”). After completion, an experimenter totals the responses to each subscale, taking into account reverse scored items, resulting in a score for each of the five UPPS-P scales. The Negative Urgency, Sensation Seeking, and Positive Urgency subscales are regularly scored, meaning the higher the numeric value for each subscale, the more they exhibit that type of impulsivity.

Premeditation and Perseverance are reversed, meaning the higher the numeric value for each subscale, the less they exhibit that type of impulsivity. Scores on each of the five UPPS-P subscales will serve as independent variables for this study.

The validity of the UPPS scale, and its successor the UPPS-P (which contains an additional scale measuring Positive Urgency) has been scrutinized in several studies of individuals with psychological disorders characterized by impulsivity. The psychopathologies examined by these studies included pathological gambling, borderline personality disorder, alcoholism, anti-social personality disorder, eating disorders, and ADHD (Miller, Flory, Lynam, & Leukfield, 2002; Whiteside, Lynam, Miller, & Reynolds 2005). Participants' UPPS-P subscale scores showed consistency among subjects with the same disorder, and significant differences between those with disorders and control groups. The discriminant function of the UPPS-P scale was statistically significant ( $p < 0.001$ ) and accurately predicted whether a participant was a member of the control group or the combined [impulsive] pathology group for 81% of cases (Whiteside, Lynam, Miller, & Reynolds, 2005).

Immediate Memory Task (IMT) (Dougherty, Marsh, & Mathias, 2002): This computerized task is an updated version of a continuous performance task, designed to measure impulsivity in high functioning populations. Participants are sequentially presented with two five digit numbers with a brief gap in between. Participants are required to respond via button pressing as quickly and accurately as possible when the two numbers presented are identical. There are three types of

stimuli, each with an equal chance of being presented. A Target stimulus occurs when both numbers displayed are identical. Responding to this type of stimuli is considered a correct detection, and abstaining from responding is recorded as an omission error. A Catch Stimuli occurs when the second number presented differs from the first by one digit. Responding to a Catch Stimuli is recorded as a commission error, whereas abstaining from responding is considered a correct detection. An example of a Catch Stimulus would be the display of the number 45912 followed by a 500 millisecond blank display followed by the number 45972. A Filler Stimulus occurs when the second number is completely different from the first. Responding to this type of stimuli is recorded as a filler error, whereas abstaining from responding is considered a correct detection.

The participant's ability to discriminate between Catch and Target Stimuli is reflected in the variable  $A'$ . Scores on  $A'$  typically fall between 0.5 (participant's discrimination was no better than chance) and 1.0 (perfect discrimination between Target and Catch Stimuli). Conceptually, this variable represents a participant's ability to accurately assess stimuli before enacting behavior. This program also contains a measure of response bias referred to as  $B''$ . Scores on this variable range from -1 (very liberal response bias on all stimuli types) to 1 (very conservative response bias on all stimuli types). Conceptually, this variable represents how likely a participant is to respond to any stimulus without adequate forethought.  $A'$  and  $B''$  both characterize the type of behavior those with the Hyperactive/Impulsive subtype of ADHD struggle with. Both  $A'$  and  $B''$  will serve as independent variables for this study.

The Go/Stop Impulsivity Paradigm (Go/Stop Task) (Dougherty Mathias & Marsh, 2005): This computerized task is designed to measure an individual's response disinhibition. Participants are sequentially presented with a stimulus consisting of a five digit number in black numerals, followed by a second five digit number which either remains black or changes from black to red. Participants are asked to respond as quickly and accurately as possible only when the first and second numbers are identical and the second stimuli remains black. Responses are made by pressing a designated key on the keyboard. Participants are presented with several trial types. In a Novel trial, the second number presented differs from the first. Pressing the designated button on the keyboard is considered an incorrect response. A large number of responses to this trial type indicates the participant is not following the instructions. In a No-Stop trial, a Go Signal is presented when the second number presented numerically matches the first and remains black. Pressing the designated button on the keyboard is considered a correct response to this signal. In the fixed procedure several Stop trial types are also presented to the participant. The Stop Signal occurs when a second stimulus numerically matches the first, but changes from black to red after a set interval of time falling between 50 and 350 milliseconds in intervals of 100 milliseconds, resulting in four Stop Trial types (50 ms, 150 ms, 250 ms, 350 ms). For example a 250ms Stop trial would occur when the number 45912 is displayed twice, but changes from black to red 250 milliseconds after the presentation of the second number.

When the Stop Signal is presented participants are required to “cancel” the already initiated response to the Go Signal by abstaining from pressing any

buttons. When a participant responds after the Stop Signal is presented by pressing the designated button, the response counts as an incorrect detection. The number of trials incorrectly and correctly responded to for each trial type is expressed as a percentage of correct detections. The percent of trials correctly inhibited on the Stop Trials are considered to be representative of the efficiency of a participant's inhibitory processes (Dougherty, et al., 2003). The lower the percentage of correct detections on a Stop trial, the less capable they are of changing their responses to match new stimuli. Participants' Percent Correct Inhibited scores (% Correct Inh.) for 50ms Stop Trials, 150ms Stop Trials, 250ms Stop Trials, and 350ms Stop Trials will serve as independent variables for this study. The Percent Correct Inhibited for 150ms and 250ms will be of the most interest since a previous study utilizing fixed interval stop trials found 50ms trials to be too easy and 350ms trials to be too difficult for all groups of participants (Marsh, Dougherty, Mathias, Moeller, & Hicks, 2002).

