A Psychometric Evaluation of Internal Restlessness and Hyperactivity Measures Among College Students

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ABSTRACT

This thesis aims to assess our current understanding of internal restlessness in adults with ADHD and how it is assessed. Currently, there is very little research on methods to objectively assess internal restlessness, with most methods relying on subjective techniques. But, based on prior research into other related conditions involving internal restlessness including Parkinson's disease, restless leg syndrome, akathisia, and hyperactivity in ADHD, a pattern of dopamine dysregulation and frontal lobe dysfunctions begins to emerge. By comparing different subjective and objective assessments including the Conner's Adult ADHD Rating Scale (CAARS), Internal Restlessness Scale (IRS), Finger Tapping Test (FTT), Grip Strength (GS), and Actigraphy (ACT), a positive correlation between the subjective assessments and the nondominant hand on the finger tapping test was seen. Additionally, there was also a correlation between actigraphy and grip strength. This new evidence may point to a major difference in subjective assessments of internal restlessness and hyperactivity being related to fine motor movement and control seen in the finger tapping test compared to the gross motor movements of the grip strength and actigraphy.

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CHAPTER I

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by three major categories of symptoms: inattention, impulsivity, and hyperactivity (American Psychiatric Association, 2013). In the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), inattention is characterized by behaviors such as wandering off task and difficulty maintaining focus. Impulsivity refers to behaviors and actions that an individual may act upon without fully considering the ramification or consequences of actions, an example of this may be buying an expensive item that they want without considering how the spending will affect their ability to pay rent in the future. Hyperactivity is defined by greater levels of motor activity that may include gross body movements, such as standing from a chair and walking around, or fine, fidgety movements such as foot or finger tapping (American Psychological Association, 2013). In many instances, these hyperactive behaviors may manifest without locomotion, but rather as a sensation of internal restlessness (Conners et al., 1999); this is especially salient in adults with ADHD (Weyandt et al., 2003). While there are no specific rates of prevalence for internal restlessness, the importance of this symptom can be seen in how it is represented in prior research. For instance, in the Conners Adult ADHD Rating Scale (CAARS), one of the four main factors involves hyperactivity and restlessness. Additionally, from other research, the rates of internal

restlessness-based symptoms like intrusive thoughts were much more prevalent in those with a history of hyperactivity (Shaw & Giambra, 1997)

In both children and adults, the neurophysiological etiology of ADHD has commonly been traced to deficits throughout the frontal lobe of the brain. As the brain develops from childhood towards adulthood, one major component of ADHD that drastically changes is hyperactivity**.** Adults with ADHD show a noticeable decrease in gross motor hyperactivity and an increase in feelings of internal restlessness (Biederman et al., 2000; Das et al., 2014). Unfortunately, these subjective feelings of internal restlessness are exactly that, subjective, and research has indicated that individuals with ADHD have difficulty reporting their subjective experiences and symptoms (Barkley et al., 2002). Therefore, the next step toward a more accurate diagnosis of adult ADHD would be the implementation of a more objective assessment of internal restlessness.

Research focusing on internal restlessness outside the realm of ADHD provides us some insight into the potential mechanisms of action, thus potential methods to assess it more objectively. For example, there is evidence that dopamine levels may be implicated in the experience of internal restless as seen in the prevalence of such conditions as Parkinson's disease and Restless Leg Syndrome (e.g., Möller et al., 2010). Given the possible influence of dopamine on behaviors associated with both hyperactivity and internal restlessness, the paper will focus on the potential associations between these two constructs and their measurement. Specifically, I will then propose a

study to assess these constructs using traditional self-report methods and more objective assessment techniques sensitive to dopamine-influenced behaviors in college students.

Internal Restlessness

Research into ADHD in college students and adults has experienced a surge of interest within the past decade, although hyperactivity is less commonly a focus compared to more prominent symptoms such as inattention. This might be related to adults presenting with significantly less observed hyperactivity than children (Biederman et al., 2000; Das et al., 2014; Murillo et al., 2015) with some studies concluding that the underlying mechanisms responsible for hyperactivity in children, such as intracortical motor inhibition, are no longer deficient in adults (Hoeppner et al., 2008). With this apparent decrease in externalized hyperactivity, research into the potential for internalized hyperactivity, or internal restlessness, began. Weyandt et al. (2003) notes this decrease in overt hyperactivity and consequent replacement with internal restlessness. Updates between the Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition (DSM—IV TR), fifth edition (DSM-V), and fifth edition text revision (DSM-V-TR) mirror this description of a restless feeling in both adults and children with an emphasis on the manifestation of extreme restlessness in adults (American Psychiatric Association, 2000, 2013, 2022; Center for Behavioral Health Statistics and Quality, 2016). The development of the internal restlessness scale (IRS) (Weyandt et al., 2003, 2005) has been a step toward identifying a client's experience of this symptom via self-report.

Based on this, a conclusion could be made that internal restlessness, in order to be adequately assessed, should include an objective measure of this symptom. Both Murphy and Schachar (2000) and Weyandt et al. (2003) identify internal restlessness as subjective, and no current research has been conducted looking into the potential of an objective evaluation of internal restlessness.

Looking outside the scope of ADHD, a handful of neurological dysfunctions and syndromes result in symptoms of internal restlessness. In particular, akathisia is defined by an objective observation of limb movements or shifting body positions as well as a subjective report of inner tension and restlessness (Mehta et al., 2015). It is often witnessed as a side-effect of neuroleptics (Walters et al., 1991) and in Parkinson's disease (PD) as the initial complaint or in "off" periods between medication doses (Witjas et al., 2002).

How do you measure restlessness?

Currently, internal restlessness is assessed with the help of self-report assessments. In akathisia patients, subjective reports often describe a feeling of tension and uncomfortability. It is often under treated and underdiagnosed due to the tendency of many clinicians to label the symptoms as anxiety (Tachere & Modirrousta, 2017). By qualitatively comparing the language used in the standardized assessment of both internal restlessness and anxiety, a pattern begins to emerge. Items relating to hyperactivity/impulsivity in the Diagnostic Interview for ADHD (DIVA 2.0) in adults uses term such as "feeling restless", "feeling agitated inside", and "finding it hard to

relax" as options for the client to describe if they have experienced restless symptoms (Semeijn et al., 2016). The Internal Restlessness Scale further adds to this similarity with anxiety and ADHD by including items such as "I have difficulty relaxing because of recurring thought", "I am always thinking. I have difficulty putting thoughts to rest", and a reverse scored item of "I feel mentally calm" (Weyandt et al., 2003). Furthermore, items from the GAD-7, a brief assessment for generalized anxiety disorder, describe similar characteristics to the aforementioned measures; items such as "being so restless that it is hard to sit still" and "trouble relaxing" (Spitzer et al., 2006) describe similar feelings of restlessness both mentally and physically. Additionally, The Barnes Akathisia Rating Scale (BARS) includes a subjective report of an individual's compulsion to move at rest and objective observation of minute, fidgety movement especially in the lower limbs (Barnes, 1989).

