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ADHD Symptoms and Inattentional Blindness in an Undergraduate Sample

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By

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ADHD Symptoms and Inattentional Blindness in an Undergraduate Sample

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ABSTRACT

The relationship between Attention-Deficit/Hyperactivity Disorder (ADHD) and the phenomenon of inattentional blindness has received little empirical attention, with only a single published study on the topic. The purpose of the present study was to investigate individual differences in ADHD symptom severity in a non-clinical, undergraduate sample as they relate to susceptibility to inattentional blindness. Because research conducted in an individual differences framework requires the use of reliable measurement instruments, the present study also set out to develop and pilot a task that could induce inattentional blindness repeatedly and reliably in the same participants. The results showed that a) the measure of noticing in the repeat inattentional blindness task had unacceptable internal consistency reliability for these purposes, despite this task inducing inattentional blindness multiple times in the same participants, as well as performance on the primary counting task showing good reliability; b) ADHD symptoms were not consistently associated with noticing on any task, and when they were the association was negative; c) ADHD symptoms predicted primary object tracking task performance on a single-trial video-based IB task, but not the repeat IB task; and d) there was no interaction between ADHD symptoms and noticing when predicting task performance. I also present incidental findings that depression symptoms and spontaneous mind wandering were associated with performance. Poor psychometric properties of the repeat IB task, potential pandemic-related cohort effects, and other issues with data collection limit the ability to generalize these results beyond this sample. Despite this, these findings have implications for research on individual differences research in inattentional blindness and suggest that future research should incorporate both state and trait-based measures of mind wandering, depression, and ADHD symptoms to disentangle their roles in the phenomenon.

DEDICATION

This project is dedicated to every person living with an invisible disability who has chased their dreams in spite of the world telling them they couldn’t.

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First, I would like to thank my mother, Veronica, for passing on to me her love of learning, her tenacity, and her insistence on standing up for what is right regardless of the personal cost. Look Mom, I did it!

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CHAPTER 1
Introduction

Inattentional Blindness

Humans are, by and large, convinced that our visual systems provide accurate, trustworthy information about the world around us, yet we reliably fail to detect unexpected but salient changes or events in our environment when our attention is occupied (Levin et al., 2000). The extent of this perceptual failure was perhaps most famously demonstrated by Simons & Chabris (1999) in their seminal "invisible gorilla" experiment, wherein over 50% of participants failed to notice a person dressed in a gorilla costume walk across the centre of their field of view. In the psychological literature, the failure to consciously perceive an otherwise salient event while attention is directed elsewhere is called 'inattentional blindness' (IB; Mack & Rock, 1998). While IB may initially seem to be little more than a curious phenomenon, is not benign; it has been estimated that this type of perceptual failure is responsible for up to half of all traffic accidents (Koustanai et al., 2008; Pammer et al., 2018). Experts and trained professionals are not immune to IB, and this can have dangerous consequences for the public; IB has been shown to have deleterious effects on the ability of trained law enforcement officers to notice violent assaults (e.g., Chabris et al., 2011) and deadly weapons in plain sight (Simons & Schlosser, 2017). IB may also result in medical professionals failing to perceive important or salient events in clinical practice (Drew, Võ, & Wolfe, 2013; Greig, Higham, & Nobre, 2014).

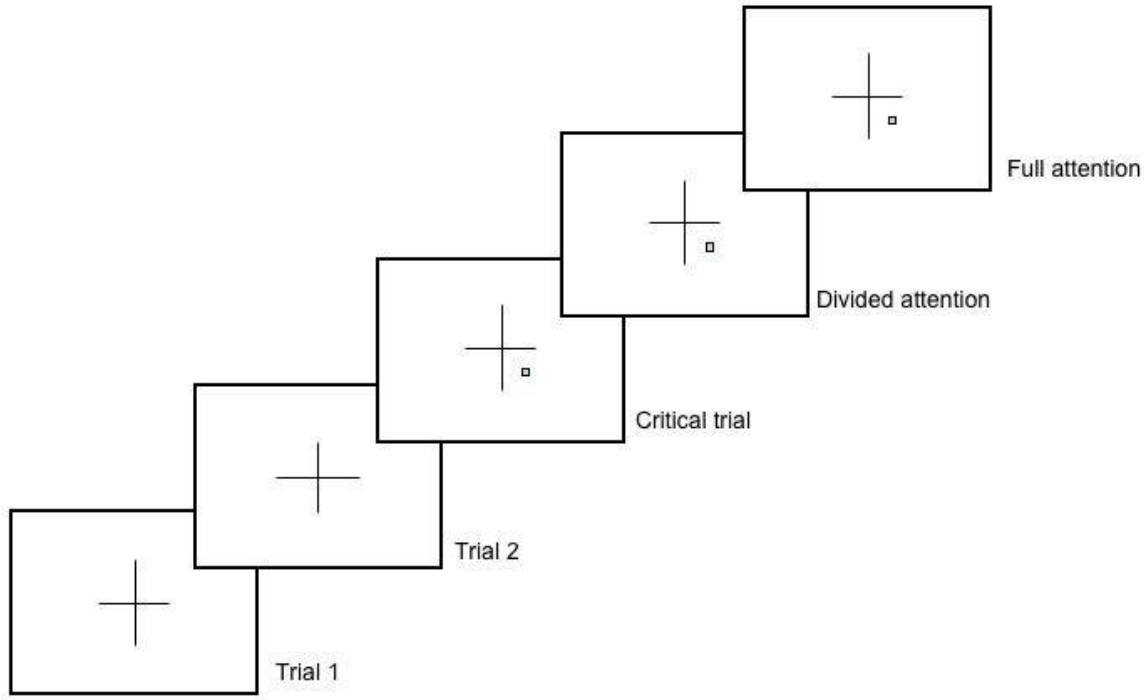
Overview of Inattentional Blindness Research

The term “inattentional blindness” was first coined by Mack & Rock (1998), in their eponymous book, which combined nearly a decade of their research on IB to put forth the (at that time) radical claim that there is no conscious visual perception without attention. In their prototypical task, observers viewed a computer display and made judgements about the relative length of horizonal or vertical arm of a briefly presented cross. On the third, or “critical”, trial of this task, an additional shape would appear in the visual display (see Figure 1) and observers were subsequently asked whether they noticed anything other than the cross. To ensure the added shape is perceptible, participants then completed a divided attention trial, where the critical trial was completed again after the participants had been told about the unexpected shape, and a full attention trial, where they are instructed to ignore the cross entirely and attend only to the previously unexpected shape. Using variations on this research paradigm, Mack & Rock found that between 25-75% of observers failed to see the unexpected shape in the critical trial depending on specific task demands (Mack & Rock, 1998).

Despite coining the term “inattentional blindness”, Mack & Rock (1998) were not the first to empirically explore perceptual failures resulting from the allocation of attention. Early experiments in dichotic listening, wherein participants are presented with separate, simultaneous auditory messages to each ear, demonstrated that participants are generally unable to report the content of messages they are not attending to (e.g., Moray, 1959). In 1975, Neisser & Becklen developed visual analogues of the dichotic listening task, which they referred to as *selective looking tasks*. They presented participants simultaneously with two different videos of people

Figure 1

Illustration of the Mack & Rock (1998) Task



Note. In this task, participants judge whether the horizontal or vertical arm of the cross is longer. In the critical trial an additional shape appears, and participants are asked whether they notice anything other than the cross

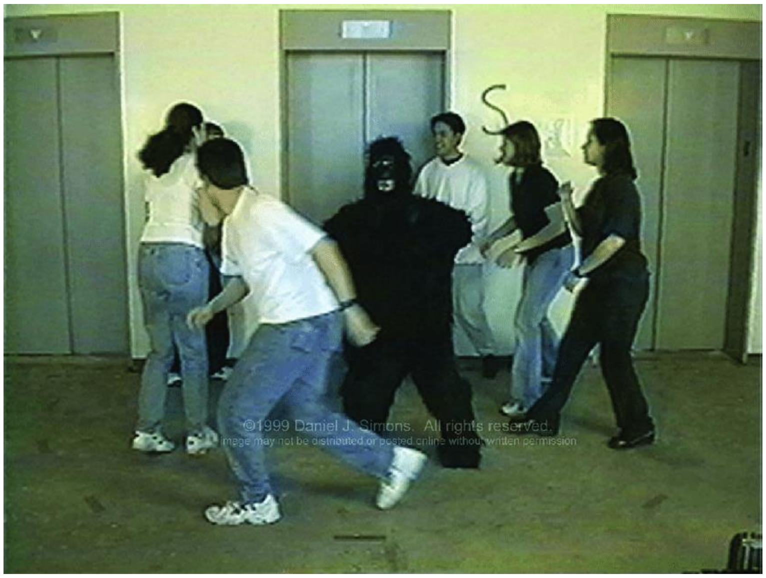
playing games; these videos were either semi-transparent and superimposed onto each other, or they were each shown to a different eye. Observers were instructed to attend to one of the layered videos and press a switch each time a target event in the attended game occurred. After several trials, an “odd event” (e.g., suddenly swapping out men for women) would take place in the unattended video. In these experiments, participants attending to one layer of the video often failed to notice events occurring in the other, despite the events being perceptible. This selective looking effect was present whether the two videos were presented to either both eyes simultaneously or each eye separately (Neisser & Becklen, 1975).