#### *Validity and Reliability of the IMT and Go/Stop task*

The validity of both the IMT and Go/Stop task as measures of impulsivity were tested by the measure's designers. The authors compared the performance of participants exhibiting clinical levels of impulsive behaviors and a control group matched on age and gender. All participants were administered four laboratory measures of impulsive behavior including the IMT and Go/Stop. Those in the impulsive group were significantly worse at differentiating between stimuli on the IMT ( $p < 0.001$ , Cohen's  $f = 0.63$ ) and significantly worse at correctly inhibiting

responses on the Go/Stop task's stop trials ( $p < 0.01$ , Cohen's  $f = 0.47$ ) (Dougherty et. al., 2003).

The Go/Stop task has been used in handful of studies to examine Response Inhibition in those with ADHD. A meta-analysis by Oosterlaan, Logan, and Sergeant examined how well the Go/Stop task differentiated between ADHD groups and control groups. Performance on the Go/Stop task was significantly different between those in the control and ADHD groups across the 8 studies examined (Cohen's  $d = 0.64$ , meta-analytic  $Z = 4.97$ ,  $p < 0.0001$ ) (Oosterlaan, Logan, & Sergeant, 1998).

The test-retest reliability of both the Go/Stop task and the Conners' Performance Task, a precursor continuous performance task to the IMT, was examined in a study on children with ADHD. These children were administered both measures once a week at the same time of day over the span of three weeks. Intra-class correlations for scores on the Go/Stop task ( $SSRT = 0.72$ ) and Conners' Performance Tasks (Commission error % = 0.72) were high, indicating that inhibitory control could be measured reliably in individuals with ADHD (Soreni, Crosbie, Ickowicz, & Schachar, 2009).

Adult ADHD Self-Report Scale (ASRS) (Kessler et. al., 2005): This 18 item checklist is used to measure the number and frequency of participants' ADHD symptoms. Each item in the ASRS is analogous to the eighteen diagnostic criteria for ADHD (9 for each subtype) in the fourth edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV). Instead of using this measure to determine a discrete diagnosis of adult ADHD, the scoring process was altered

to create two quantitative scales reflective of the behavior exhibited by the participants. Participants' responses to each item will be assigned a numerical value from 0 to 4 according to their reported frequency engaging in the behavior (Never to Frequently). These values will then be totaled for each subtype's scale resulting in two scores, Inattentive Symptoms Total and Hyperactive/Impulsive Symptoms Total. These scores can range from 0 to 36 with higher scores reflecting more frequent and maladaptive subtype behavior. In one of the analyses conducted Inattentive Symptoms Total ( $\alpha = 0.81$ , 9 items) and Hyperactive/Impulsive Symptoms Total ( $\alpha = 0.77$ , 9 items) are added together to create a score representative of ADHD symptomology as a whole. This score is referred to as Overall ADHD Symptoms Total ( $\alpha = 0.86$ , 18 items).

Each item on the ASRS asks the participant to rate the frequency of which they engage in the behavior described from Never to Very Often. For example, one item representative of Inattentive Behavior reads, "When you have a task that requires a lot of thought, how often do you avoid or delay getting started?" Inattentive Symptoms Total and Hyperactive/Impulsive Symptoms Total scores will serve as the dependent variables for this study.

Creation of the ASRS was commissioned by the World Health Organization for use in their World Mental Health surveys. The extent of agreement between several versions and scoring methods of the ASRS and DSM-IV based clinical interviews were examined on a sample of 154 survey participants. The method which best resulted in diagnoses that mirrored the results of the clinical interview was totaling the numerical response for items into two



scores for the Predominantly Inattentive and Predominantly Hyperactive/Impulsive subtypes. This method also had the highest sensitivity (60.2%, S.E. = 8.9) and specificity (96.3, S.E. = 2.1) (Kessler et. al., 2005).

## Data Analysis

Variables whose distributions exhibited high levels of skew were log-transformed. Table 1 details the descriptive statistics of all independent and dependent variables. A preliminary examination of the relationship between participants' Inattentive Symptom Total and Hyperactive/Impulsive Symptom Total found the two variables to be strongly correlated  $r(136) = .64, p < 0.000$ . A strong relationship between ADHD subtype symptomology appears problematic, but is common in research of this type. In 2005, a study examined the differential associations of Hyperactive/Impulsive and Inattentive symptoms of ADHD with measures of executive functioning and cognitive regulatory functions in adults (Nigg et. al., 2005). Researchers found a strong correlation between Hyperactive/Impulsive ADHD symptom scores and Inattentive ADHD symptom scores on a measure of current Adult ADHD Symptomology ( $r(193) = .72, p < .01$ ) (Nigg, et al., 2005). A longitudinal twin study examining genetic contributions to the development of ADHD from childhood into adolescence also examined the relationship between participants' Inattentive and Hyperactive/Impulsive symptoms at three periods (ages 8-9, 13-14, and 16-17). At all three intervals in both monozygotic and dizygotic twins, participants' scores on a DSM based measure of inattentive and hyperactive/impulsive subtype symptoms were significantly correlated with  $r$  ranging from .49 to .58 (Larsson, Lichtenstein, & Larsson, 2006).

Considering the epidemiology of ADHD and its subtypes, a large correlation between Inattentive and Hyperactive/Impulsive symptoms is to be

expected. The Combined subtype of ADHD, where clinical levels both of Inattentive and Hyperactive/Impulsive behaviors are exhibited, is the most prevalent form of the disorder. Approximately 60% of all individuals diagnosed with ADHD are diagnosed with the Combined subtype (Willcutt, 2012; Wilens, et al., 2009). This tendency of ADHD subtype symptoms to manifest together likely extends to those exhibiting a subclinical number of symptoms.

Pearson correlations were conducted to examine the associations between ADHD subtype symptom scores and scores on the measures of impulsivity. These correlations utilized participants' Inattentive Symptoms Total and Hyperactive/Impulsive Symptoms Total scores as dependent variables and scores on each of the five subscales of the UPPS-P, A' and B'' on the IMT, and the four Percent Correct Inhibited scores of the Go/Stop Task as independent variables. These correlations were conducted to obtain a general idea of how the impulsive behaviors in question relate to Inattentive behavior levels and Hyperactive/Impulsive behavior levels.