What are the challenges/issues with these measures?

Each of these assessments mentioned previously is used in the testing of a different symptom, disorder, or dysfunction and yet, they seem to be describing a very similar concept with common themes focusing on an individual's difficulty being relaxed and a desire to move. This opens up the possibility of some overlap between the symptoms of hyperactivity and internal restlessness which continues to push the question of whether or not these two symptoms are the same construct.

Neurological/Biological Basis of Internal Restlessness

The goal of this next section is to provide a more concrete background of dopamine's role in different forms of internal restlessness. To do this, a number of dopaminergic medications, brain structures, and neuropsychological assessments will be explored to paint a clearer picture of how dopaminergic dysfunction is primarily responsible for internal restlessness in conditions such as akathisia, Parkinson's disease, and restless leg syndrome.

Akathisia, as a symptom of PD and antipsychotic medication side effects, has a strong correlation with decreases in the neurotransmitter dopamine (DA). PD has long been linked back to an imbalance of DA when Jean-Martin Charcot and William Gowers attempted to treat PD using belladonna alkaloids, an anticholinergic agent (Ordenstein, 1968). Further study into the treatment of PD using levodopa after identifying a decrease in striatal dopamine in the brains of PD patients (Ehringer & Hornykiewicz, 1960). Akathisia associated with the extrapyramidal side effects of antipsychotic medication can also be linked to dopamine. Medications such as chlorpromazine and haloperidol block striatal D_2 dopamine receptors (Musco et al., 2020) thereby decreasing dopaminergic activity. Additionally, stimulants such as methylphenidate and dextroamphetamine are commonly used in the treatment of ADHD (del Campo et al., 2011; Prince et al., 2015). Both methylphenidate and dextroamphetamine increase levels of extraneuronal dopamine and norepinephrine by blocking reuptake. Dextroamphetamines have been shown to further increase dopamine levels by limiting monoamine oxidase activity, an enzyme

responsible for the removal of dopamine and norepinephrine from the extracellular space (Kuczenski & Segal, 1975).

Restless Leg Syndrome (RLS), a symptom seen in up to 50% of PD cases (Möller et al., 2010), shares a common dopaminergic factor with akathisia and PD. While there is no current clear pathophysiological explanation for RLS, there are a few common factors that have been noted in patients; specifically, DA deficiency and brain iron deficiencies (Suzuki et al., 2015). DA dysregulation in RLS can be linked to the A11 cell group of the hypothalamus. This cell group has been shown to inhibit the functioning of the neocortex, dorsal raphe nucleus, and the sensory dorsal horn and intermediolateral nucleus in the spinal cord. This reduction of inhibition can lead to the symptoms seen in RLS such as abnormal sensations, focal akathisia, and muscle restlessness (Suzuki et al., 2015). Another structure of importance is the putamen; dysfunction of the putamen has also been linked to dopamine, specifically in the decrease of D2 receptor concentration of individuals with RLS (Connor et al., 2009). But, according to other research, this DA dysregulation is not the root cause of the issue. An important precursor in the synthesis of dopamine is iron (Earley et al., 2014) and, when assessing brain-iron-deficient rats, Erikson et al. (2000) found that these rats have lower concentrations of D2 receptors than healthy rats.

Dopamine can be measured behaviorally using a number of neuropsychological tasks. Two examples of these tasks are the Finger Tapping task and grip strength. Finger tapping has a history of being used in the neuropsychological evaluation of Parkinson's

disease due to its correlation with dopamine levels of the striate (Meyer et al., 2006; Yang et al., 2003). Similarly, grip strength has been found to be related with a decline in cognitive functioning due to age-related factors such as myelin degeneration, vascular disease, and dopamine depletion (Christensen et al., 2001).

Hyperactivity

Hyperactivity has long been considered to be the symptom that differs the greatest between adults and children with ADHD, with a marked decline in hyperactive behaviors as an individual gets older (Biederman et al., 2000; Das et al., 2014). However, further research into hyperactive symptoms in an adult population indicates that hyperactivity is greater in children and adults with ADHD than in healthy children and adults (Murillo et al., 2015). When comparing effect sizes between ADHD and healthy children and adults, the ADHD groups in both children and adults differed nearly identically from their healthy group counterparts, even though the healthy children group had significantly greater hyperactivity than adults with ADHD (Murillo et al., 2015). This indicates that the decrease in hyperactivity is prevalent in all adults, not just those with ADHD, and therefore remains an important factor in the diagnostic procedure of ADHD in adults since this decline is not directly correlated with the presence of ADHD.

How do we measure hyperactivity?

ADHD diagnoses are regularly determined using self-report measures (Nelson & Lovett, 2019), and while this has provided a way to easily diagnose individuals due to their relative cost-effectiveness and availability (Murphy & Adler, 2004), a number of

issues concerning the efficacy of using these measures have also been noted. For example, Barkley et al. (2002) found that individuals with ADHD often have difficulties correctly identifying their own executive dysfunction. Thus, the assessment of ADHD should use a multi-method approach, consisting of objective measurements of symptoms and clinical interviews in addition to subjective self-report measures (Murphy & Adler, 2004).

While hyperactivity does not have distinct self-report scales that are used to identify hyperactivity, numerous different and widely used ADHD scales include a hyperactivity component or factor. A review of 14 different ADHD assessment scales found the two most valid and psychometrically sound assessments to be the Conners Adult ADHD Rating Scale (CAARS) and the Wender Utah Rating Scale (WURS) (Taylor et al., 2011). While these two scales both assess ADHD symptomology in adults, the WURS uses a retrospective approach to identifying symptoms by focusing on childhood behaviors (Ward et al., 1993). The CAARS, on the other hand, identifies ADHD symptomology by focusing on current behaviors (Conners et al., 1999). In particular, the factor structure of the CAARS contains the four factors of inattention, hyperactivity, impulsivity, and self-concept (Conners et al., 1999).

Objective measurement of hyperactivity is notably difficult to capture, and clinicians therefore must rely on other means of observation including the self-report scales discussed above. Continuous Performance Tasks (CPTs) are most often used in the assessment of attention difficulties with different variants, such as the Conner's CPT

(CCPT), loading in additional factors such as focused attention, hyperactivity, impulsivity, vigilance, and sustained attention (Egeland & Kovalik-Gran, 2008). Due to the overlapping nature of these factors, some variants of the CPT, such as the Quantified Test Plus (Qb+), supplement the CPT aspects of the assessment with a motion-tracking system (Emser et al., 2018) to more clearly measure hyperactive factors. Other forms of motion tracking such as actigraphy have been shown to differentiate ADHD individuals from controls in both children (Dane et al., 2000) and adults (Cheung et al., 2016). Results from these studies have shown incredibly high effect sizes for differentiating ADHD and control groups (Cheung et al., 2016; Murillo et al., 2015).