In their famous "invisible gorilla" experiment, Simons & Chabris (1999) further extended the use of live-action video in IB research. In their IB task, participants watched a video of two teams of people passing basketballs back and forth and were instructed to count the number of passes made by a given team. The difficulty of this primary counting task was manipulated, with those in the Easy condition being instructed to keep a silent mental count of the total number of passes made by the attended team and those in the Hard condition being instructed to maintain two separate counts for aerial and bounce passes. During this task, an unexpected event (UE) would occur; either a person dressed in a gorilla suit or a woman with an open umbrella would walk across the scene, pausing briefly at the centre (see Figure 2).

Depending on the task difficulty and the stimuli used, between zero and 92% of participants did not report noticing the UE. Critically, the rate of noticing the gorilla depended on which of the two teams the participant was attending to; the black gorilla was noticed more frequently by participants attending to the team with black shirts (58%) than those attending to the team with white shirts (27%), suggesting the perceptual similarity between the unexpected stimulus and attended task may make a difference to IB. However, the live-action video stimuli used for this type of task introduced logistic barriers and confounds that made the continued experimental manipulation of perceptual features difficult (Most et al., 2001). Further experimental research into IB required the development of visually dynamic tasks (i.e., tasks with moving stimuli; Neisser &

Figure 2

Still from Simons & Chabris (1999) “Invisible Gorilla” Task



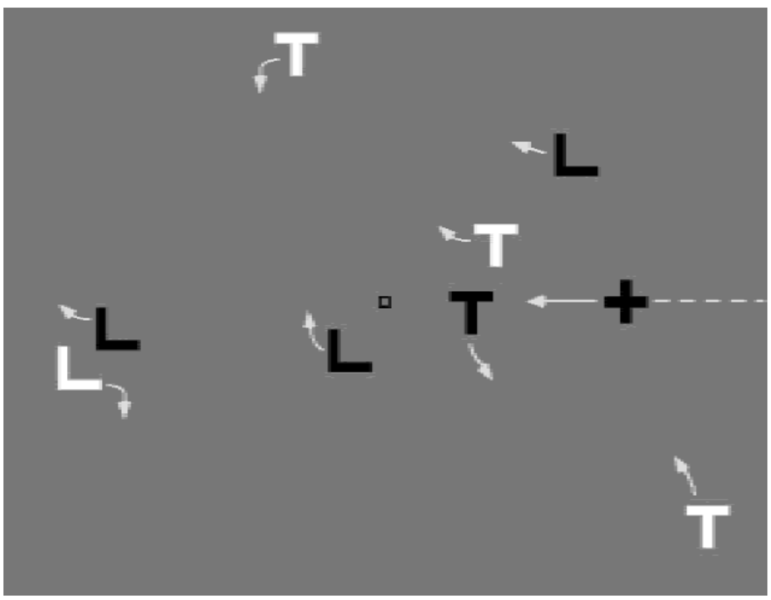
Note. A still frame from the critical trial of Simons & Chabris’ (1999) inattentional blindness task. In this task, participants attend to a game played by the actors on screen while a person in a gorilla costume walks across the field of view, pause in the middle, and beat their chest before exiting the frame.

Becklen, 1975; Simons & Chabris, 1999) comprised of stimuli with simple visual features that could be manipulated systematically, like those used in Mack & Rock’s (1998) static paradigm.

In 2001, Most et al. designed a new paradigm to address this gap. They conducted a series of experiments, systematically varying stimulus properties hypothesized to alter susceptibility to sustained inattentional blindness. Across their tasks, participants were instructed to fixate on the central point of a computer display and count the number of times that either white or black shapes hit the edge of the display window (see Figure 3). The sequence of trials in this task was modeled after Mack & Rock (1998), using four total trials: two trials with no unexpected object, a third "critical" trial containing an unexpected object (see Figure 3), and the divided-attention and full attention trials at the end of the experiment to ensure the unexpected object was perceptible. The unexpected object in this study was a small equal-armed cross. Five seconds into the critical trial, this

Figure 3

Task from Most et al., (2001)



Note. A still frame from the critical trial of Most et al.'s (2001) inattentional blindness task. The arrows and dashed line were added to indicate the direction of motion. The Unexpected Object (the cross) always moved from left to right, while the other objects moved in random, nonlinear paths.

cross travelled in a straight line from right to left across the display. Most et al., (2001) manipulated the luminance (i.e., the amount of light emitted from a given area) and colour of the cross over their three experiments.

In their first experiment, Most et al. found that when the unexpected object was more similar in luminance to the attended items, more observers noticed its appearance on the critical trial (2001). For example, those counting black shapes were very likely to notice a black (94%) or dark grey cross (44%), but unlikely to notice a light grey (12%) or white cross (0%). Their second and third experiments further explored the effects of visual similarity between the unexpected stimulus and the unattended set of shapes. Their results collectively showed that participants were likely using top-down attentional sets based on visual features of both the attended stimuli and the ignored stimuli when completing the primary counting task (Most et al., 2001). This study was highly influential, and variations of this task have since become the most used paradigm used to study inattentional blindness (Redlich et al., 2021).

Individual Differences in Susceptibility to Inattentional Blindness

IB is often thought of as a stochastic phenomenon arising from situational factors, stimulus properties, and the general limits of human perception. Little empirical attention has been paid to the potential role of individual differences in susceptibility to IB (Kreitz et al., 2015a). Despite this, individual differences in susceptibility have occasionally been noted, particularly at the group level. Observers are, for example. more likely to notice the UE if they have some level of expertise with the primary task (Memmert, 2006, Furley, Memmert, & Heller, 2010), or if they are high in the personality trait of openness to experience (Kreitz et al., 2015b). Individual difference factors with known relationships to perceptual abilities have also been linked to group differences in IB. Among these, age appears to influence susceptibility to IB; young children (Memmert, 2006) and older adults (Horwood & Beanland, 2016) are both more likely to experience IB than young adults. Curiously, children with autism spectrum disorder (ASD; Swettenham et al., 2014) and adults with attention-deficit hyperactivity disorder (ADHD; Grossman et al., 2015) have both been observed to be less susceptible to IB in single studies, and the latter of these effects is the focus of this proposal.

In 2015, Grossman et al. conducted a quasi-experimental study comparing the performance of 14 adults with ADHD to 18 control participants without ADHD on a continuous performance task (CPT) and an IB task to distinguish between three theoretical accounts of ADHD. Participants completed both the MOXO d-CPT, which is a standardized continuous performance task that includes visual and auditory distractors (Berger & Cassuto, 2014), and the Simons and Chabris (1999) gorilla task to assess IB. In line with the ADHD literature, participants with ADHD were found to perform more poorly than controls on the CPT. Surprisingly, the ADHD participants outperformed controls on the pass counting component of the IB task and exhibited a relative lack of IB to the UE, suggesting a lack of attentional trade-off during the IB task. The magnitude of the group difference in this study was substantial, with 88% of control participants failing to notice the gorilla, but only a single participant with ADHD failing to notice. While this finding is based on a relatively small sample and has yet to be replicated or adequately explained, the unexpected and substantial effect warrants further investigation.

In 2015, Kreitz et al. conducted a multi-part study investigating the role that individual differences in various cognitive abilities may play in susceptibility to IB. The researchers did not find any substantial predictive relationships between IB and individual differences in working memory, inhibitory control, or attention breadth as measured by standard cognitive tasks. What is notable about this study is that participants completed two distinct IB tasks – one using a static cross similar to Mack & Rock (1998), and the other using an IB task using the paradigm developed by Most et al. (2001) - within a larger battery of tasks. Kreitz et al., used these two tasks to test if IB is a stable individual difference across IB task types. The association between noticing the UE on each task was small (or possibly non-existent), which the authors interpreted as suggesting that the proneness to IB is not a stable individual difference but rather a stochastic process that relies primarily on task demands (Kreitz et al. 2015a). This account would provide some explanation for the inconsistencies in the literature regarding whether individual differences in cognitive ability, such as working memory or attentional breadth, have an effect on IB (e.g., Hannon & Richards, 2010; Seegmiller et al., 2012; Bredemeier & Simons, 2012). This interpretation, however, depends on the assumption that performances on a given IB task are reliable, and that static and dynamic IB tasks rely on the same perceptual processes.

Reliability of any IB task has not yet been assessed in the literature due to the single-trial nature of most IB research, and as a result any claims made about stable individual differences in IB are questionable. I suggest that noticing the UE in different IB paradigms may rely on different perceptual and attentional processes, and much like any set of cognitive or neuropsychological tasks intended to study the same construct, some tasks may be more valid and reliable than others. It seems unlikely that a phenomenon with known relationships to fundamental perceptual processes is entirely stochastic in nature when individual differences in perceptual abilities exist. Rather, it is likely that unreliable and unstandardized measures of IB are unable to accurately capture the nature of these effects.

In 2015, Ward & Scholl introduced methodology to evoke repeated inattentional blindness (IB) in the same participants within the same test session. Participants were recruited from Mechanical Turk (mTurk) and completed 10 trials of an object tracking task, with 4 of these trials including an unexpected stimulus of a new symbol moving across the midline of the screen. The authors demonstrated that repeated IB can occur even when observers are asked about the unexpected stimuli after each instance, and that IB occurs both when participants have no expectations of an event and when they have incorrect expectations about the event (i.e., colour, shape, etc.). This study's methodology of inducing repeated IB may enable the assessment of IB task reliability, which has historically been considered "impossible" or at least problematic (e.g., Kreitz et al., 2015a). This informs the methodology of the present study, in which I attempted to induce repeated IB in the same participants in order to assess individual differences in susceptibility to IB and assess the reliability of the IB task.