After the correlations between all independent variables and dependent variables were obtained, a test of the differences between two dependent correlations with a common variable (each impulsivity dimension) was conducted. Each impulsivity measure's correlation with Inattentive Scores and Hyperactive/Impulsive Scores served as the pairs for these analyses. For example the Negative Urgency subscale on the UPPS-P held a correlation of 0.55 with Inattentive Symptoms Total and a correlation of 0.52 with Hyperactive/Impulsive Symptoms Total. These two scores served as one pair for an analysis. The

impulsivity measure's correlation with Inattentive scores and with Hyperactive/Impulsive scores were converted into z scores which were then used in a z-test. The result is a single z score for each comparison which was subjected to a two tailed hypothesis test (Lee & Preacher, 2013). These analyses were conducted to determine if the symptomology of the two ADHD subtypes were differently associated with each impulsivity dimension.

Two series of linear regression analyses were conducted with ADHD symptomology serving as independent variables and scores on each measure of impulsive behavior as the dependent variable. The First group of analyses utilized both Inattentive Symptom Total and Hyperactive/Impulsive Symptom Total as independent variables in each model. Eleven multiple regressions were conducted using each measure of impulsive behavior as the dependent variable. This was done to determine if one subtype has a significant association with an impulsivity dimension while controlling for the effect of the other. The Second group of analyses utilized the Overall ADHD Symptoms Total as the independent variable. Eleven linear regressions were conducted using each measure of impulsive behavior as the dependent variable. This was done to see if ADHD symptomology as a whole was associated with participants' scores on the impulsivity measures.

## Results

Because of the large number of comparisons between variables used in this study, the problem of raised Familywise error rates must be addressed. The small sample size of this project coupled with a Bonferonni correction would have rendered associations between the variables very difficult to detect. Interpretation of the data analysis instead considered effect sizes in addition to significance.

A significance level of  $p < .05$  was utilized for all analyses in this study. The studies cited in this project which examine ADHD or use the same measures of impulsivity generally had moderate effect sizes. Correlations significant at the  $p < .05$  level ranged from 0.18 to 0.35 and Betas from regression analyses ranged from 0.28 to 0.31 (Grall-Bronnec et. al., 2011; Marmorstein, 2013; Nigg et. al., 2005). In light of these findings, statistically significant findings whose correlations were lower than 0.20 and whose regressions produced betas lower than .25 were not regarded as evidence of an important relationship between an impulsive behavior and ADHD symptoms.

Pearson correlations revealed disparity between the self-report and behavioral measures' associations with participants' ADHD subtype scores. Table 2 details the associations between impulsivity measures and ADHD subtype symptomology. Three of the five subscales on the UPPS-P were significantly correlated with both Inattentive Symptoms Total and Hyperactive/Impulsive Symptoms Total. None of the scores derived from participants' performance on the IMT or Go/Stop Task were significantly associated with either Inattentive Symptoms Total or Hyperactive/Impulsive Symptoms Total. Participants'

Perseverance scores on the UPPS-P were strongly and significantly associated with Inattentive symptom scores ( $r = -0.43, p < .01$ ) whereas their correlation with Hyperactive/Impulsive symptom scores were weak and barely insignificant ( $r = -0.16, p = .06$ )

The difference between the correlations of participants' Inattentive Symptoms Total and Hyperactive/Impulsive Symptoms Total with scores on each of the impulsivity measures were examined using a difference test of two dependent correlations. This method tests the difference between correlations which have the same dependent variable in common while accounting for the relationship between both independent variables. Of the eleven impulsivity scores examined, only participants' Perseverance scores on the UPPS-P showed a significant difference between its' correlation with Inattentive Symptoms Total and Hyperactive/Impulsive Symptoms Total ( $p < .01$ ) (see Table 3 for the results of all 12 analyses).

The associations between Inattentive and Hyperactive/Impulsive Symptoms and impulsivity dimensions were examined again utilizing multiple regression analyses. Table 4 displays the beta coefficients of Inattentive Symptoms Total and Hyperactive/Impulsive Symptoms Total for each multiple regression analysis which utilized both subtype scores as independent variables and each impulsivity measure as the dependent variable. The results displayed in this table have partialled out any effect the opposite subtype has on the dependent variable. The results of these analyses were similar to the results of the Pearson correlations in that none of the scores derived from the IMT or Go/Stop Task

were significantly associated with either participants' Inattentive Symptoms Total or Hyperactive/Impulsive Symptoms Total. Both Negative Urgency and Positive Urgency were significantly associated with both subtypes' symptomology. The only impulsivity measure to be singularly influenced by one subtype's symptomology was the Perseverance subscale of the UPPS-P. Inattentive Symptom Total held a beta weight of  $-0.56$  ( $p < .001$ ) with Perseverance whereas Hyperactive/Impulsive Symptom Total held a smaller non-significant beta weight of  $0.20$  ( $p = 0.06$ ).

In addition to conducting a multiple regression analyses of Inattentive Symptoms Total, Hyperactive/Impulsive Symptoms Total, and impulsivity measures, linear regression analyses were conducted using participants' Overall ADHD Symptoms Total as the independent variable and each impulsivity measure as the dependent variable. Table 5 details the results of the regression analyses examining ADHD symptoms as predictors of scores on the impulsivity measures. At a glance both groups of analyses are comparable in significance and explained variance for each impulsivity measure.

The disparity between the UPPS-P and behavioral measures of impulsivity associations with ADHD symptomology raises the question of whether these measures are truly examining different dimensions of the same type of behavior. A Post-Hoc analysis was conducted examining Pearson Correlations between the UPPS-P sub-dimensions, A' and B'' scores, and Percent Correct Inhibited scores. Table 6 displays the results of these analyses. Strong and significant intercorrelations were found within the UPPS-P sub-dimensions and within the

behavioral measures. None of the scores on the IMT or Go/Stop task were correlated with any of the sub-dimensions on of the UPPS-P.