Neurological/Biological Basis of Hyperactivity

Just as the other symptoms of ADHD, hyperactivity is often thought to be correlated with frontal lobe deficits (Kolb & Whishaw, 2015). The frontal lobe acts as a behavioral inhibitor as well as the hub for complex actions and executive functions including attention (Darby & Walsh, 2005; Luria, 1973). Inhibition is a term used widely throughout psychological research, it generally refers to the control of current actions or behaviors (Schachar et al., 2007). Motor response inhibition has two main aspects: restraint and cancellation. Restraint refers to the ability to prevent an impulse to respond, while cancellation refers to the ability to stop an ongoing response (Schachar et al., 2007).

The dual pathway model of ADHD (Sonuga-Barke, 2003) describes these inhibitory deficits as more than just response inhibition failures, but an overall inadequate

activation of the inhibitory system. Thus, anterior parietal and subcortical structures may play a key part in the lack of inhibition seen in motor hyperactivity. One such area, the basal ganglia, is thought to be involved with inhibition (Aron et al., 2007a; van Wouwe et al, 2017) and hyperkinetic disorders (Snell, 2010). The subthalamic nucleus (STN) of the basal ganglia is responsible for the integration and smoothing of movements throughout the body (Snell, 2010) and lesions therefore results in the involuntary limb spams seen in hyperkinetic disorders such as hemiballismus, an involuntary movement disorder characterized by ipsilateral limb spasms. Aron et al. (2007) and van Wouwe et al. (2017) implicate the dorsal aspect of the STN in the hyperactivity seen in ADHD. By using the stop-signal task, they posit that activation of the STN is generated by signals from the inferior frontal cortex. Efferent fibers from the STN lead to the excitation of the pallidum and inhibition of thalamocortical signals resulting in the reduction of motor cortex activation. Successful trials during the stop-signal task would require an individual to properly inhibit a motoric response when presented with the stop signal. Therefore, dysfunction of this circuit, referred to as the fronto-basal ganglia circuitry, results in slower response times or failure to comply with the presented stop signal. Furthermore, Aron et al. (2007a) found that stimulation of the dorsal STN improved control of the reactive impulsive response to the stop signal.

The frontal-striatal-pallidal-thalamic circuits are also thought to be involved in executive dysfunctions (Hoeppner, 2008; Barkley, 1997). According to the cognitive-energetic model (Sergeant, 2000), a lack of compensatory effects from the striatum

results in a deficit of signals being sent from the striatum to the motor cortex. As described with the frontal-basal ganglia circuitry, the frontal-striatal-pallidal-thalamic pathway provides reciprocal feedback to the motor cortex for the facilitation of the mechanisms involved with controlling response inhibition (Sonuga-Barke et al., 2002; Sonuga-Barke & Sergeant, 2005).

As implied by the previous articles (Aron et al., 2007a; Barkley, 1997; Hoeppner, 2008; Sergeant, 2000; Sonuga-Barke et al., 2002; Sonuga-Barke & Sergeant, 2005; van Wouwe et al, 2017), dysfunction of subcortical structures of the basal ganglia play an incredibly important role in failed response inhibition. But, due to the interconnectedness of the brain, there are multiple points of failure besides the subcortical structures, namely, the frontal lobe. Both the frontal-striatal-pallida-thalamic (Aron et al., 2007a; van Wouwe et al, 2017) and fronto-basal ganglia (Barkley, 1997; Hoeppner, 2008) pathways receive information from the premotor and inferior aspects of the frontal cortex, depending on the desired action. Sometimes referred to as the neocortex, a number of cortical structures are responsible for the initiation of movement (Kolb & Whishaw, 2015). The most posteriorly located structure in the neocortex is the primary somatosensory cortex, this region sends movement information informed by the culmination of incoming sensory information (Snell, 2010). In the frontal lobe, the most anterior structure of the neocortex is the prefrontal cortex. The right inferior frontal gyrus (RIFG) has often been implicated in poor behavioral inhibition performance (Aron et al., 2003). Interestingly, a follow-up study from Swick et al. (2008) found that the analogous section contralateral to the RIFG,

the left inferior frontal gyrus (LIFG) also plays a role in the behavioral inhibition process. Although, when comparing the overall effects of the deficits, lesions to the LIFG corresponded to more minor deficits than RIFG lesions. This would indicate that functional compensation from the RIFG does not provide a large enough effect to completely rule out double-dissociation for localization of response inhibition in the RIFG.

Internal restlessness does not necessarily replace the hyperactive symptoms present earlier on in life, as it is also seen in children but to a lesser degree than in adults (Agnew-Blais et al., 2016). In adulthood, the higher-order cortical structures in the superior and dorsolateral prefrontal cortices responsible for inhibiting motor functioning have matured (Shaw et al., 2007). Therefore, a decreased amount of locomotion should be seen. Castellanos et al. (2002) looked into the development of children with and without ADHD and found that their overall developmental trajectories run parallel in just about all cortical and subcortical structures aside from the caudate nucleus. By the age of 10, the caudate nucleus reaches its maximum volume, and the difference in volume between the ADHD and non-ADHD children was minimal. Nakao et al. (2011) found similar results in their meta-analysis; they found that increasing age was correlated with the progressive increase in grey matter volume of the right putamen. Therefore, as the individual with ADHD ages, the once smaller putamen begins to resemble the size of the putamen of a control individual. Additionally, the somatosensory system in adults with ADHD was found to have less hypoactivation compared to children with ADHD

(Biederman et al., 2000). All of these results present a pattern of returning to relative baseline hyperactivity as an ADHD individual ages, supporting the theory that adults with ADHD seemingly age out of their hyperactive symptoms.

Overlap

A simple way of relating the concepts of hyperactivity and internal restlessness is in their physical motor activity. While hyperactivity involves increased locomotor activity, such as body movements, internal restlessness can be described as the cognitive urge to move (Conners et al., 1999). In the development of the Conners' Adult ADHD Rating Scales (CAARS), a factor analysis resulted in the emergence of four main factors; one of which covers both symptoms of hyperactivity, the external behavior, and internal restlessness, the internal urge (Conners et al., 1999). This factor analysis suggests an underlying relationship between these two symptoms.

Another factor tying these dysfunctions to one another is the neurotransmitter dopamine (DA). Psychopharmacological treatments for ADHD may include stimulants and non-stimulants. A number of different formulations of the stimulants methylphenidate (Ritalin, Concerta) and amphetamine (Adderall, Vyvanse) are FDA approved for the treatment of ADHD (del Campo et al., 2011; Prince et al., 2015). The common target neurotransmitter of both is dopamine. This also extends to non-stimulant medications such as Atomoxetine (Strattera) which are intended to increase dopamine levels as well. Internal restlessness also seems to be related with decreased dopaminergic

activity in PD (Ehringer & Hornykiewicz, 1960), akathisia (Musco et al., 2020), and RLS (Connor et al., 2009; Erikson et al., 2000; Suzuki et al., 2015).