Attention-Deficit/Hyperactivity Disorder (ADHD)

ADHD is commonly described as a childhood-onset neurodevelopmental disorder characterized by impulsivity, inattention, and hyperactivity (American Psychiatric Association, 2013) and is considered to be the most prevalent neurodevelopmental disorder worldwide (Faraone et al., 2003), with Planck et al. estimating a worldwide childhood prevalence of 5.29% (2007) which has likely remained stable over the past 4 decades (Polanczyk et al., 2014). While the common belief was once that children would begin to “outgrow” ADHD symptoms during adolescence, longitudinal studies have revealed that the majority of children with ADHD will continue to show impairing symptoms into adulthood (Barkley et al., 2008; Biederman et al., 2011), with adulthood prevalence being estimated between 1.2-4.7% (Faraone et al. 2005). The prevalence of clinically significant levels ADHD symptoms in both North American and international post-secondary students has been estimated between 2-8% (Weyandt & DuPaul, 2013; Nugent & Smart, 2014).

The Visual Attention System in ADHD

Both structural and functional differences of the visual attention system are present in those with ADHD (Castellanos & Proal, 2012; Mueller et al., 2017). Adult ADHD patients show a significant reduction of gray matter volume in the early visual cortex (Ahrendts et al., 2011), decreased cortical thickness in the medial occipital cortex (Proal et al., 2011), and hyperactivation across the occipital lobe while engaged in various cognitive tasks (Castellanos et al, 2012). There is a genetically influenced relationship between top-down eye movement control and ADHD traits (Siqueiros Sanchez et al., 2020). Adults diagnosed with ADHD show distinct, aberrant patterns of eye movement that normalize with the use of stimulant medication (Fried et al., 2014), and ADHD traits in the general population have been shown to predict a distributed style of eye movement behaviour that is stable across tasks (Poynter et al., 2013).

Panagiotidi et al., (2017a) examined differences in performance on a sustained attention to response task with far-peripheral distractors between adults with high and low levels of self-reported ADHD symptoms. Manipulating the onset time of distractors produced differences in target reaction times between groups; distractors presented 80ms before a stimulus produced decreases to both reaction times and reaction time variability in the high ADHD group but not in the low ADHD group. This apparent advantage disappeared when the delay between distractor and stimulus was reduced to 10ms. The authors suggest that the early distractor was cueing the high ADHD group to the arrival of the target stimulus and thereby providing a reaction time benefit, whereas the low-ADHD group failed to detect the distractor entirely. The authors tentatively state these results support theories that hypersensitivity of the superior colliculus, a midbrain structure involved in spatially orienting attention, may underlie some ADHD-related behavioural phenotypes (see also Overton, 2008). Detecting far-peripheral visual stimuli relies heavily on the reactivity of this superior colliculus.

Collectively, studies examining ADHD-related patterns of eye movement suggest that ADHD symptoms are related to decreased arousal in response to visual stimuli and attenuated control of anticipatory eye movements, both of which are heavily dependent on the superior colliculus. For example, Fried et al. (2014) found increased rates of microsaccades and blinking in participants with ADHD. Microsaccades, which are tiny eye movements that occur during fixation, are generated by the superior colliculus (Hafed et al., 2009). Normally, people suppress these movements when anticipating a visual event, when attending to an expected or unexpected stimulus, and when the attentional load is high. Participants with ADHD, however, were generally unable to suppress these movements during behavioural tasks. Blinking has long been associated with visual attention and arousal, both of which are intimately linked with the function of the superior colliculus (e.g., Krauzlis et al., 2013), and ADHD-diagnosed participants had significantly higher rates of blinking during visual tasks. Interestingly, these effects were only present when ADHD participants had not taken their stimulant medications; Fried et al. (2014) experimentally manipulated stimulant usage such that ADHD participants were tested both on and off their prescribed stimulant medication. When participants were tested after taking stimulants, their oculomotor behaviour became indistinguishable from the non-ADHD control group. While this effect has not been demonstrated to originate from responsiveness of the superior colliculus in humans, studies using animal models have shown that visual responses generated by the superior colliculus are attenuated by stimulant medication (e.g., Gowan et al., 2008; Clements et al., 2014).

Together these findings hint at a potential framework for understanding the reduced susceptibility to IB in ADHD populations (e.g., Grossman et al., 2015). If individuals with ADHD are uniquely sensitive to distractor stimuli in the visual periphery due to a distributed style of eye movement and/or hyperresponsiveness of the superior colliculus, and awareness of these stimuli does not impair primary task performance for those with ADHD under certain circumstances, it follows that people with ADHD may be more likely to notice the UE in an inattentional blindness task without their primary task performance suffering.

Categorical vs. Continuous Operationalization of ADHD

While clinical diagnosis of ADHD typically relies on a categorical understanding of the disorder (i.e., American Psychiatric Association, 2013), ADHD is likely best understood as an extreme expression of highly heritable traits that are continuously and normally distributed throughout the population (Larsson et al., 2011; Martin et al., 2014). Using this rationale, collecting samples from the general population with the full range of ADHD symptom severity, rather than strictly clinical samples, has recently become a popular choice in the study of ADHD and subclinical ADHD (or ADHD traits). Under this framework, scores on self-report ADHD symptom inventories are used as individual differences measures in both observational and quasi-experimental research designs across several fields of study, including clinical psychology, neuroscience, cognitive and biological psychology (e.g., Poynter et al., 2013; Polner et al., 2015; Panagiotidi et al., 2017a; Panagiotidi et al., 2017b; Siqueiros Sanchez et al., 2020).

The Present Study

The aim of this study was to establish a relationship between ADHD traits and susceptibility to IB in a non-clinical population. While it has been demonstrated in a single study that a diagnosis of ADHD predicts reduced susceptibility to IB (Grossman et al., 2015), this effect has not yet been replicated nor extended to ADHD symptom severity in non-clinical populations. Further, this study aimed to establish internal reliability estimates of an IB task for the first time by inducing repeated IB in participants. Within these general aims, the following specific hypotheses were investigated:

1. I anticipated that the reliability of the IB task in this sample would be of sufficient magnitude (e.g., >.5; Soon, 2015) to meaningfully test hypotheses within an individual differences framework (H1).
2. I hypothesized that ADHD symptom severity as measured by the Adult ADHD Self Report Scale (ASRS v1.1; Kessler et al., 2005) would predict noticing on IB tasks. Specifically, I anticipated that higher levels of ADHD symptoms would be associated with an increased likelihood of noticing the unexpected event (H2)
3. I hypothesized a large effect of ADHD symptom severity; such that higher ADHD symptom scores would predict decreased accuracy on the primary task (H3).
4. I expected that there would be a large main effect of noticing the unexpected event, such that participants who noticed the UE would perform worse on the primary task in that trial (H4a). Further, I hypothesized that the effect on performance associated with noticing the UE would become smaller or negligible as severity of ADHD symptoms increased (H4b).

CHAPTER 2

Methods

Participants

Participants were recruited from the undergraduate psychology research participant pool at the University of Windsor. An *a priori* power analysis indicated that anticipating a small Cohen's f-square effect size of .10 with a specified statistical power level of .90 and an alpha of .05 called for minimum sample size of 113 participants.

Exclusion Criteria

Exclusion criteria for all participants included an absence of English literacy, current prescription of any psychiatric medication except stimulant medication used for the treatment of ADHD, a self-reported history of traumatic brain injury with loss of consciousness and/or symptoms lasting longer than one week, or a diagnosis of neurological disorders or impairments impacting cognition, visual attention, and impulsivity (e.g., Parkinson's, multiple sclerosis, autism spectrum disorder). Participants with an active prescription for stimulant medication were requested to abstain from taking their medication or to complete the study before taking their medication on the day of participation. Stimulant medication has been shown to normalize patterns of eye movement in adults with ADHD (e.g., Fried et al., 2014), which could confound the results.

Given that I was trying to isolate the effects of ADHD symptoms on IB task performance, it was crucial to remove as many sources of outside variability as possible in the early stages of investigating the effect. Any psychiatric or neurological condition or any medication with known effects on oculomotor behaviour, attention, concentration, stimulus sensitivity, impulsivity, perception, or any other mental process that could systematically alter responses on either the ADHD measures or the IB task could introduce further measurement error and error variance into the design. This reduces the validity of the study in terms of both replication and the strength of inferences one can make from their data. Ideally, this study would only include participants who are "healthy" aside from their variability in ADHD symptoms. However, rates of anxiety and depressive symptoms are estimated to quite high in post-secondary student populations, with the average postsecondary student worldwide endorsing mild symptoms of depression, anxiety, and stress and approximately 30-39% of Canadian students reporting elevated levels of psychological distress (see Sharp & Theiler, 2018 for a review).

In the wake of the recent COVID-19 pandemic, the prevalence and average severity of anxiety, depression, and stress symptoms is likely higher in at least some sub-populations of students (e.g., Dozois & Mental Health Research Canada, 2021; Hamza et al., 2021; Watkins-Martin, 2021). Postsecondary students with ADHD are at an increased risk of developing problems with anxiety, depression, or general psychological distress compared to neurotypical students (e.g., Weyandt & DuPaul, 2013). Further, functional impairments and executive dysfunction caused by ADHD cannot be meaningfully disentangled from similar impairments caused by mood and anxiety symptoms using simple self-report measures, and relationships between mood symptoms and ADHD in patients with comorbid disorders may be largely accounted for by these nonspecific symptoms (e.g., Mohamed et al. 2021). As such, measures of depression, anxiety, and stress were included as control variables rather than attempting to exclude participants with these symptoms altogether.