## Discussion

The results of the analyses conducted do not support the hypothesis that symptoms of the Predominantly Inattentive subtype and the Predominantly Hyperactive/Impulsive subtype are differently associated with the various impulsivity dimensions examined in this study. For all but one impulsivity dimension, there was no difference in impulsivity's association with Inattentive Symptoms Total or Hyperactive/Impulsive Symptoms Total. Either both subtypes or neither subtype were significantly associated with each impulsivity measure. The exception to this pattern was the unique association between the Perseverance subscale and symptoms of the Predominantly Inattentive Subtype of ADHD.

The lack of any meaningful relationships between the UPPS-P Impulsive Behavior Subscale and the IMT or the Go/Stop Task may be due to the difference in what type of impulsivity each measure is quantifying. Self-Report measures of impulsivity like the UPPS-P examine a participant's disposition or tendency to commit certain impulsive behaviors. Behavioral measures of impulsivity like the IMT or Go/Stop Task examine a participant's specific impulsive response to a specific type of stimuli. Although both fall under the blanket term of impulsivity, the behaviors examined by these measures may be too distinct from one another to be meaningfully correlated.

Another difference between the UPPS-P and the two behavioral tasks are in the way they quantify and collect data on impulsivity. The UPPS-P is a self-report measure requiring participants to disclose the frequency of which they conduct various forms of impulsive behaviors. These reports can be subject to

measurement error stemming from a participant's unawareness of their own behavior patterns or unwillingness to disclose information about their behavior. The behavioral tasks IMT and Go/Stop Task are able to directly collect data on a participant's impulsive behavior. While this eliminates the error that stems from relying on a participant's self-disclosure, other factors such as a participant's ability to focus on the tasks or how well they understand the measure can produce error. These differences in the way the tests quantify and measure impulsive behavior could explain why the data collected from measures of impulsivity could be so disparate.

Correlations between participants' scores on the ASRS and the UPPS-P may also be influenced by similarities in the way the two tests measure behavior. Both are self-report measures which examine patterns of behavior and then quantify these patterns as a single digit number which represents how frequent and pervasive these behaviors are in the participant's life. These findings imply that properties of the measures themselves, could influence the strength of their relationship.

### *Interpretations of Analyses*

Neither ADHD subtype was significantly associated with the Sensation Seeking subscale of the UPPS-P. This null-finding is consistent with the other studies which have failed to find meaningful relationships between participants' Sensation Seeking scores and ADHD Symptomology. In a study of the clinical profiles of pathological gamblers, researchers found no differences in Sensation Seeking scores between those participants who presently exhibited clinical levels

of ADHD and those who did not (Grall-Bronnec et. al., 2011). Another study on the associations between children's UPPS-P scores and various psychopathologies found no significant associations between Sensation Seeking and either subtype of ADHD (Marmorstein, 2013).

The lack of statistically significant associations between Sensation Seeking and ADHD symptomology is surprising since the tendency to pursue stimulating activities matches the popular conception of those with ADHD as perpetually restless and bored individuals in pursuit of the next interesting activity. These findings indicate that the impatience and compulsions to be active experienced by those exhibiting Hyperactive/Impulsive symptoms of ADHD are not the same type of impulses or needs as the drive to seek out stimulation which characterizes the Sensation Seeking impulsivity dimension.

Across analyses the Positive Urgency and Negative Urgency subscales of the UPPS-P were significantly associated with both ADHD subtypes. Although no specific predictions were made for either subscale, their significant association with both subtypes did not support the general hypothesis that different associations would be found between each ADHD subtype's symptoms and impulsive behavior. As previously mentioned Negative Urgency and Positive Urgency are defined as the tendency to engage in impulsive behaviors under conditions of positive affect or negative affect respectively. Emotions such as joy or sadness can cause any individual to act in unusual or impulsive ways. Consider how a restrained or goal oriented individual would behave during periods of intense grief or exuberance. Perhaps, just as ADHD symptoms are extreme

reactions to everyday situations, “Urgent” behaviors are indicative of extreme reactions to trivial levels of emotions. Since a lower threshold for boredom or restlessness is characteristic of ADHD, those with the disorder exhibit Hyperactive or Inattentive behavior out of proportion to their situation. In a similar fashion, those with high Positive Urgency and Negative Urgency scores have a lower threshold for emotionally induced impulsive behavior. When they experience what could be considered a “normal” amount of emotion these individuals act impulsively in a manner out of proportion to what would be expected. These lowered thresholds for maladaptive behavior are associated with one another.

The Premeditation subscale was significantly associated with Overall ADHD symptomology, but when the subtypes were considered separately this relationship was not significant. This means that when one ADHD subtype’s influence on Premeditation scores is controlled for, the other subtype does not account for a significant amount of the variation in Premeditation scores. This implies a lack of premeditation is characteristic of all forms of ADHD, but is not ascribable to any one subtype. These findings go against the prediction that lack of Premeditation would be uniquely associated with the Predominantly Hyperactive/impulsive subtype. Although the findings of these analyses were significant, the lack of differentiation between the ADHD subtypes’ associations with each impulsivity dimension went against the predictions of the general hypothesis.