Summary and Purpose

Adult ADHD is a relatively new and yet still important area of study. Specifically, hyperactivity sees the greatest decrease in overall symptom prevalence from childhood to adulthood (Agnew-Blais et al., 2016; Biederman et al., 2000; Das et al., 2014; Hoeppner et al., 2008; Murillo et al., 2015; Weyandt et al., 2003). But, due to the fairly unreliable responses to self-report measures by individuals with ADHD (Barkley et al., 2002), there needs to be a push to identify objective measures that can reliably identify this symptom.

Due to the subjective nature of internal restlessness (Schachar, 2000; Weyandt et al., 2003), there are no objective measurements currently available. But, if strong correlations between current self-report assessments for hyperactivity and internal restlessness and potential respective objective measures are identified, it may provide a new line of assessment research to investigate. Based on the dopaminergic dysfunction seen in both instances of hyperactivity and internal restlessness, an objective assessment of dopaminergic functioning may be the key to tying these two together. Additionally, based on the qualitative overlap between the wording on tests of hyperactivity and internal restlessness, it would be worth determining if any correlation exists between both of these symptoms as well. In this study, we proposed to compare different self-report, neuropsychological, and physiological assessments that each relates to either

hyperactivity and internal restlessness, and we evaluated the potential correlations between the measures to begin to address this gap in the current literature.

To help adequately describe the comparisons between the numerous assessments and methodologies, a diagram similar to the Multitrait-multimethod (MTMM) matrix (Campbell & Fiske, 1959) is implemented. In this matrix, the methods being compared are self-report and neuropsychological/physiological assessments and the traits are internal restlessness and hyperactivity. The point when this diagram differs from the matrix outlined by Campbell and Fiske (1959) is the presence of multiple measurement techniques overlapping with one trait. While the two self-report assessments map onto the traits of hyperactivity and internal restlessness, grip strength and the finger tapping test map onto internal restlessness while actigraphy maps on to hyperactivity. One of the aims of this study is to determine if the neuropsychological and/or physiological measures correctly map onto these two traits (See Table 1). Specifically, it was hypothesized that the constructs measured by each self-report measure are actually measuring very similar, if not the same construct. Therefore, the measures should be correlated with one another. In regard to the neuropsychological and physiological measurements, we predicted them to positively correlate with one another because they all assess motor function and dopamine and therefore should have some within-method correlations. When looking between methods, we hypothesized to find positive correlations between the CAARS and each of the neuropsychological/physiological

measures, and also to find positive correlations between the IRS and each of the neuropsychological/physiological measures.

Table 1

MTMM-like Matrix of Self-Report and Neuropsychological/Physiological Measures

			Self-Report		Neuro/Physio		
			A_1	B_1	A_2	B_{2a}	B_{2b}
Self-Report	Hyperactivity (CAARS)	A_1	-				
	Internal Restlessness (IRS)	B_1	x.xx	-			
Neuro/Physio	Hyperactivity (ACT)	A_2	x.xx	x.xx	-		
	Internal Restlessness (FTT)	B_{2a}	x.xx	x.xx	x.xx	-	
	Internal Restlessness (GS)	B_{2b}	x.xx	x.xx	x.xx	x.xx	-

Note. CAARS = Conners Adult ADHD Rating Scale, IRS = Internal Restlessness Scale, FTT = Finger Tapping Test, GS = Grip Strength, ACT = Actigraphy.

CHAPTER II

Method

Participants

A total of 45 participants aged 18-22 (*M* = 19.07, *SD* = 1.16), were recruited from Middle Tennessee State University's Psychology Research Pool through the SONA system. Of the 45 participants, 32 were female (71%), 12 were male (27%), and one identified as nonbinary (2%). A majority of the participants were college freshmen (*n* = 27; 60%), with seven sophomores (16%), seven juniors (16%), and four seniors (9%). Additionally, 27 of the participants were white (60%), 8 participants were Black/African American (18%), three were Hispanic (7%), two were Asian (4%), one biracial (2%), one Native American (2%), and three labeled themselves as other (7%).

After participating in the study, participants responded to a series of questions involving mental health diagnoses, physical diagnoses, and prescribed medications that may impact their ability to perform tasks of motor function or provide additional confounding factors that may influence their performance on the tasks. Out of the 45 participants, seven had an ADHD diagnosis and were taking a range of medications including Concerta, Adderall, Guanfacine, or generic methylphenidate. Some other diagnoses included carpal and cubital tunnel, depression, anxiety, OCD, bipolar disorder, dyslexia, and dysgraphia. Almost all of the participants were right-handed (*n* = 40) and the majority were also right-footed (*n* = 43). Handedness and footedness were assessed by asking directly, and if a participant was unsure, they were asked an additional

clarifying question such as “which foot would you use to kick a ball with?”. In order for an individual to participate in this study they must be at least 18 years old and have unimpaired usage of their dominant and nondominant hands/arms. All 45 participants met these criteria; none were excluded from the sample.

Measures

Demographics

The self-report demographics questionnaire included items about the participant’s age, sex, ethnicity, and years of education (see Appendix A). Additionally, they were asked to affirm or deny the presence of psychological and physical diagnoses that may have impacted their performance during testing. This section of the demographics also asked participants to affirm or deny if they were currently taking medications that may have impacted their performance during testing.

Self-Report

Conners Adult ADHD Rating Scale (CAARS). The Conners Adult Rating Scale (CAARS) (Conners et al., 1999; Erhardt et al, 1999) is a 42-item self-report measure of symptoms and behaviors related to ADHD in adults aged 18 to 80. Responses for each item are on a four-point Likert scale, these quantitatively range from 0 to 3 and qualitatively range from “not at all/never” to “very much/very frequently” (Conners et al., 1999). The items on the CAARS load into 4 distinct factors: Inattention/Memory Problems, Hyperactivity/Restlessness, Impulsivity/Emotional Lability, and Problems with Self-Concept. Inattention/Memory Problems consists of 12 items (males 18-29: α =

.89; females 18-29: α = .88) with a maximum raw score of 36; 18–29-year-old males have a mean of 13.64 (6.88) and females have a mean of 10.05 (6.28). Hyperactivity/Restlessness consists of 12 items (males 18-29: α = .89; females 18-29: α = .90) with a maximum raw score of 36; 18–29-year-old males have a mean of 16.69 (7.32) and females have a mean of 13.12 (7.36). Impulsivity/Emotional Lability consists of 12 items (males 18-29: α = .89; females 18-29: α = .86) with a maximum raw score of 36; 18–29-year-old males have a mean of 13.24 (6.80) and females have a mean of 10.20 (5.41). Inattention/Memory Problems consists of 6 items (males 18-29: α = .88; females 18-29: α = .87) with a maximum raw score of 18; 18–29-year-old males have a mean of 6.62 (4.24) and females have a mean of 7.26 (4.27) (Erhardt et al., 1999). Raw scores are then converted into t-scores. The hyperactivity/restlessness index will be used in this current study. Test-retest reliability was found to be .90 for the hyperactivity/restlessness subscale after a one-month gap between administrations. Concurrent validity was calculated using the Wender Utah Rating Scale (WURS) total score and each subscale of the CAARS. The hyperactivity/restlessness subscale was found to have a correlation of .48 with the WURS total score (Erhardt et al., 1999). The hyperactivity/restlessness subscale was used as a dependent variable in this study.