Materials

Self-Report Measures

The Adult ADHD Self Report Scale Version 1.1 (ASRS v1.1; Kessler et al., 2005). The ASRS was used to assess the presence and severity of ADHD symptoms in participants. The ASRS was developed by the World Health Organization (WHO) and measures current adult symptoms of ADHD using 18 questions, which correspond to the 18 core symptoms identified in the DSM-5 (American Psychiatric Association, 2013), for use in diagnosing ADHD . Respondents are asked how often a given symptom of ADHD occurred to them over the past six months on a 5-point scale with response options ranging from 'Never' (0) to 'Very Often' (4). Optimal scoring of the ASRS v1.1 was empirically derived and involves dichotomizing each item and deriving the sum of these unweighted dichotomous responses across all 18 ASRS questions, as described in Kessler et al. (2005). Kessler et al. (2005) established good psychometric properties for the 18-item ASRS scored in this manner, with a positive predictive value of 0.94, a sensitivity of 56.7% and specificity of 98.3%. While the ASRS was initially designed to measure inattention and hyperactivity/impulsivity symptoms on two separate 9-item subscales, a recent study of ADHD symptoms in college students demonstrated that a single-factor model provided a superior fit to the data over bifactor and other models, indicating that ADHD symptoms assessed using this measure are best represented with a unidimensional factor (Flory et al., 2021). A newer, 6-item screening version of the ASRS published by the World Health Organization was also included in this study (ASRS-5; Ustun et al., 2017). This version of the scale is comprised of 4 items from the ASRS v1.1 (items 9, 12, 14, and 16; see Appendix A) as well as the following two additional items: “How often do you put things off until the last minute?” and “How often do you depend on others to keep your life in order and attend to details?” , which are rated on the same 5-point scale. The ASRS-5 was scored using the total unweighted raw score for these 6 items. This version of the ASRS was reported to have improved operating characteristics when compared to the ASRS v 1.1 by its authors (Ustun et al., 2017).

The Depression Anxiety and Stress Scale – 42 Item Version (DASS-42; Lovibond & Lovibond, 1995a). The DASS-42 is a 42-item self-report measure comprised of three scales designed to measure the current experience of depression, anxiety, and stress based on a dimensional conceptualization of psychological disorder. Each of these three scales is comprised of 14 items which can be further divided into subscales of 2-5 items as shown in Table 1. Participants rate items on a 4-point severity/frequency scale to indicate the extent to which they have experienced each state over the past week. Scores for each scale are summed from the scores of the relevant items. DASS subscale scores were used as covariates to statistically control for the potential influence of negative emotional states on other variables in this study. The DASS-42 has well-established psychometric properties in both clinical and community samples and can differentiate between the negative emotional states of depression, anxiety, and stress (Lovibond & Lovibond, 1995b). Each scale of the DASS-42 showed strong reliability in the original sample, with Cronbach’s alpha values of α = .91, 84, and .90 for the depression, anxiety, and stress scales respectively (Lovibond & Lovibond

1995b). The DASS-42 shows good reliability and construct validity for use in undergraduate samples (Bayram & Bilgel, 2008; Ciobanu et al., 2018). The DASS-42 can be viewed in Appendix B.

Table 1

Scales and Subscales of the DASS-42

Scale	Subscales
Depression	Dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia, inertia
Anxiety	Autonomic arousal, skeletal muscle effects, situational anxiety, subjective experience of anxious affect
Stress	Difficulty relaxing, nervous arousal, being easily upset/agitated, irritable/over-reactive, impatient

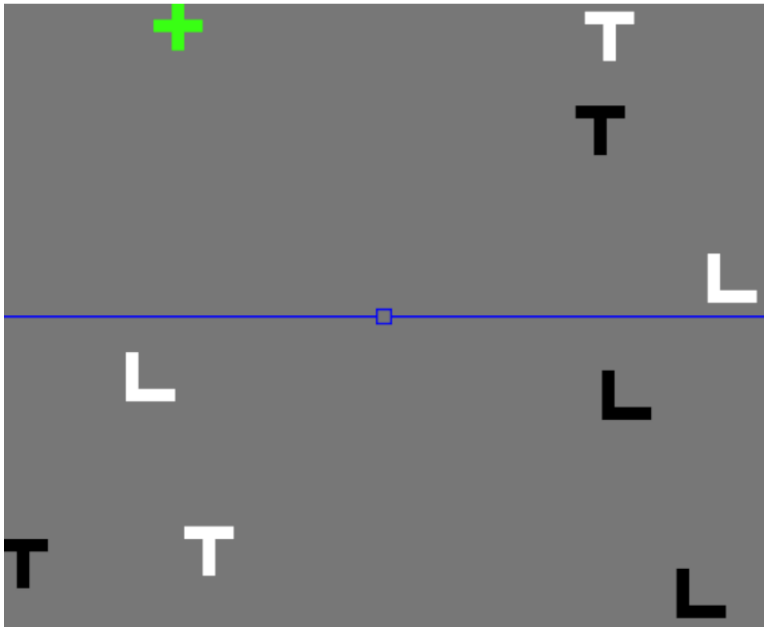
Mind Wandering Deliberate (MW-D) and Spontaneous (MW-S) Scales (Carierre, Seli & Smilek, 2013). The MW-D and MW-S are each 4-item scales that retrospectively assess self-reported frequency of intentional and unintentional mind wandering. Items use 5-point Likert-type rating scales with varied response wording. Carriere et al. (2013) report high internal consistency for the measures, with Cronbach's alphas of .84 and .83 for the MW-D and MW-S, respectively. Scores on this measure were included as a covariate to control for the impact of mind-wandering tendencies not measured by the ASRS on the inattentional blindness task. See Appendix C for the full scales.

Behavioural Tasks

Repeat Inattentional Blindness Task. We attempted to induce IB multiple times within subjects using repeated trials of a dynamic IB task with varied characteristics. In this task, participants viewed L and T shapes of two different colours on a gray rectangular background (see Figure 4). The shapes moved around the display, bouncing off the edges of the grey rectangle and changing speeds randomly. Participants were asked to count the number of times that a subset of these shapes cross the midline of the display while fixating on a central fixation point. After each trial, participants were asked to report how many times the target shapes crossed the midline. On the fourth trial, a grey cross appeared and crossed the display from right to left, below the midline. Participants were asked questions probing their awareness of the unexpected event (UE) adapted from Ward & Scholl (2015). Participants were asked if they noticed “anything … that was different from the first three trials” — and if so, to describe what was different. Five total blocks of this task would be presented, and the number of primary task trials presented

Figure 4

Still From the Repeated Inattentional Blindness Task (Matchett & Lukawski, 2021)



Note. This task functions similarly to that of Most et al. (2001). The visual features of the unexpected stimuli varied throughout the study in an attempt to induce repeated IB.

before critical trials varied across blocks. Unexpected stimuli of various shape, colour, and trajectory appearing at the final trial of each block and were followed by the same probing questions. All participants were exposed to the same 16 trials, and after the first block, blocks were presented in a pseudo-random order.

The method of inducing repeated IB by manipulating the features of the UE is adapted from Ward et al. (2015). We constructed a dynamic task based on Most et al. (2001) and adapted from HTML code used in Stothart et al. (2015). This code was modified to vary the stimulus characteristics of the UE and letters in each trial. These trials were video recorded using a screen capture program. 50 potential trial videos were generated, from which the 16 videos used in this study were selected. Stimulus characteristics for each block and trial can be viewed in Appendix D.

To limit between-trial learning and minimize the chance of participants' expectations effecting the likelihood noticing (as per Ward et al., 2015). , as well as in the interest of improving the generalizability of results and limiting undue influence of single stimulus features, the stimuli used in this study were created and selected using principles of random stimulus sampling (i.e., Brunswick, 1947 as cited in Young et al., 2012). The number and colours of the letters; the colour, direction, shape, spawn time, and velocity of the UE if present; and the length of each trial were varied in a pseudo-random fashion, and the final videos used in the study were selected randomly.

Accuracy on the primary counting task was operationalized as the difference between a participant's count and the actual number of passes for a given trial, with the resulting value being a measure of how far they were from being correct on each trial (i.e., Accuracy = [Correct Answer] – [Actual Response]). The repeat noticing variable was calculated as the total number of times that a given participant correctly reported noticing the UE. Estimates of internal consistency reliability were calculated based on participant responses to this measure, and this is first attempt at establishing reliability estimates for an inattentional blindness task in the literature, to the best of our knowledge (Kreitz, 2015a). The reporting of reliability for cognitive-behavioural measurements is uncommon, yet reliability is an essential part of drawing meaningful conclusions and producing replicable research (Parsons et al., 2019). This is particularly important when using these paradigms to study individual differences (Goodhew & Edwards, 2019).

Dynamic Video IB Task. The "invisible gorilla video" from Simons (2010) was intended to be used as a manipulation check, as Grossman et al. (2015) used this video. This video is a recording of six people, three wearing white shirts and three wearing black shirts, passing two basketballs between each other. Participants were asked to keep count of the number of times the ball is passed between players wearing a given shirt colour. During the game, a person dressed in a gorilla suit enters the scene from the right-hand side and walks across the scene, stopping midway to beat his chest, and exits to the left. After watching the video, participants were asked to indicate the number of passes they counted. They were then asked whether they had seen the video before, and then asked the following questions from Simons & Chabris (1999) probing their awareness of the UE: (i) While you were doing the counting, did you notice anything unusual on the video? (ii) Did you notice anything other than the six players? (iii) Did you see anyone else (besides the six players) appear on the video? (iv) Did you see a gorilla walk across the screen? After any "yes" response, observers are asked to provide details of what they noticed in an open-ended question.