The Perseverance subscale of the UPPS-P was significantly associated with the Inattentive subtype. Analyses revealed a unique relationship between a subtype and impulsivity dimension. When inattentive and H/I symptoms of ADHD were entered into the same model, participants' Inattentive Symptom Total's held a large association with the Perseverance subscale ( $\beta = -0.56$ ) and remained highly significant ( $p < .001$ ), whereas its association with the Hyperactive/Impulsive Symptom Total was much smaller ( $\beta = 0.20$ ) and only bordered on significance ( $p = 0.06$ ). Consistent with this finding, the difference tests comparing all of the correlations between ADHD subtype scores and each impulsivity measure were all found to be non-significant except one. The correlation between Participants' Inattentive symptom total and Perseverance scores on the UPPS-P were found to be significantly stronger than Hyperactive/Impulsive symptom total's correlation with Perseverance scores ( $p < .01$ ). This finding is consistent with the results of the other analyses and lends credence to the unique association found between Inattentive symptoms and Perseverance Scores by the regression analysis.

Symptoms of the (Lack of) Perseverance impulsivity dimension are attributed to a lack of sustained attention on boring or difficult tasks. Sustained attention is one of the key characteristics of the Predominantly Inattentive Subtype of ADHD. Perhaps both the Lack of Perseverance and the Inattentive symptoms of ADHD are related to an individual's difficulty inhibiting the impulses which interrupt sustained attention over longer periods of time. This was consistent with the prediction that the number of inattentive symptoms of ADHD

exhibited by participants would be associated with their Perseverance score on the UPPS-P measure.

Across all analyses conducted, scores from the IMT and Go/Stop Task were not significantly associated with ADHD symptomology and had negligible effect sizes. In this study non-significant associations with both subtypes are also informative since they indicate that there was no evidence for either ADHD subtype's symptoms relating to these dimensions of impulsivity. These results failed to uphold the general hypothesis since they make up a large portion of the impulsivity dimensions examined and were not significantly associated with either subtype.

#### *Behavioral Tasks and the Contradictory Findings in Prior Research*

These findings are inconsistent with previous research into ADHD's relationship with performance on behavioral measures of this type. A 2003 study compared performance on a Continuous Performance Task (similar to the IMT) between participants who met the DSM-IV criteria for ADHD and those who did not. Significant differences were found between the two groups' abilities to discriminate between target and non-target stimuli (analogous to A'), and the level of response bias exhibited (analogous to B'') (Epstein et. al., 2003).

Another study examining the difference between adults with ADHD and a control group compared groups' performance on the Logan Stop Task. The Logan Stop Task operates similarly to the Go/Stop Task in that participants are required to respond only to stimuli which match pre-ordained criteria, but must inhibit

their response when an auditory stimulus is signaled. Performance on the Logan Stop Task was significantly correlated with the number of symptoms of ADHD exhibited by participants. In addition a MANOVA revealed significant differences in performance on the Logan Stop Task between the ADHD and control groups (Nigg et. al., 2005). The contradiction between results of the articles cited and the results of this study may be due to the difference in how these studies conceptualized ADHD and compared participants' performance. The studies cited separated their participants into two groups, those who exhibited clinical levels of ADHD and those who exhibited few to no symptoms of ADHD. This means that their participants exhibited either very high levels of ADHD symptomology or levels so low they were considered negligible. By recruiting participants with symptoms on the extreme ends of ADHD symptomology, these researchers were able to create two dichotomous groups to compare in their study. This enabled the researchers to examine the data using t-tests which made it easier to detect differences between the groups compared (Nigg et. al., p. 708). Since my study conceptualized ADHD as a continuous disorder, participants exhibited scores across the breadth of ADHD symptomology. Associations between these participants' scores on measures of impulsivity were examined instead of comparing the scores between two disparate groups. While this technique is less effective at detecting the nuanced differences between related sets of behaviors, it remains true to the dimensional perspective on ADHD symptoms.

#### *Post-Hoc power and Sensitivity Analyses*

Post-hoc power analyses were conducted for an additional layer of protection against statistical error. The desired level of power for this study was 0.80 in accordance with the guidelines set by Jacob Cohen (1992). Power was calculated using the G\*Power Statistical Power Analyses software (Faul et. al.,2009). Power levels are displayed in Tables 3 through 5 alongside the results of the analyses they describe.

For the difference tests between dependent correlations only the Perseverance scale on the UPPS-P measure had sufficient power (0.97). All other difference tests had power levels well below the desired level; however to have sufficient power with such small effect sizes would have required an unreasonably large sample size. For example, the difference between the two ADHD subtypes' correlations with Sensation Seeking scores (0.07 and 0.16) produced a Z-score of -1.24. To achieve a Z-score of 1.96 with a power level of 0.80 with these effect sizes we would need to have examined 694 participants, a sample size far higher than the scope of this study. A post-hoc sensitivity analysis utilizing a 0.80 power level indicates that the two dependent correlations would need to differ by approximately 0.20 to be considered significant. Since none of the correlation pairs, besides those of the Perseverance subscale of ADHD, differed by 0.20 or greater we can safely reject the null hypothesis for the remainder of the difference tests.

The power analyses for the linear regressions produced higher power levels. Negative Urgency and Perseverance held sufficient power levels for both sets of analyses. Positive Urgency and Premeditation held a high level of power in



the analysis looking at overall ADHD symptomology, but not when subtype scores were used separately as predictors. Sensitivity analyses found the minimum variance explained by a regression equation ( $R^2$ ) with two predictors, a power level of 0.80, and a sample size of 138 would be  $R^2 = 0.07$ , an effect size too low to be considered meaningful. When examining a regression equation with only one predictor this minimal amount of variance explained drops to  $R^2 = 0.05$ . The power of the remaining regression analyses were well below 0.80, but because the variance explained was so small and they lacked significance, these findings are not considered noteworthy.