Internal Restlessness Scale (IRS). The IRS **(**Weyandt et al., 2003, 2005) is a 24-item self-report measure of internal restlessness. Items use a 7-point Likert scale ranging from “none of the time” (1) to “all of the time” (7). The items load into 4 factors: internal (cognitive) distractibility, internal (mental) restlessness, internal (cognitive) impulsivity,

and internal disorganization (Weyandt et al., 2003). Total scores are calculated by summing the points earned on each of the 24 items, with 21 being scored positively and 3 being reverse-scored (Weyandt et al., 2003). The test-retest reliability of the IRS, after a 4-week gap in administration, was found to be .80 for both participants with and without ADHD (Weyandt et al., 2003). The Adult Rating Scale (ARS) was used as a measure of concurrent validity. The IRS was found to be highly correlated to similar ADHD rating scales such as the Adult Rating Scale (ARS; r = .849), Young Adult Rating Scale (YARS; r = .866), and the Wender Utah Rating Scale (WURS; r = .736) while showing statistically significantly lower correlation with non-ADHD scales such as the Brief Symptom Inventory (BSI; r = .577) and the Shipley Institute of Living Skills (SILS; r = .216). No statistically significant correlations were found between the IRS and the Test of Variable Attention (TOVA) with values of .007, .025, .034, and .115 for the auditory TOVA using commission errors, auditory TOVA using omission errors, visual TOVA using commission errors, and visual TOVA using omission errors respectively (Weyandt et al., 2005). This would indicate that while the IRS is measuring ADHD, it is not measuring the attentional aspect. The total IRS score was used as a dependent measure in this study.

Neuropsychological/Behavioral

Finger Tapping Test. The Finger Tapping Test (FTT) (Reitan, 1969; Reitan & Wolfson, 1985) is an assessment of fine motor functioning, but it has also shown to be useful in the assessment of alertness, impaired attention, and response delays (Sherman &

Spreen, 2006). The device is made up of a wooden board with a small counter and lever attached to the top of the board at the far end. During this test, participants placed their hand flat on the board and were allowed to only move their index finger, not their entire hand or arm, and pressed on the lever of the manual finger tapping counter (Psychological Assessment Resources, Inc.) as fast as possible. They complete 5 consecutive trials on their dominant hand with a short break in between each trial, and a one-to-two-minute break after trial 3. Then, the process is repeated on the non-dominant hand (Sherman & Spreen, 2006). A total score was assessed for each hand individually and was calculated based on the mean of 5 consecutive trials, each lasting 10 seconds each. In this study the z-score based on the mean tapping frequency for each hand were used as dependent variables; all the z-scores were calculated based on the norms from Ruff and Parker (1993).

Performance tends to be worse with the hand on the opposite side of the lesion (Sherman & Spreen, 2006). Therefore, if hyperactivity and internal restlessness are most seen in right frontal lobe dysfunction, the left hand should have worse performance. The FFT can be used to distinguish patients with subcortical motor dysfunctions, namely the basal ganglia, as well of cerebellar origination. But, to differentiate between each of these, other measurements, aside from tapping frequency, should be used such as intertap variability, time in flexion and extension in the tap cycle, and

time-sequential histograms of tapping intervals (Shimoyama et al., 1990). Additionally, there is an established relationship between striatal D2 receptor density and performance on the FTT (Meyer et al., 2006; Yang et al., 2003).

Grip Strength. Grip strength (Bornstein, 1985; Heaton et al., 2004; Reitan & Wolfson, 1985; Strauss, Sherman, & Spreen, 2006; Yeudall et al., 1987) is often employed as a measure of motor functioning and dopaminergic activity. This tool requires the participant to grip a hand dynamometer (Model 78010, Lafayette Hand Dynamometer) and squeeze as hard as they can, resulting in an output of force measured in kilograms. When the grip of the hand dynamometer is squeezed, a pointer is moved to the amount of force being exerted by the individual. Participants completed 5 consecutive trials on each hand, starting with their dominant (preferred) hand. The mean was calculated using the maximum input force of each trial for each hand, resulting in a left and right (preferred and not preferred) mean grip strength. The z-score based on the mean maximum input force for their preferred and not preferred hands were the dependent variables; all the z-scores were calculated based on the norms from Bornstein (1985) and Yeudall et al. (1988).

Cronbach's α from eight trials (four for each hand) was calculated to be .82 (Christensen et al., 2001). Test-retest reliability coefficients had a range of .52 to .96 with a time delay of up to 30 months between sessions. Grip strength loads into a sensorimotor, anthrometric, and biomedical factor. Anthrometric factors include height,

weight, and head circumference while biomedical factors were defined with systolic and diastolic blood pressure (MacDonald et al., 2004).

Actigraphy. Actigraphy is a method of measuring the gross physical/motor activity of an individual. The actigraph (Actigraph GT9X Link) can be worn on the wrist, waist, ankle, or head and measures acceleration normalized to Earth's gravity (g). The actigraph uses a triaxial (3-axis) accelerometer (+/- 16 g) using a 12-bit analog to digital converter that can be set to sampling rates ranging from 30 Hz to 100 Hz in multiples of 10. This unfiltered data is stored on the device in G's to be later transferred to Actigraph's Actilife program for analysis. In this study, we had participants wear the actigraph on the non-dominant ankle, although prior research has not found a meaningful difference between the sides (Driller et al., 2017), the actigraph has historically been placed on the nondominant side (Sadeh, 2011). The device was worn for the duration of their completion of the neuropsychological and self-report assessments with a sampling rate of 60 Hz. Instructions from the white-papers for the actigraph (Miller, 2013) describe that a greater sampling rate is not necessary for collecting adequate data, so a sampling rate greater than the standard 30 Hz but less than the maximum of 100 Hz was chosen to allow for enough data to be collected without the creation of unnecessarily large files. The final data was compiled into 1-minute epochs using Actigraph's proprietary software, Actilife. During the data transfer process, Actigraph's Low Frequency Extension (LFE) was applied to the data. This extension reduces the standard activation

threshold for movement to be counted as an action, specifically, it allows the recording of lower amplitude movements. The average vector magnitude was the dependent variable.

Procedure

Approval was obtained to conduct this study through the MTSU Institutional Review Board (see Appendix B). During each in-person individual session, participants consented to participate (see Appendix C) then completed the assessments. Participants were first asked their handedness and footedness to determine the placement location of the actigraph and to inform differentiation between dominant and nondominant hands for finger tapping and grip strength. Following this, participants completed the grip strength assessment before being asked to wear the actigraph on their non-dominant ankle; the time was recorded to mark when the activity has begun recording. The assessments were split into self-report or neuropsychological/behavioral sections. These two major sections were randomized in their presentation, and the three subtests within these sections are randomized as well. This resulted in 6 unique assessment paradigms to minimize potential order effects. The two self-report questionnaires included the Conners Adult ADHD Rating Scale (CAARS) and Internal Restlessness Scale (IRS). The three neuropsychological/behavioral tasks were Grip Strength (GS), the Finger Tapping Task (FTT), and objective movement measurement using actigraphy. The actigraph was removed once all other assessments were complete. The time of removal of the actigraph was also recorded to mark the end of the collection period when analyzing the data.