Given that all participants were students enrolled in psychology courses at the University of Windsor, it was deemed likely that they had been exposed to either the Simons (2010) video or the original Simons & Chabris (1999) video in an introductory psychology class. As such, the participants were first shown a different inattentional blindness video, created by Webb (2018). This video is a recording of two people shuffling a series of pink, yellow, and blue coloured paper cups around a table. A piece of chocolate is placed under one of the pink cups, and participants are instructed to track the cup that contains the chocolate as the cups are moved around the table rapidly. During this task, three unexpected events happen: a cup is replaced with a rubber duck for three seconds, a third person's hand appears in the frame, and the blue cups are replaced one by one with green cups. After this video, participants were asked to indicate which of the cups contained the chocolate, and then asked the following questions: : (i) While you were tracking the chocolate, did you notice anything unusual on the video? (ii) Did you notice anything on the table other than the twelve cups? (iii) Did you notice anything about the cups change? (iv) Did you notice anyone other than the two people who were moving the cups? After any "yes" response, observers are immediately asked to provide details of what they noticed in a text entry box.

Auditory and Audiovisual Filler Tasks. A series of auditory and audiovisual perception tasks were used in this study. We used these tasks only to provide a "filler" between instances of IB task trials to clear the participants working memory, as well as to break up blocks of the IB tasks with tasks that participants may find engaging or interesting and to avoid fatiguing participants' visual attention. While data from these tasks may be used in future studies, we did not use the response data in the present study. All behavioural filler tasks used existing open-access HTML, JavaScript, and/or PsychoPy code (Peirce, 2007) and were be administered through Pavlovia.org. Participants completed two blocks of each filler task. Descriptions of these tasks can be found in Appendix D.

Procedure

Data was collected in a single testing session online. Stimuli were presented via Qualtrics cloud-based survey software (https://www.qualtrics.com) and Pavlovia (https://www.pavlovia.org). Participants were asked to give informed consent, and those who agreed immediately began the behavioural section of the study. The filler tasks were presented as Pavlovia web links, and before each filler task began, participants were asked to provide their UWindsor email address in order to link their response data to their compensation and survey information. Blocks of the IB task were embedded directly into the survey. The battery of IB and filler tasks was presented in a pseudo-randomized order to mitigate any fatigue or order effects. Finally, participants completed the self-report measures in a randomized order, which were presented with embedded attention checks (e.g., “if you are paying attention, select ‘Very Often’” or “please select 2”). After completing the ASRS v1.1, the DASS-42, the mind -wandering measures, and a demographic questionnaire, participants were asked what they thought the study was about and whether they had previously seen any of the tasks completed in the study. Participants were then debriefed as to the purpose of the study and given the opportunity to consent to be contacted about future studies.

CHAPTER 3

Results

Preliminary Analyses

Data Cleaning and Preprocessing

The raw self-report and inattentional blindness data were exported from Qualtrics as a comma-separated worksheet ('.csv'). The data were first screened for duplicate responses, as identified by name and IP address. After removing these cases, the dataset was de-identified and uploaded to GitLab to facilitate reproducibility. Then the data were screened for substantially incomplete profiles (e.g., missing all or most of the data from measures to be used in the analysis) and these cases were deleted. Additionally, unnecessary variables were deleted and retained variables were renamed and/or recoded for ease of analysis.

Participant responses for the critical trials of both the repeat and dynamic IB tasks were evaluated qualitatively to determine if participants had noticed the unexpected event (UE). In the repeat IB task, responses that correctly identified at least one salient visual feature of the UE (e.g., shape, colour) were coded as noticing in a given trial. These responses were then summed to produce a combined IB outcome variable. In the dynamic video task, participants who reported observing the rubber duck were coded as noticing. Coding for both tasks was completed by two independent raters and no inconsistencies were found between their classifications.

Missing Value Analysis

Due to a technical malfunction in the survey software, only 36 (26%) participants completed the Simons & Chabris (1999) gorilla video task, resulting in a substantial amount of missing data and an insufficient sample size to run the planned analyses. As recommended by Tabachnick & Fidell (2013), this measure was removed entirely from the remaining analyses. IB in a dynamic video task was still able to be assessed in the cup tracking video.

A missing values analysis was then conducted in R for the remaining variables of interest using the *naniar* (Tierney & Hook, 2018) package. The ASRS data, the mind wandering data, and the data from the dynamic cup tracking video IB task all contained complete data. Seven values were missing from the repeat IB count data, and 13 were missing from the repeat IB probe questions. One datapoint was missing from the DASS-42, on item 2. Seven participants in total had any data missing, with four of them having one missing value, and the three others having between 4 and 8 values missing. The total proportion of missing values was found to be inconsequential at 0.14% (e.g., Schafer, 1999) and as such any reasonable procedure for handling these missing values was expected to yield similar results (Tabachnick & Fidell, 2013). Imputation of missing values was handed using *mice* (van Buuren, 2021) package for R. Five imputed datasets were created and then combined into a single dataset using the Single Center Imputation from Multiple Chained Equations algorithm (*SICE)* proposed by Khan & Hoque (2020) for simplified data handling after imputation.

Outliers & Exclusionary Criteria

Participants who endorsed items indicating they met exclusionary criteria for the study were identified. 22 participants endorsed using psychiatric medication to treat a mental health condition. Regarding neurological issues that may affect results, 7 participants reported a history of head injury with loss of consciousness or symptoms lasting longer than 1 week, 1 participant reported having Tourette's syndrome, and 1 participant reported being red-green colorblind (this participant's data was removed, as several of the IB tasks used pink and green stimuli). With respect to participants who took stimulants within the past 24 hours, 9 reported having taken their prescription stimulants, 4 reported taking non-prescription amphetamines, 1 reported cocaine use, and 1 reported methcathinone and pseudoephedrine use. Each primary analysis was repeated with these cases included and excluded from the model to assess if they substantially affected the models or if they could instead be retained to conserve power. The use of both stimulants and psychiatric medication were found to substantially effect the regression models. History of neurological issues did not substantially affect the result or interpretation. None of the exclusionary criteria substantially effected the reliability analyses or the correlation matrix of self-report predictors. As such, reliability estimates and descriptive statistics below include the full sample, but the regression models reported below were fitted without the data of participants who reported either stimulant use within the past 24 hours or the use of psychiatric medication. Further, participants who reported being previously exposed to a given IB task were removed from analyses of that task.

Univariate outliers were identified using a combination of visual examination of plots and standardized score cut-offs. Based on the sample size, a cut-off of Z±2.5 was used for all self-report measures and a cut-off of Z<2.5 was used for the IB task count data to handle the potential for invalid responding.[1] Nine outlier cases were identified at this step and removed from analysis. Multivariate outliers were identified and handled at the level of the individual analysis, as detailed below.

Descriptive Analysis

The final overall sample for this study included data from *N*=126 participants. Participants in this sample had a median age of 21 years (*M* =20.98 , *SD* = 2.62). The gender makeup of the sample was 85.7% female (*n* = 108), 12.7% male (*n* = 16) and 1.6% non-binary (*n* = 2). Within this sample, 12 participants identified themselves as having a diagnosis of ADHD and 12 reported having a current prescription for stimulant medication. Further, 30.2% of the sample (*N* = 38) reported having been previously told that they might have ADHD.

Participants endorsed a mean of 9.6 (*SD* = 4.05) symptoms on the 18-item ASRS v1.1, with scores ranging from 0-18. Participants obtained a mean total item score of 12.62 on the ASRS-5, with scores ranging from 2 to 23 out of a possible 24. Descriptive statistics for both ASRS scoring methods, the DASS-42 subscales, and the Mind Wandering Scales can be viewed in Table 2. Intercorrelations between these measures can be viewed in Table 3.

[1] Given that participants tended to underestimate the answer, the upper end of these distributions were closer to the correct answers than to the trial mean. Removing the bottom end of the distribution only removed *extremely and unreasonably low* responses (e.g., response of '2' when the correct answer is 28), whereas removing the top end of the distribution would lead to removing correct or almost correct responses.

Table 2

Descriptive Statistics for Self-Report Measures

	ASRS		Mind Wandering		DASS-42		
	v1.1	ASRS-5	MW-D	MW-S	Depression	Anxiety	Stress
Median	9	12	18	19	10.5	9	14
M*(SD)*	9.6*(4.1)*	12.6*(4.4)*	18.1*(5.4)*	18.8*(5.2)*	12.81*(10.5)*	10.7*(8.2)*	15.8*(9.8)*
Skewness*(SE)*	0*(.22)*	.15*(.22)*	-.03*(.22)*	-.27*(.22)*	.75*(.22)*	.73*(.22)*	.46*(.22)*
Kurtosis*(SE)*	-.45*(.43)*	-.40*(.43)*	-.45*(.43)*	-.59*(.43)*	-.38*(.43)*	-.34*(.43)*	-.60*(.43)*
Min	0	2	6	6	0	0	0
Max	18	23	28	28	40	32	38

Note. ASRS = Adult ADHD Response Scale. DASS-42 = Depression, Anxiety, and Stress Scales, 42 item version.

Table 3

Pearson Correlations Between Self-Report Measures

	1.	2.	3.	4.	5.	6.
1. ASRS v1.1	—					
2. MWS	0.56***	—				
3. MWD	0.25**	0.43***	—			
4. DASS	0.53***	0.37***	0.14	—		
5. DASS	0.51***	0.35***	0.06	0.73***	—	
6. DASS Stress	0.61***	0.37***	0.07	0.81***	0.80***	—

Note: ASRS = Adult ADHD Response Scale. MWS = Mind Wandering Spontaneous.