The only instance where power and significance were in conflict was for the multiple regression analysis examining Positive Urgency. This analysis had a power level of only 0.17 yet was statistically significant ( $p < 0.05$ ). The beta values of this regression equation were 0.27 for Inattentive Symptom total and 0.25 for Hyperactive/Impulsive symptom total. These beta values are slightly higher than the cutoff of the minimum acceptable effect size set for this study ( $\beta = 0.25$ ). The low power of this analysis means that there is a high probability of type two error. Statistically speaking this means that only exceptionally large estimates of the “true” effect size would be found significant by this analysis (Gelman, 2011). Therefore, it is more likely than not that the “true” beta values for this equation are lower than the estimates deduced by this analysis. Since the beta values for Inattentive scores and Hyperactive/Impulsive scores straddle the line of minimum acceptable effect size, and these values are likely higher than

their “true” effect size, these findings should not be considered evidence of an actual effect in spite of their statistical significance.

The results failed to support the hypothesis that impulsivity sub-dimensions are uniquely associated with the symptoms of one subtype of ADHD. This means that ADHD subtypes do not differ on what types of impulsive behaviors they exhibit. While impulsivity sub-dimensions are not related to which ADHD subtype’s symptomology an individual presents, certain impulsivity sub-dimensions are associated with ADHD in general. Negative Urgency, Positive Urgency, and lack of Premeditation’s strong associations with both subtypes indicates that those who exhibit ADHD symptomology are more likely to act impulsively in response to strong affect and fail to consider the consequences of their actions. The one exception to this pattern was the sub-dimension Perseverance holding strong significant associations with Inattentive symptoms and weak or non-significant association with Hyperactive/Impulsive symptoms.

The impulsivity sub-dimensions which were associated with ADHD were all reflective of a disposition or tendency to commit certain overt impulsive behaviors. Looking at the continuous presentation of ADHD symptoms in this sample it appears that the number of ADHD symptoms a person exhibits doesn’t increase in conjunction with the frequency of brief impulsive responding to misleading or fluctuating stimuli.

### *Limitations*

The main limitation faced by this study was the lack of control over how the data was collected since secondary data was used. This means participants and measures were not selected for use in a study examining impulsivity and ADHD symptomology. Simplifying the way the Go/Stop Task collected data on impulsivity would also have improved this study.

Neither the Immediate Memory Task nor the Go/Stop Impulsivity Paradigm produced any significant results across the analyses conducted. For the Go/Stop Task, this may be because of the way the measure was conducted. The Go/Stop task can alternatively be administered using the adjusting procedure. This differs from the fixed procedure by changing the interval between the presentation of the Stop Signal and Go Signal throughout the course of the procedure. This adjusting interval makes the task easier or more difficult for the participant depending on the participant's performance. The adjusting procedure results in one Stop Latency score indicative of the interval of time where the participant correctly withholds responding on 50% of the stop trials. Utilizing only one variable to represent the speed of a participant's inhibitory process would be preferable to the four variables used in this study. In addition the lone Stop Signal Reaction Time may be more representative of impulsivity and show greater variation across participants.

In addition to potential issues with the measures, the participants utilized in this study may not have had severe enough impulsivity deficits to show up on the measures utilized. Of the 138 participants in this study only 11 had scores on the Adult ADHD Self-Report Scale indicative of clinical levels of ADHD.

Perhaps a sample of participants who exhibited moderate to clinical levels of ADHD symptoms would perform worse on impulsivity measures. This could make associations between impulsivity dimensions and ADHD symptomology easier to detect without compromising the distribution of ADHD symptoms in the sample.

### *Impulsivity and ADHD*

This study looked at the symptoms of ADHD which are present in most individuals. These symptoms fall under two categories, Inattentive symptoms and Hyperactive/Impulsive symptoms. The analyses examined whether one of these two symptoms groups were more likely to appear in tandem with various forms of impulsive behaviors. For the most part, impulsive behaviors appeared in conjunction with both symptoms or neither symptom. When looking at symptoms of ADHD in the general population, there doesn't appear to be any link between which type of symptoms an individual exhibits and what kinds of impulsive behavior they engage in. The one exception was that those who had Inattentive symptoms were more likely to also struggle with perseverance. Difficulty with perseverance could be a distinguishing characteristic between those who have the Inattentive subtype and those who do not. The general lack of differences in impulsivity's relationship with ADHD subtype symptoms imply that there may not be as much of a difference in the types of behaviors the ADHD subtypes produce.

### *The Dual Pathway model of ADHD*

The findings of this study indicate that the tendency to engage in impulsive behaviors are associated with ADHD in general, but not with any specific subtype. One theory of ADHD which could explain why there was uniformity in the impulsivity sub-dimensions from the UPPS-P is the Dual Pathway Model of ADHD. The Dual Pathway model proposes that the cognitive deficits behind impulsive behaviors and ADHD symptomology do not produce separate forms of behavior, but instead are distinct cognitive processes each of which results in the same set of behaviors.

The two cognitive processes or “pathways” which lead to the behaviors indicative of ADHD are the Executive Dysfunction pathway and the Delay Aversion pathway. The Executive Dysfunction pathway mirrors the cause of ADHD hypothesized by the Self-Regulation model. Deficits in response inhibition and working memory lead to difficulty engaging in and maintaining appropriate or goal oriented behavior. These dysfunctional patterns of behavior are manifested as the symptoms of ADHD.

The Delay Aversion pathway starts with an individual’s motivational-reward processes. Those with delay aversive tendencies do their best to avoid or minimize any sort of delay in delayed-reward oriented tasks. This is accomplished either by engaging in behaviors which subjectively cause time to pass faster for them, such as daydreaming (inattention) or fidgeting (hyperactivity). When those with delay aversive tendencies are presented with the opportunity for an immediate or delayed reward they typically respond as quickly possible to

minimize any delay despite any other potentially lost rewards (Songua-Barke, 2003).

Both the Delay Aversion pathway and the Executive Dysfunction pathway are maladaptive cognitive processes which can lead to ADHD symptomology. Each is associated with the combined form of ADHD rather than to either particular subtype. The development of these two processes are thought to occur independently and the presence of one is not hypothesized to be related to the other. Both executive dysfunction and delay aversion can be present in the same individual, although this is expected to occur no more likely than chance (Songua-Barke, 2003).