Movement data from the actigraph was converted into an average vector magnitude from the average movements for each of the 3 axes.

CHAPTER III

Results

All data and hypotheses were analyzed using the statistical analysis software Jamovi (Version 2.3.28.0). Each scale uses a different scoring methodology. For the CAARS a summed total of each item's score will be used, the IRS will use the summed total of each item's score, Grip Strength uses the z-score based on the mean maximum input force for each hand, finger tapping will use the z-score based on the mean number of taps for each hand, and actigraphy will use average vector magnitude. Table 2 displays the descriptive statistics for all dependent measures. Most of the variables were found to be normally distributed based on skewness, kurtosis, and visual analysis of the frequency plots. The only variable found not to be normally distributed was the average vector magnitude (AVM) recorded from the actigraph (M = 73.40, SD = 70.67) which had a kurtosis value of 0.85 and a skewness of 1.28. Results from a Shapiro-Wilks assessment of normality further confirmed the non-normality of AVM. This non-normal variable will require the use of nonparametric statistical tests to analyze the data more accurately. It's important to note that AVM is skewed positively, with more of the values centered around the lower end of the range. Therefore, the results of the nonparametric tests may not have as much power compared to the standard parametric assessments.

A Pearson correlation was used to assess the relationship between the assessment techniques including Conners' Adult ADHD Rating Scale (CAARS), Internal Restlessness Scale (IRS), Finger Tapping Test Dominant Hand (FTT Dom), Finger

Tapping Test Nondominant Hand (FTT Nondom), Grip Strength Left Hand (GS Left), and Grip Strength Right Hand (GS Right). Multiple statistically significant results were found from this analysis (see Table 3). In order to determine if the self-report measures are measuring the same construct, the CAARS Hyper and IRS were compared using a Pearson's correlation. The CAARS Hyper and the IRS were found to have a strong positive correlation ($r = 0.50$, $p < .001$). To compare between methods of the subjective and objective assessment measures, a Pearson's correlation and a Spearman's rank correlation were used. FTT Nondom was found to have low to moderate positive statistically significant correlations with the IRS, ($r = 0.36$, $p < .01$) and the CAARS Hyper ($r = 0.37$, $p < .05$). The remainder of the assessments were not statistically significantly correlated, apart from those correlated with their opposing pairs (i.e., FTT Dom vs FTT Nondom).

When looking within methods for the neuropsychological assessments, both a Person's correlation and a Spearman's rank correlation were used to compare the scale. A Spearman's rank-order correlation was used to assess the relationship between AVM and the other assessment techniques. Bishara and Hittner (2014) found that Spearman's rho is a more accurate analysis method for correlations than Pearson's *r* when using non-normal data. Results from this analysis showed a moderate negative statistically significant relationship between AVM and both GS Right ($r_s = -0.30$, $p < .05$) and GS Left ($r_s = -0.31$, $p < .05$) (see Table 4). No other statistically significant correlations were found within methods.

Table 2

Variable Descriptives

	AVM	CAARS Hyper	IRS	FTT Dom	FTT Nondom	GS Left	GS Right
N	44	45	43	45	45	45	45
Mean	73.40	17.67	97.65	-1.15	-1.00	-1.50	-1.14
Median	52.15	18.00	100.00	-0.96	-0.73	-1.41	-1.19
SD	70.67	6.75	21.75	1.61	1.73	1.01	0.77
Min	2.20	5.00	51.00	-4.53	-5.65	-3.78	-2.79
Max	255.30	35.00	144.00	2.10	2.16	0.21	0.53
Skewness	1.28	0.13	0.00	-0.40	-0.76	-0.54	-0.02
Kurtosis	0.85	-0.17	-0.13	-0.35	0.47	-0.42	-0.31
Shapiro-Wilk	0.84*	0.98	0.99	0.96	0.95	0.95	0.99

Note. $*p < .001$

CAARS Hyper = Conners Adult ADHD Rating Scale – Hyperactivity Subscale, IRS = Internal Restlessness Scale, FTT Dom = Finger Tapping Test Z-Score Dominant Hand, FTT Nondom = Finger Tapping Test Z-Score Nondominant Hand, GS Left = Grip Strength Z-Score Left Hand, GS Right = Grip Strength Z-Score Right Hand, AVM = Average Vector Magnitude Actigraphy.

Table 3

Correlation Matrix of All Assessments

	CAARS Hyper	IRS	FTT Dom	FTT Nondom	GS Left	GS Right
CAARS Hyper	-					
IRS	0.50***	-				
FTT Dom	0.29	0.25	-			
FTT Nondom	0.37*	0.36*	0.64***	-		
GS Left	-0.26	-0.01	0.20	0.13	-	
GS Right	-0.28	-0.17	0.23	0.03	0.82***	-

Note. $*p < .05$, $**p < .01$, $***p < .001$

CAARS Hyper = Conners Adult ADHD Rating Scale – Hyperactivity Subscale, IRS = Internal Restlessness Scale, FTT Dom = Finger Tapping Test Z-Score Dominant Hand, FTT Nondom = Finger Tapping Test Z-Score Nondominant Hand, GS Left = Grip Strength Z-Score Left Hand, GS Right = Grip Strength Z-Score Right Hand.

Table 4

Spearman's Correlation Matrix of Average Vector Magnitude

	AVM	CAARS Hyper	IRS	FTT Dom	FTT Nondom	GS Left	GS Right
AVM	-	0.20	0.08	-0.14	-0.02	-0.31*	-0.30*

Note. $*p < .05$

CAARS Hyper = Conners Adult ADHD Rating Scale – Hyperactivity Subscale, IRS = Internal Restlessness Scale, FTT Dom = Finger Tapping Test Z-Score Dominant Hand, FTT Nondom = Finger Tapping Test Z-Score Nondominant Hand, GS Left = Grip Strength Z-Score Left Hand, GS Right = Grip Strength Z-Score Right Hand, AVM = Average Vector Magnitude Actigraphy.

CHAPTER IV

Discussion

In this study I set to assess the relationship between various neuropsychological and behavioral assessment techniques and the assessment of internal restlessness. Previous literature is scant on the potential to more objectively assess internal restlessness; relating it to behavioral and neuropsychological assessment is a first step. Studies on internal restlessness are few and far between. The development of the internal restlessness scale by Weyandt et al. (2003) marks an important evolution in understanding the concepts of internal restlessness. Although, this concept has been seen in other forms in individuals with ADHD (Murphy & Schachar, 2000), akathisia (Mehta et al., 2015), and Parkinson's Disease (Witjas et al., 2002). The purpose of this study, therefore, was to further our understanding of internal restlessness, its measurement, and relationship to other similar constructs.