On the dynamic video task, 28.5% of participants reported noticing the UE (*n* = 36) and 84.92% (*n* = 107) of participants responded correctly to the cup-tracking task in the video. For the repeat IB task, in the first critical trial only 4.96% (*n* = 5) of participants reported noticing the UE. Conversely, 90.49% (*n* = 114) of participants reported noticing on Trial 6. Participants tended to underestimate the correct answer for the primary counting task, with the average estimate being lower than the actual count across all trials. Mean count accuracy was best in the fourth trial, and worst in the sixth. Trial-level noticing frequencies and descriptive statistics for accuracy are presented along with stimulus characteristics for each trial in Table 4.

Table 4

Stimulus Properties and Descriptive Statistics for Noticing and Accuracy in Each Critical Trial

	Critical Trial					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Noticing						
Noticed (*N*)	5	53	77	71	76	114
Did not notice (*N*)	121	73	49	55	50	12
% Noticed	3.96	42.06	61.11	56.53	60.32	90.48
Count Accuracy						
M	-9.70	-4.85	-9.69	-1.46	-9.35	-13.5
SD	4.31	2.64	3.38	2.72	4.09	4.77
Min	-19	-10	-18	-8	-19	-24
Max	6	9	-3	13	6	2
Stimulus Properties						
Number of Targets	11	8	8	8	11	11
Colour of Target	White	Black	L.Pink	D.Pink	White	Black
Colour of UE	Grey	Yellow	Peach	Blue	White	Red
Distance from Fixation Point[a]	30%D	75%D+L	25%D	50%L	60%U	0%

Note. Accuracy is defined as (Correct Answer – Response). A value's distance from zero represents how far from the correct answer it is. D= down, L = left, U = up. UE = unexpected event.

[a] Percentage of total distance from fixation point to edge of display.

Correlations between all IB variables are presented in Appendix F. Of note, no statistically significant associations were found in noticing between the video task and any trial of the repeat IB task ($p > .05$). While the in the repeat IB task, noticing on the first critical trial showed significant associations with primary task performance on the second ($r = -.21$, $p < .05$), third ($r = -.30$, $p < .01$), fourth ($r = -.24$, $p < .05$), and sixth ($r = -.29$, $p < .01$) trials, this is likely an artifact of the very low proportion of noticing in that trial. as no other relationships were observed between trial-level task performance and noticing.

Main Analyses

Hypothesis 1

Internal reliability of each self-report measure was assessed with Cronbach's Alpha (α), McDonald's omega (ω), and the average interitem correlation using the Classical Unidimensional Reliability Analysis procedure in JASP 0.16.3 (JASP Team, 2022). All self-report measures demonstrated either good or excellent scale reliability (i.e., values > 0.80; see Table 5) in this sample, with the exception of the ASRS-5, which

Table 5

Reliability Statistics for Self-Report Measures

	ASRS		Mind Wandering		DASS-42		
	v1.1	ASRS-5	MW-D	MW-S	Depression	Anxiety	Stress
Cronbach's α	.90	.74	.85	.84	.95	.90	.93
95% CI	*.88-.93*	*.66-.81*	*.80-.89*	*.78-.88*	*.94-.96*	*.87-.93*	*.91-*
McDonald's	.90	.74	.85	.84	.95	.90	.93
95% CI	*.88-.93*	*.68-.81*	*.81-.89*	*.79-.88*	*.94-.97*	*.88-.93*	*.92-*
Interitem	.34	.33	.58	.56	.59	.40	.50
95% CI	*.27-0.41*	*.24-0.40*	*.48-.67*	*.57-.65*	*.53-.66*	*.33-0.46*	*.43-*

demonstrated acceptable reliability. Given that the ASRS v1.1 showed superior reliability over the ASRS-5 in this sample, the ASRS-5 was not used in the following analyses.

The internal reliability of each repeat inattentional blindness measure was next assessed. Four estimates of scale reliability are reported, including Cronbach's Alpha (α), McDonald's omega (ω), and Guttman's λ2 and λ6 (split-half reliability estimates). Whereas the count accuracy variable demonstrated acceptable to good reliability across indicators, the noticing variable did not. Importantly, noticing during first critical IB trial did not correlate with the remainder of the scale (mean r = 0.01). However, the removal of Trial 1 data did not meaningfully improve the internal reliability estimates. See Table 7 for reliability coefficients and individual item reliability statistics for noticing the UE.

Table 6

Scale Reliability Statistics for Count Accuracy

	McDonald's ω	Cronbach's α	Guttman's λ2	Guttman's λ6	Avg. interitem *r*
Estimate	0.81	0.79	0.80	0.80	0.39
95% CI	0.75-0.86	0.73-0.84	0.73-0.86	0.73-0.86	0.29-0.49

Table 7

Individual Item Reliability Statistics for Noticing in Critical Trials of Repeat IB Task

	If item dropped				
Item	McDonald's ω	Cronbach's α	Guttman's λ2	Guttman's λ6	Item-rest *r*
Critical Trial 1	0.57	0.56	0.57	0.54	0.01
Critical Trial 2	0.55	0.49	0.53	0.45	0.27
Critical Trial 3	0.50	0.45	0.48	0.42	0.34
Critical Trial 4	0.56	0.52	0.55	0.48	0.21
Critical Trial 5	0.42	0.39	0.42	0.37	0.44
Critical Trial 6	0.50	0.45	0.49	0.39	0.38

Hypothesis 2

Hypothesis 2 stated that ASRS scores would predict noticing the UE during critical trials of a given IB task. This hypothesis was tested using data from the dynamic video IB task as well as the repeat IB task.

Dynamic video task. Hypothesis 2 was first tested with a binary logistic regression analysis. First, the assumptions of logistic regression were assessed, and the data were examined for influential observations and outliers. The Box-Tidwell procedure confirmed linearity between the predictors and the logit ($p > .10$). Independence of observations is assumed to be met by design and the predictors were found to be sufficiently reliable so correction for measurement error was not required. Examination of leverage values, delta betas, and Cook's distance revealed the presence of several influential observations; however, their removal did not substantially alter the result, so they were retained. Studentized residuals revealed no outliers on Y. Tolerance and VIF values indicated there were no issues with multicollinearity. The sample for the final fitted model included data from $n = 95$ participants.

Hypothesis 2 was not supported by the results of this analysis. Mind-wandering and DASS-42 subscale scores were entered into the first step of the model. The likelihood ratio test of the overall model was not significant at this step ($\chi 2 = 7.72$, $df = 5$, $p = .17$). ASRS v1.1 scores were entered into the second step of the model, which also showed a nonsignificant likelihood ratio test ($\chi 2 = 10.91$, $df = 6$, $p = .091$). Model estimates can be viewed in Table 8.

Table 8

Model Estimates Predicting Noticing the UE in the Dynamic Video Task

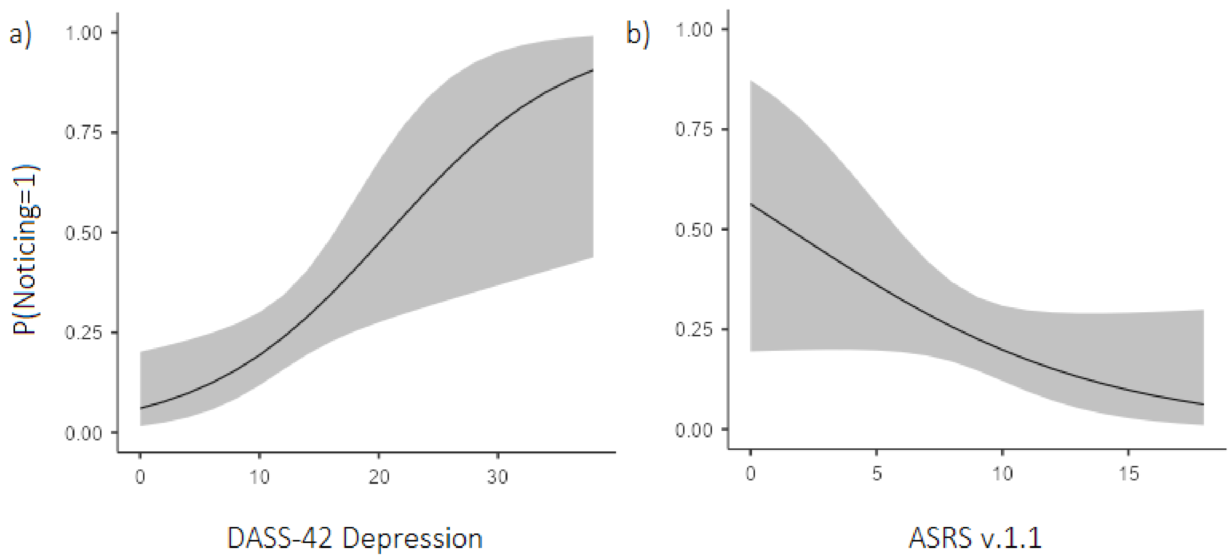
Predictor	Estimate	SE	Z	p	Odds ratio	95% CI Lower	95% CI Upper
Step 1							
(Intercept)	-1.01	1.03	-0.98	0.330	0.37	0.05	2.76
MW-D	0.00	0.06	0.09	0.932	1.00	0.90	1.12
MW-S	0.01	0.06	0.09	0.931	1.01	0.89	1.14
Depression	0.12	0.05	2.46	0.014	1.13	1.03	1.24
Anxiety	-0.00	0.06	-0.04	0.968	1.00	0.88	1.13
Stress	-0.12	0.06	-1.81	0.071	0.89	0.78	1.01
Step 2							
Intercept	-1.03	1.05	-0.98	0.326	0.36	0.05	2.79
MW-D	0.01	0.06	0.25	0.803	1.01	0.91	1.13
MW-S	0.05	0.07	0.73	0.467	1.05	0.92	1.21
Depression	0.13	0.05	2.63	0.009	1.14	1.03	1.26
Anxiety	-0.01	0.06	-0.16	0.870	0.99	0.87	1.12
Stress	-0.09	0.07	-1.32	0.187	0.91	0.80	1.04
ASRS	-0.16	0.10	-1.72	0.085	0.85	0.70	1.02

Note. Estimates represent the log odds of noticing the unexpected event (UE). MW-D = Deliberate Mind Wandering. MW-S = Spontaneous Mind Wandering. ASRS = Adult ADHD Self Report Scale v1.1.