Instead of these distinct deficits in executive function and motivation-reward strategies leading to distinct behavior patterns, these distinct deficits produce similar issues with inhibition. This results in a common behavior set of ADHD symptoms. The possibility of multiple pathways to one large group of behaviors could explain the interrelation of ADHD symptoms and the majority of the impulsive tendencies measured by the UPPS-P. If the same deficits lead to both Hyperactive/Impulsive and Inattentive symptoms, then impulsive behaviors rooted in these deficits would be associated with both subtypes and one another.

#### *Implications & Future Directions for Research*

This study found no significant relationships between the ADHD symptomology and the computerized measures of impulsivity. These findings are in conflict with the results of multiple other studies, which generally used children

as subjects (Dougherty, 2003; Epstein, 2003; Whiteside, 2005). A recent study looking at the longitudinal development of ADHD found that 90% of those with Adult ADHD did not exhibit symptoms of ADHD as children. Furthermore their performance on computerized behavioral tasks were significantly better than children with ADHD and no different from control group (Moffitt et. al., 2015). These findings, combined with the results of this study, imply that the differences in those with childhood ADHD and those with adult ADHD may also transfer over to what kinds of impulsive behaviors they engage in. These differences may be due to adults having learned to mitigate their cognitive impairments which are measured by tests like the IMT and Go/Stop task, but still struggle with broader dispositional impulsivity. It could also be due to Adult ADHD and Childhood ADHD being separate disorders with similar symptoms. In light of this theory, a replication of this study with a sample of children instead of adults may produce different results. Further research examining this difference could be conducted by comparing the relationship between ADHD symptomology and scores on impulsivity measures between an Adult ADHD group and a Childhood ADHD group.

The range of ADHD subtype symptom scores was large in this study. Of the 138 participants, only eleven reached the clinical level of symptoms for at least one subtype of ADHD. As a result, some of the participants in this sample may not have had significant enough deficits to produce measurable deficits on the IMT or Go/Stop tasks. A replication of this study may benefit from only utilizing participants who exhibit moderate to severe ADHD symptomology.

### *Conclusions*

The results of this study failed to find support for the idea that symptoms of the two ADHD subtypes are differently related to the various dimensions of impulsivity. Although one analysis revealed a specific association between participants' Lack of Perseverance and Inattentive Symptoms, the general lack of differences between subtypes across analyses suggest that ADHD symptomology cannot be used to predict what subtypes of impulsive behavior an individual will exhibit. Future research may benefit from administering the measures in a way which creates fewer scores to represent impulsivity.



Table 1*Descriptive  
Statistics*

Variable	Mean (SD)	Median	Range	Skew	Kurtosis
<b>ASRS</b>					
Hyper/Imp	13.69 (4.91)	14	0 - 26	-0.04	0.09
Inattentive	16.53 (5.38)	14	0 - 33	0.01	0.99
<b>UPPS - P</b>					
Neg. Urgency	16.02 (6.82)	16	0 - 36	-0.08	-0.08
Perseverance	20.69 (5.07)	21	8 - 30	-0.32	-0.37
Premeditation	23.61 (4.65)	24	7 - 33	-0.37	0.35
Sens. Seeking	23.18 (7.26)	23	4 - 36	-0.32	-0.27
Pos. Urgency	11.32 (7.49)	13	0 - 29	0.13	-0.84
<b>IMT</b>					
A'	0.79 (0.10)	0.81	0.28- 0.98	-1.67	4.81
(Log Trans.)	0.08 (0.04)	0.08	0.01– .24	1.24	2.89
B''	-0.23 (0.51)	-0.25	-1 - 0.95	0.34	-0.85
<b>Go/Stop Task</b>					
%Correct 50ms	90.22 (14.63)	100	20 - 100	-1.91	4.26
50ms(Log Trans.)	0.58 (0.66)	1.04	0 – 1.91	0.40	-1.59
%Correct 150ms	74.59 (22.29)	80	20 - 100	-0.53	-0.78
%Correct 250ms	55.63 (25.03)	50	0 - 100	0.03	-0.77
%Correct 350ms	37.04 (25.07)	40	0 - 100	0.48	-0.37

Table 2

*Pearson Correlations between Participants' Scores on Impulsivity Measures and ADHD Subtype Totals.*

Impulsivity Measure	Inattentive Symptom Total		Hyperactive/ Impulsive Symptom Total	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
UPPS - P				
Negative Urgency	<b>.55</b>	<b>.00</b>	<b>.52</b>	<b>.00</b>
Perseverance	<b>-.44</b>	<b>.00</b>	-.16	.06
Premeditation	<b>-.23</b>	<b>.01</b>	<b>-.23</b>	<b>.01</b>
Sensation Seeking	.07	.41	.16	.06
Positive Urgency	<b>.44</b>	<b>.00</b>	<b>.43</b>	<b>.00</b>
IMT				
A' (Log Transformed)	.10	.16	.09	.22
B''	.05	.56	.07	.45
Go/Stop Task				
% Correct Inh. 50ms (Log Transformed)	.09	.06	.05	.38
% Correct Inh. 150ms	-.09	.30	-.08	.34
% Correct Inh. 250ms	-.16	.07	-.10	.26
% Correct Inh. 350ms	.08	.33	.05	.53

*Note: Correlations Significant at the  $p < .05$  level are in boldface.*

Table 3

*Results of the Test of the Difference between ADHD Subtypes Symptomology's Correlations with Impulsivity Measures.*