When comparing this study's sample to the clinical and nonclinical scores reported in the original studies, the mean scores of the CAARS (non-clinical: $M = 13.62$, clinical: $M = 21.72$; Erhardt et al., 1999) and IRS (non-clinical: $M = 76.00$, clinical: $M = 112.25$; Weyandt et al., 2003) fall right in the middle of the non-clinical and clinical sample for each of the two studies. This indicates that the sample from this study is subclinical compared to the mean scores for clinically diagnosed ADHD individuals from the creation of the two scales.

Results indicate a connection between the Hyperactivity subscale of the CAARS and the IRS, which would mean that these two scales are measuring similar constructs. Based on the wording of the questions from both scales, it appears that both the CAARS hyperactivity and IRS are in fact assessing similar, if not the same, constructs. Although the CAARS hyperactivity subscale uses wording to imply a need for movement (e.g. “I tend to squirm or fidget” or “I’m always moving even when I should be still”), the IRS implies an internal struggle of activity (e.g. “I am always thinking” or “I have difficulty relaxing because of reoccurring thoughts”) and yet they seem to be sharing constructs. The answer to how they are connected may be seen in how the objective measures correlate with these scales.

The results of this current study show statistically significant correlations between the nondominant hand in the objective finger tapping test, subjective internal restlessness scale, and subjective CAARS Hyper showing that there is some connection between measures. But, neither grip strength nor actigraphy correlated with the IRS or CAARS Hyper. Therefore, there may be a difference in the brain localizations into which the latter two assessments tap. At this point, we can say that individuals with higher scores of hyperactivity and internal restlessness also score higher on the finger tapping test of the nondominant hand. From our understanding of the finger tapping test, dysfunction is contralateral to the hand tapping (Sherman & Spreen, 2006). This means that the hemisphere of the brain opposite the hand in question is experiencing dysfunction. For instance, left hemispheric dysfunction of the frontal lobe would lead to altered

performance of the right hand. Since the majority of participants were nondominant in the left hand, this would implicate the right hemisphere for dysfunction. Specifically, since there are more taps occurring with greater hyperactivity and restlessness, there seems to be a lack of inhibition occurring which tracks back to dysfunction of the right frontal lobe. These results mirror our current knowledge on hyperactivity and internal restlessness being the result of dysfunction of the right frontal lobe, and specifically the RIFG (Aron et al., 2003). The RIFG, according to Aron et al. (2014) acts as the brake for motor inhibition. If the RIFG is not functioning properly, this would lead to lack of response inhibition; this dysfunction may prove to be beneficial for the finger tapping task since the decreased ability to break could allow for greater speed when tapping.

So, if actigraphy and grip strength aren't related to the measures of hyperactivity or internal restlessness, why aren't they? For actigraphy, the answer may come from the type of pathway attempting to be measured. The leg movements measured using the actigraph seem to be more involuntary than voluntary. Sachdev and Kruk (1996) present the idea that restlessness is directly related to dysfunction in the limbic and sensorimotor sections of the striate. According to Aron et al. (2003) lack of inhibition occurs in the cortex, specifically the right frontal lobe. This may mean that the hyperactive dysfunction that would be seen in leg tapping, for instance, occurs past this point and is located along the pathway towards the basal ganglia. The involuntary movements, as stated by Ugawa (2020), may be the result in abnormal pathway development within the basal ganglia or disinhibition of standard movements.

The difference between the finger tapping test and grip strength may be more nebulous. Both assessments seem to be used for similar purposes, specifically, measuring motor functioning and subtle motor impairment (Strauss et al., 2006; Holtz, 2011). At this point, there doesn't seem to be much research comparing these two assessment measures. So, I will propose a few theories on what might be leading to the difference in outcome seen in this study. Activity complexity may play a role in the differences. The finger tapping task requires more cognitive control compared to grip strength, with processes involving timing and coordination from the cerebellum and primary motor cortex.

This leads to another major difference between the two, grip strength is more of a gross motor task due to the involvement of the large muscle group of the forearm compared to the fine motor skills involved in the finger tapping task. In terms of cortical localization, the forearm and fingers are found in different locations along the primary motor cortex with the forearm being superior to the fingers. Although both functions receive signals from the motor cortex, the tracts which the fine or gross motions inhibit are distinct. Fine motor functions, especially in the distal regions of the limbs (i.e. hands, feet), follow the corticospinal tract descending from the motor cortex. Large muscle flexions, on the other hand, descend from the red nucleus after receiving input from the motor cortex; this is referred to as the rubrospinal tract. While both fine and gross motions involve flexion of muscle groups of the hand and arm, the finger tapping task would also include the need for additional fine motor control. This addition of fine motor

control would also require greater coordination between multiple cortical structures, leading to more points of failure.

The final area of distinction may come from dopamine levels. Interestingly, the results of this study seem to contradict prior research on the topic. In this current study, there was a positive correlation found between the FTT and increased scores on the IRS and CAARS Hyper, indicating decreased dopamine levels. The prior research indicates that a decrease in dopamine leads to decreased motor functioning and performance on the FTT (Meyer et al., 2006; Yang et al., 2003). This may suggest that there's another explanation to why the FTT was higher with other indicators pointing to lower levels of dopamine. Since there was no correlation found with another dopaminergic task, grip strength, the aspect of note for the FTT may instead be related to the cognitive aspects of the task such as coordination or pace.

Limitations and Future Directions

There are a number of aspects of this study that could be improved in further iterations. First, a different paradigm for measurement by actigraphy might yield different results. Research surrounding the use of actigraphy generally involves using the device for multiple hours or days at a time, with no current research on its use for short-term sessions. It may be worth doing a much longer assessment period to provide more data points as well as using multiple actigraphs to measure movements of both legs. Secondly, the sample was not ideal with the majority of participants being under 20 years old. This provided an unforeseen problem with using the assessment norms since grip strength did

not provide dominant versus nondominant norms for those 18 and under. This leads into the next limitation, the accuracy of the norms. The results of this study showed the majority of participants scoring negative z-scores, which may indicate that the norms were not as accurate as they should be. Considering the age of these norms, it may be worth using more recently developed norms or developing updated norms.

The smaller sample size of this study may also be another confounding factor. In general, the sample size may not allow for a truly externally valid sample. With a larger sample size, there would be room to do more in-depth analyses of the data. For instance, a larger sample would allow for an adequate comparison between medication usage or ADHD diagnosis. Due to the small sample size, comparing ADHD diagnosed and non-ADHD diagnosed participants was not possible because of the limited number of ADHD diagnosed participants in this sample; this conclusion also applies to those taking medication. Future iterations of this study could take a few extra steps to allow for these analyses. A larger sample size would be the initial factor for improving these results, but it would also be worth seeking an ADHD diagnosed population to gather a sample from; this would allow for a more externally valid comparison between those with and without ADHD.