Given that this study is largely exploratory in nature and the risk associated with Type I error is low, this model was examined further. As shown in Table 8, the depression subscale of the DASS-42 was found to be a statistically significant predictor with the largest effect and was associated with an increased probability of detecting the UE (b = 0.13, *SE* = .05, *p* <.001, OR = 1.14, 95% CI [1.03-1.26]). ASRS v1.1 scores showed the next largest effect, which contrary to expectations, were associated with a decreased likelihood of noticing the UE (b = -0.16, *SE* = .10, *p* = .08, OR = 0.85, 95% CI [0.70-1.02]), however this effect was not statistically significant. All other predictors showed log odds estimates that were an order of magnitude smaller (i.e., |b| <.10) and statistically insignificant. See Figure 5 for marginal means plots for DASS-42 depression scores and ASRS scores.

Figure 5

Estimated Marginal Means Plots Predicting Noticing the Unexpected Event



Note: DASS-42 = Depression, Anxiety, and Stress Scale, 42-item version. ASRS v.1.1 = Adult ADHD Self Report Scale v1.1.

Repeat inattentional blindness task. The hypothesis that ASRS scores would predict noticing in the repeat IB task could not be meaningfully tested as originally planned, as the reliability of the combined IB variable was too poor. Further, the IB variable did not have linear relationships with any predictors and the model violated the assumption of multivariate normality. Estimates for this model are presented in Appendix

G for completeness only. Noticing on this task was also modelled separately for each trial using binomial logistic regression, with identical steps to the previous analyses. It should be noted that because noticing was rare in Trial 1 (n = 4) and not noticing was rare in Trial 6 (n = 6), the correlation coefficients are likely truncated for these models and observations in these smaller categories are disproportionately influential and could be considered outliers (Tabachnick & Fidell, 2013).

The trial-level logistic regression models did not support hypothesis 2. Likelihood ratio tests were nonsignificant for all trials of the IB task at both Step 1 and Step 2. Further, no individual predictors were associated with noticing in any trial, with the exception of Trial 2, where ASRS v1.1 scores were associated with a decreased probability of noticing the UE (b = -.16, SE = .08, p <.05, OR = 0.85, 95% CI [0.73-0.99]). See Appendix H for log odds estimates noticing the UE across each trial.

Hypotheses 3, 4a, & 4b

The third and fourth hypotheses stated that ADHD symptom severity would predict primary task accuracy (H3), that noticing the UE would be associated with decreased accuracy on the primary task (H4a), and that ADHD symptoms would interact with this effect, such that the effect of noticing the UE would decrease with increases in ADHD symptom severity (H4b). These hypotheses were tested with logistic and linear regression analyses as appropriate.

Dynamic video task. Hypotheses 3 and 4 were first evaluated with binary logistic regression models predicting object tracking accuracy in the dynamic video task. Inspection of the data did not suggest concerns with multicollinearity, outliers, or independence. For the final fitted model, several influential observations were identified using leverage values; however, no cases had Cook's D values larger than 0.07. A sensitivity analysis showed only a single influential observation that materially changed study conclusions, which was then removed. This analysis was ultimately conducted using data from $n=94$ participants. Interpretation of these models warrants caution due to the small number of observed events ($n = 11$) for the dependent variable in the sample.

Hypothesis 3 was supported by the first and second steps of the logistic regression. Model 1, which included mind-wandering and DASS-42 subscale scores, showed a nonsignificant likelihood ratio test ($\chi 2 = 2.12$, $df = 5$, $p = .833$) and no statistically significant individual predictors. As expected, the overall model fit improved significantly from Model 1 with the addition of ASRS v1.1 scores ($\Delta\chi 2 = 12.61$, $df = 1$, $p < .001$). The likelihood ratio test of Model 2 was statistically significant and represented a 22% improvement in fit over the null model ($\chi 2 = 14.72$, $df = 6$, $p = .023$). As Table 9 shows, participants with higher ADHD symptom scores were more likely to give the correct response (b = .53, $SE = .18$, $p = .004$, OR = 1.70, 95% CI [1.19-2.44]). Specifically, as ASRS v1.1 scores increased by 1 standard deviation the odds of a correct response increased by a factor of 1.70. Conversely, increases in spontaneous mind wandering were significantly associated with a decreased likelihood of a correct response (b = -.21, $SE = .11$, $p = .045$, OR = 0.81, 95% CI [0.66-0.99]). No other predictors in the model showed significant associations with accuracy on this task. See Table 9 for Model 2 coefficient estimates.

Hypothesis 4a was not supported when noticing the UE was added to the model. Contrary to expectations, the addition of noticing in this task did not significantly improve model fit (Δχ2 = 0.84, *df* = 1, *p* = 0.359) and there was no main effect of noticing (b = -.70, *SE* = .75, *p* =.357, OR = 0.49, 95% CI [0.11-2.21]). Similarly, hypothesis 4b was not supported when an interaction term between ASRS scores and noticing was added to the model. The addition of the interaction term did not improve model fit, (Δχ2 = 1.31, *df* = 1, *p* = 0.252) and the interaction term itself was nonsignificant (b = .27, *SE* = .26, *p* =.289, OR = 1.31, 95% CI [0.79-2.17]). See Figure 6 for a plot of the estimated marginal means for this interaction. The addition of these terms did not materially affect the interpretation of other predictors, and as such model coefficients are only reported here for Model 2 (see Table 9).

Table 9

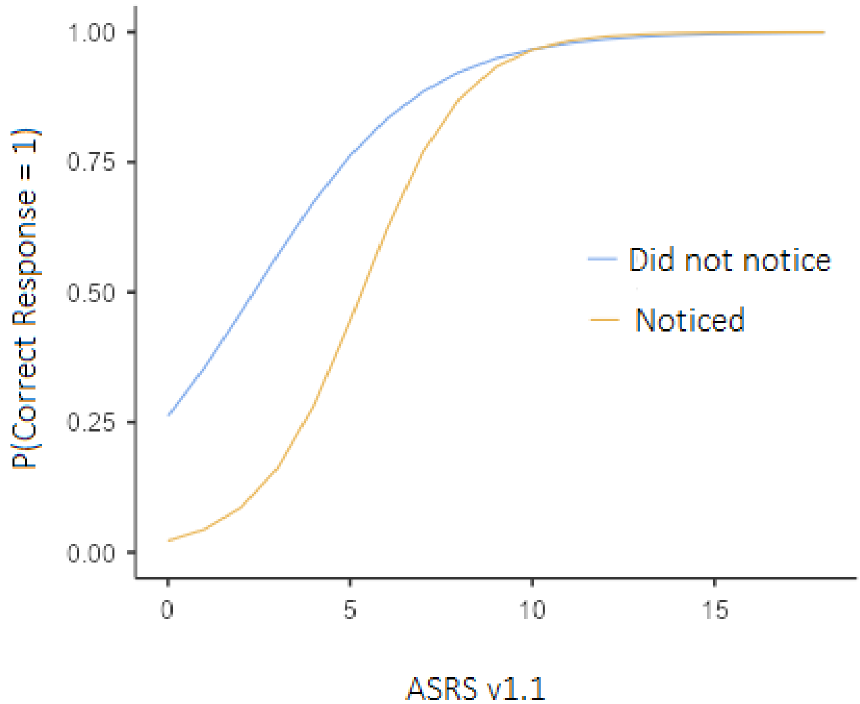
Model 2 Coefficients for the Odds of Correct Response in the Dynamic Video Task

						95% CI	
Predictor	β	SE	Z	p	OR	Lower	Upper
Intercept	2.29	1.43	1.61	0.108	9.89	0.60	162.20
MW-D	0.08	0.07	1.05	0.295	1.08	0.93	1.25
MW-D	-0.26	0.11	-2.40	0.016	0.77	0.62	0.95
DASS-42 Depression	-0.12	0.07	-1.77	0.077	0.89	0.78	1.01
DASS-42 Anxiety	0.03	0.09	0.37	0.714	1.03	0.87	1.22
DASS-42 Stress	0.01	0.10	0.06	0.956	1.01	0.83	1.22
ASRS	0.53	0.17	3.05	0.002	1.70	1.21	2.40

Note. β estimates represent the log odds of a correct response. MW-D = Deliberate Mind Wandering. MW-S = Spontaneous Mind Wandering. DASS-42 = Depression, Anxiety, and Stress scales, 42-item version. ASRS = Adult ADHD Self Report Scale v1.1.