Impulsivity Measure	Z Score	Two Tailed $p$	Power
UPPS-P			
Negative Urgency	0.45	0.65	0.08
<b>Perseverance</b>	<b>-3.89</b>	<b>&lt; 0.01</b>	0.98
Premeditation	0.31	0.75	0.08
Sensation Seeking	-1.24	0.22	0.23
Positive Urgency			0.05
IMT			
A' Transformed	0.25	0.80	0.05
B''	-0.18	0.86	0.06
Go/Stop Task			
% Correct Inh. 50ms (Trans.)	0.55	0.59	0.09
% Correct Inh. 150ms	-0.11	0.91	0.05
% Correct Inh. 250ms	-0.81	0.42	0.13
% Correct Inh. 350ms	0.41	0.68	0.07

*Note: Correlations significantly different from each other at the  $p < .05$  level are in boldface.*

Impulsivity Measure	IN. Symptom total			H/I Symptom Total			R <sup>2</sup>	Pwr.
	$\beta$	Partial Corr.	$p$	$\beta$	Partial Corr.	$p$		
UPPS - P								
Neg. Urgency	<b>.37</b>	<b>.33</b>	<b>.00</b>	<b>.28</b>	<b>.26</b>	<b>.00</b>	.35	.99
Perseverance	<b>-.56</b>	<b>-.44</b>	<b>.00</b>	.20	.17	.06	.21	.99
Premeditation	-.15	-.12	.17	-.13	-.10	.25	.06	.75
Sens. Seeking	-.06	-.05	.60	.20	.15	.08	.03	.43
Pos. Urgency	<b>.27</b>	<b>.023</b>	<b>.01</b>	<b>.25</b>	<b>.22</b>	<b>.01</b>	.01	.17
IMT								
A' Trans.	.08	.06	.46	.03	.03	.77	.01	.17
B''	.02	.01	.89	.05	.04	.63	.00	.05
Go/Stop Task								
%Correct 50ms(Trans.)	.09	.07	.44	.00	.00	.98	.01	.17
%Correct 150ms	-.06	-.05	.58	-.03	-.03	.71	.01	.17
%Correct 250ms	-.16	-.12	.16	.01	.00	.97	.02	.30
%Correct 350ms	.08	.06	.46	.00	.00	.99	.01	.17

Note: Associations Significant at the  $p < .05$  level are in boldface. Inattentive symptom total and H/I symptom total were entered together as predictors of each impulsivity measure in the models.

Table 5

*Impulsivity Measures' Beta weights and Partial Correlations with ADHD subtype scores from Linear Regression*

Impulsivity Measure	Overall ADHD Symptom			R <sup>2</sup>	Power
	Total		p		
	β	Partial Correlation			
UPPS - P					
Neg. Urgency	<b>.59</b>	<b>.59</b>	<b>.00</b>	.35	0.99
Perseverance	<b>-.33</b>	<b>-.34</b>	<b>.00</b>	.11	0.98
Premeditation	<b>-.25</b>	<b>-.25</b>	<b>.00</b>	.06	0.84
Sens. Seeking	-.13	-.13	.15	.02	0.38
Pos. Urgency	<b>.48</b>	<b>.48</b>	<b>.00</b>	.23	0.99
IMT					
A' Transformed	.11	.11	.22	.00	0.05
B''	.06	.06	.46	.00	0.05
Go/Stop Task					
% Correct Inh. 50ms (Trans.)	.08	.08	.38	.01	0.22
% Correct Inh. 150ms	-.10	-.10	.27	.01	0.22
% Correct Inh. 250ms	-.14	-.14	.10	.02	0.38
% Correct Inh. 350ms	.08	.08	.46	.01	0.22

*Note: Associations Significant at the  $p < .05$  level are in boldface.*

Table 6

	Neg.Urg. <i>r</i> ( <i>p</i> )	Premed. <i>r</i> ( <i>p</i> )	Persev. <i>r</i> ( <i>p</i> )	Sens.Seek. <i>r</i> ( <i>p</i> )	Pos.Urg. <i>r</i> ( <i>p</i> )	IMT A' <i>r</i> ( <i>p</i> )	IMT B'' <i>r</i> ( <i>p</i> )	50% <i>r</i> ( <i>p</i> )	150% <i>r</i> ( <i>p</i> )	250% <i>r</i> ( <i>p</i> )
Negative Urgency	1									
Premeditation	<b>-.24 (.00)</b>	1								
Perseverance	<b>-.29 (.00)</b>	<b>.37 (.00)</b>	1							
Sensation Seeking	.06 (.46)	<b>-.28 (.00)</b>	.06 (.50)	1						
Positive Urgency	<b>.50 (.00)</b>	<b>-.42 (.00)</b>	<b>-.36 (.00)</b>	<b>.19 (.00)</b>	1					
A Prime	.09 (.31)	.07 (.41)	-.06 (.51)	-.02 (.78)	.02 (.87)	1				
B Primed	-.01 (.92)	-.06 (.51)	-.03 (.70)	.04 (.69)	.05 (.54)	<b>-.26 (.00)</b>	1			
% 50ms	-.04 (.65)	-.02 (.79)	-.13 (.14)	-.09 (.31)	.09 (.28)	<b>.25 (.00)</b>	.04 (.52)	1		
% 150 Inh	-.01 (.93)	-.02 (.84)	.09 (.28)	.13 (.15)	-.06 (.49)	<b>.24 (.01)</b>	-.02 (.80)	<b>-.68 (.00)</b>	1	
% 250 Inh	-.03 (.72)	-.02 (.80)	-.03 (.76)	.08 (.34)	.01 (.89)	-.12 (.18)	.07 (.43)	<b>-.43 (.00)</b>	<b>.59 (.00)</b>	1
% 350 Inh	.12 (.16)	-.03 (.73)	-.15 (.09)	.07 (.41)	.07 (.43)	-.02 (.84)	.13 (.13)	<b>-.21 (.01)</b>	<b>.42 (.00)</b>	<b>.60 (.00)</b>

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