Conclusion

This study shows that the self-report measures of hyperactivity and internal restlessness seem to be measuring the same construct and that the finger tapping test on the nondominant side is correlated with scores on both the internal restlessness scale and

the Conners Adult ADHD Rating Scale. These findings leave open many further questions about how these constructs are related, it does indicate that pursuing further work into the potential role of dopamine in both hyperactive and internally restless behavior. This study represents an initial step into our understanding of internal restlessness and how we can more adequately assess this symptom objectively.

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Appendices

Appendix A

Demographic Questionnaire

Please either circle the choice that best describes you or write your answer in the blanks.

1. Age _____
2. Gender Identity
    a) Male
    b) Female
    c) Transgender
    d) Nonbinary
    e) Not listed (*please specify*) _____
3. Racial/Ethnic Identity
    a) Asian
    b) Black/African American
    c) Hispanic
    d) Native American/Alaska Native
    e) Native Hawaiian/Pacific Islander
    f) White
    g) Not listed (*please specify*) _____

4. What year are you in school?

    a) Freshman

    b) Sophomore

    c) Junior

    d) Senior

    e) Graduate School

Have you been diagnosed with….	YES	NO
Attention Deficit Hyperactivity Disorder (ADHD, ADD)		
Restless Leg Syndrome (RLS)		
Carpal Tunnel Syndrome		
Tourette's Syndrome		
Tic Disorder		

Have you been diagnosed with any other psychological or neurological disorders that may impact your motor/movement abilities?

_____

_____

_____

If you replied yes to any of the items above, are you taking any medication to treat that condition? Please list the medications below.

Attention Deficit Hyperactivity Disorder (ADHD, ADD)	
Restless Leg Syndrome (RLS)	
Carpal Tunnel Syndrome	
Tourette's Syndrome	
Tic Disorder	

Please list any additional medications that may impact your motor/movement abilities.

_____

_____

_____

_____

Appendix B

MTSU IRB Approval Letter

Office of Research Compliance
2269 Middle Tennessee Blvd.
Sam H. Ingram Bldg (ING) Room 010A
Box 124
Murfreesboro, TN 37132
www.mtsu.edu/irb

Date: November 6, 2023
PI: Kyle Thatcher
Department: Middle Tennessee State University, Psychology
Re: Initial - IRB-FY2024-10
A Psychometric Evaluation of Internal Restlessness Measures Among College Students

The Middle Tennessee State University Institutional Review Board has rendered the decision below for the above referenced study.

Decision: Exempt
Category: Category 2.(ii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or

Findings:
Research Notes:

Please note that even though your proposed study is deemed exempt from further IRB review, the following apply to your approved study:

1. In accordance with 45 CFR 46.110, expiration dates do not apply to research eligible for Exempt Review under the Common Rule, and continuing review is not required by the IRB.
2. Any unanticipated harm to participants or adverse events must be reported to the Office of Compliance.
3. All modifications to the approved study must be submitted for review through Cayuse IRB for approval before their implementation. Adding new researchers constitutes a modification to the protocol. Per MTSU Policy, a researcher is defined as anyone who handles the data or interacts with participants. Everyone meeting this definition for this project must have completed the required CITI training and received IRB approval prior to becoming actively involved in the project.
4. Closure of the study must be submitted within Cayuse when the study ends or when personal identifiers are removed from the data and all codes and keys are destroyed.
5. All research materials must be retained by the PI for at least three (3) years after study completion and then destroyed in a manner that maintains confidentiality and anonymity.

Sincerely,

The Middle Tennessee State University Institutional Review Board

Appendix C

Informed Consent Form

Study Title: A psychometric evaluation of internal restlessness measures among college students
Protocol Number:
Approval Date:
Principal Investigator: Kyle Thatcher
Co-Investigators: Kimberly Ujcich Ward, PhD.; Paul Foster, PhD.
Institution: MTSU

Name of participant: _____ Age: _____

You are being asked to participate in a research project. The following information is provided to inform you about the research project and your participation in it. Please read this form carefully. You will be given an opportunity to ask questions, and your questions will be answered. Also, you will be given a copy of this consent form.

Your participation in this research study is voluntary. You are free to withdraw from this study at any time with no penalty and no loss of benefits already earned. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision about whether or not to continue your participation.

1. Purpose of the study: ***The purpose of this research study is to further understand internal restlessness that college students experience. We are also interested in how this restlessness might related to other aspects of your psychological functioning.***

2. Description of procedures to be followed and approximate duration of the study: ***This study will be conducted with you individually with one of the researchers. You will attend one session that will take approximately 45-50 minutes to complete. During this session, you will be asked to wear a monitor on your ankle that measures your movement while completing two questionnaires about your behaviors involving internal restlessness and hyperactivity. Additionally, you will complete a grip strength activity and a finger tapping activity.***

3. Expected costs: ***There are no expected costs to you for your participation.***

4. Description of the discomforts, inconveniences, and/or risks that can be reasonably expected as a result of participation in this study: ***You are not expected to experience any discomforts or risks by participating beyond what might be expected when answering questions about your behaviors and performing assessments of motor functioning.***

5. Compensation in case of study-related injury: ***There are no study related injuries expected.***

6. Anticipated benefits from this study:
a) The potential benefits to science and humankind that may result from this study include: ***Your participation in this study may provide novel insight into our ability to objectively measure internal restlessness in college students, which may improve our ability to assess for other health or mental health conditions.***

b) The potential benefits to you from this study include: ***You will not benefit personally from participating in this study other than to earn research credits for your Psychology course at MTSU.***

7. Alternative treatments available: ***No treatments or interventions are included in this study.***

8. Compensation for participation: ***You will not receive compensation for your participation in this study***.

9. Circumstances under which the Principal Investigator may withdraw you from study participation: ***Participants who have a condition that will inhibit their ability to move their hands or stand on two legs (e.g., a broken arm) will be withdrawn from the study. Other than that situation, there are no circumstances under which you will be withdrawn from the study.***

10. What happens if you choose to withdraw from study participation: ***You may withdraw from participation in this study at any time with no negative consequences. You can skip any questionnaire item or activity that you do not wish to participate in at any time during the study with no negative consequences.***

11. Contact Information: If you should have any questions about this research study or possible injury, please contact:
Principal Investigator: Kyle Thatcher
Contact Information: kt5q@mtmail.mtsu.edu or 678-654-6249

For additional information about giving consent or your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance at 615-494-8918 or via email at irb_information@mtsu.edu. (http://www.mtsu.edu/irb)

12. Confidentiality: All efforts, within reason, will be made to keep the personal information in your research record private, but total privacy cannot be promised. Your information may be shared with people at MTSU (such as the MTSU Institutional Review Board) or other agencies (such as the Federal Government Office for Human Research Protection) if you or someone else is in danger or if we are required to do so by law.

13. STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY

I have read this informed consent document and the material contained in it has been explained to me. I understand each part of the document, my questions have been answered, and I freely and voluntarily choose to participate in this study.

_____ _____

Date Signature of participant

Consent obtained by:

_____ _____

Date Signature

_____

Printed name and title