Figure 6

Estimated Marginal Means Plot of Hypothesis 4b



Note: Main effect of noticing and interaction effect not statistically significant, $p > .10$. Main effect of ASRS scores significant at $p < .01$

Repeat inattentional blindness task. Hypotheses 3, 4a, and 4b were not supported by the results of a linear regression model predicting primary task accuracy on the repeat IB task. All assumptions for linear regression were met, and the analysis was conducted with a final sample of $n = 101$. Mind-wandering and DASS-42 subscale scores were entered into the first step of the model and the overall model was not statistically significant ($F = 0.78$, $p = .57$, Adjusted $R^2 = -0.01$), nor were any predictors. ASRS v1.1 scores were entered into the second step of the model, which was again not statistically significant ($F = 0.67$, $p = .67$, Adjusted $R^2 = -0.02$) with no significant predictors. Addition of the noticing variable did not improve the model ($F = 0.63$, $p = .73$, Adjusted

R^2 = -0.03) nor did the inclusion of an ASRS * noticing interaction term (F = 0.54, p =.82, Adjusted R^2 = -0.04). See Table 10 for final model estimates.

Table 10

Model Coefficients for the Final Model Predicting Count Accuracy on the Repeat IB Task

Predictor	b	SE	t	P	β	95% CI Lower	95% CI Upper
(Intercept)	-34.15	10.6	-3.20	0.00			
Mind Wandering (D)	0.11	0.28	0.39	0.69	0.05	-0.19	0.29
Mind Wandering (S)	-0.50	0.33	-1.51	0.13	-0.21	-0.48	0.07
DASS-42 Depression	-0.01	0.25	-0.03	0.97	-0.01	-0.39	0.38
DASS-42 Anxiety	-0.29	0.34	-0.87	0.38	-0.18	-0.58	0.23
DASS-42 Stress	0.20	0.32	0.62	0.53	0.15	-0.33	0.62
ADHD Symptoms	0.13	1.10	0.12	0.90	0.06	-0.23	0.35
Noticing UE	0.44	2.73	0.16	0.87	0.06	-0.14	0.27
ADHD * Noticing	0.02	0.29	0.08	0.93	0.01	-0.22	0.24

Note. Estimates represent the log odds of noticing the UE. (D) = deliberate, (S) = spontaneous, DASS-42 = Depression, Anxiety and Stress Scales, 42-item version, ADHD Symptoms = Adult ADHD Self Report Scale v1.1.

Hypotheses 3, 4a, and 4b were also investigated at the trial level. Separate linear regression models were constructed for each critical trial of the repeat IB task, again with mind-wandering and DASS-42 subscales entered into the first step, the ASRS v1.1 added into the second step, noticing added to the third step, and finally the interaction term added in a fourth step. Outliers on the dependent variable were removed from each trial, after which all six models showed acceptable normality, linearity, and homoskedasticity of residuals. The trial-level regression models did not support these hypotheses. Omnibus model tests were not statistically significant for any trial of the repeat IB task at any step ($p > .05$). Further, no main effects were identified, as individual predictors were not associated with count accuracy in any trial. See Appendix I for standardized regression coefficient estimates for the final models, including the (ADHD * Noticing) interaction term, across each critical trial.

Supplementary Analyses

Results of the descriptive and main analyses prompted me to investigate the difficulty of the primary counting task and the instance of IB across critical trials. As I did not measure task difficulty or engagement in this study, I chose to compare accuracy and IB between trials with the expectation that accuracy would be worse and IB would be higher in trials with larger numbers of targets. Specifically, accuracy on trials 1, 5, and 6 (11 targets) were expected to be lower than accuracy on trials 2, 3, and 4 (8 targets). To test if mean differences in accuracy were present between trials, I conducted a series of 9 paired samples t-tests between all possible trial pairings with a Bonferroni adjusted alpha of .005 (.05/9).

Results suggest that accuracy on Trial 1 (M = -9.7, SD = 4.31) was significantly lower than accuracy on Trial 2 (M = -4.85, SD = 2.64) and Trial 4 (M = -1.46, SD = 4.09), but not Trial 3 (M = -9.7, SD = 4.31). Similarly, accuracy on Trial 5 (M = -9.35, SD = 4.09) was also lower on Trials 2 and 4, but not Trial 3. Accuracy on Trial 6 (M = -13.5, SD = 4.77) was lower than Trials 2, 3, and 4. See Table 11 for *t*-statistics and effect sizes for accuracy comparisons. McNemar's paired samples tests were used to assess if frequency of noticing was higher in trials with higher numbers of targets.

Crosstabulations and X^2 statistics for these comparisons are presented in Table 12. Of note, Trial 1 had lower frequencies of noticing than any of the trials with 8 targets, whereas Trial 6 had higher frequencies of noticing than trials with 8 targets. Trial 5 had more noticers than Trial 2 but was not significantly different from Trials 3 or 4.

Table 11

Paired Samples t-tests Comparing Count Accuracy Across Trials

Mean Comparison		*t*(100)	*p*	Difference	*SE*	Cohen's
Trial 1	Trial 2	-11.95	< .001	-4.65	*0.39*	-1.19
	Trial 3	0.13	0.895	0.07	*0.50*	0.01
	Trial 4	-17.29	< .001	-8.20	*0.47*	-1.72
Trial 2	Trial 5	10.51	< .001	4.27	*0.41*	1.05
	Trial 6	16.52	< .001	8.28	*0.50*	1.64
Trial 3	Trial 5	-1.10	0.273	-0.45	*0.40*	-0.11
	Trial 6	7.50	< .001	3.56	*0.48*	0.75
Trial 4	Trial 5	24.39	< .001	7.82	*0.32*	2.43
	Trial 6	28.51	< .001	11.83	*0.41*	2.84

Table 12

Crosstabulation and χ^2 Statistics for Noticing vs. IB Between Trials with Different Numbers of Targets

		8 Targets								
11 Targets		Trial 2			Trial 3			Trial 4		
		IB	Noticed	χ^2	IB	Noticed	χ^2	IB	Noticed	χ^2
				44.0 ***			59.06***			47.61***
Trial 1	IB	53	44		35	62		41	56	
	Noticed	0	4		1	3		3	1	
				7.71 **			0.03			2.08
Trial 5	IB	23	12		18	17		20	15	
	Noticed	30	36		18	48		24	42	
				41.68 ***			26.47***			36.10***
Trial 6	IB	3	3		4	2		5	1	
	Noticed	50	45		32	63		39	56	

Note. **= p<.01, ***=p<.001.

IB = inattentionally blind (i.e., did not report the stimulus).

CHAPTER 4

Discussion

I designed this study with two primary objectives. First, I sought to contribute to the debate surrounding the suitability of an individual differences approach to the study of inattentional blindness. Informed by the work of Ward & Scholl (2015), Kreitz et al. (2015), and others, I attempted to design a repeat inattentional blindness task with sufficient scale reliability for use in online individual differences research. The secondary aim of the study was to clarify the role that individual differences in ADHD symptom severity plays in susceptibility to inattentional blindness (IB). I hypothesized that participants with greater ADHD symptom severity would have a reduced susceptibility to IB, perform better on the primary task, and show a reduced effect of noticing on primary task performance. I designed this study partially as a conceptual replication and extension of Grossman et al.'s (2014) work on individuals with ADHD and inattentional blindness, wherein a reduced susceptibility to inattentional blindness, as well as an absence of performance trade-off when noticing the unexpected event (UE), were observed in participants diagnosed with ADHD when compared to normal controls. This study furthered this line of work by assessing ADHD symptoms on a continuum of severity rather than a binary diagnostic classification. This was accompanied with the use of a larger, non-clinical undergraduate sample, and statistical control for overlapping constructs such as mental distress and trait mind wandering using multivariate statistical techniques. Unfortunately, unexpected issues with the online survey platform and task difficulty introduced significant limitations and caveats to the interpretation of these results. Despite these limitations, this study nevertheless provides meaningful contributions to the literature.

Discussion of Findings

I first hypothesized that the measures derived from the repeat IB task would be of acceptable internal consistency reliability to meaningfully test hypotheses in an individual differences paradigm. This hypothesis found partial support in the observed data. Analyses showed good internal consistency reliability on the primary counting task, but poor internal consistency for noticing across critical trials. When I examined inter-item correlations, less than half of the possible bivariate correlations between trials were statistically significant, and these correlations were weak. In contrast, the primary counting task showed good internal consistency reliability, moderate inter-item correlations, and strong item-total correlations.

ADHD symptom severity was not associated with an increased likelihood of noticing the UE in the IB tasks. When investigated using regression modelling, neither the dynamic video task nor the combined repeat IB task showed statistically significant associations between ADHD symptoms and noticing, and the relationship was only significant in a single trial of the repeat IB task when each trial was examined separately. Further, the associations that were observed were in the opposite direction of the predictions made from past research (e.g., Grossman et al., 2014; Panagiotidi et al. 2017a); while the effect of ADHD symptom severity was not statistically significant ($p = .085$) in the dynamic video task and was only significant in a single critical trial of the repeat IB task (trial 2), the direction of these observed effects indicated *decreased* likelihood of noticing as ADHD symptom levels rise. That is, these results suggests that ADHD symptom severity may be associated with greater susceptibility to inattentional blindness to peripheral distractors. This directly contradicts the main finding of the study that the present study was attempting to replicate (i.e., Grossman et al., 2014), as well as work that has suggested that ADHD traits are associated with increased stimulus sensitivity in the visual periphery (i.e., Panagiotidi et al., 2017a); however, because there was an insufficient amount of data to test these effects using the Simons (2011) video, one cannot rule out the possibility that the primary tasks or properties of the UE in the cup tracking and 'invisible gorilla' videos simply involve different attentional processes. Further, given the number of comparisons involved in modelling each trial of the repeat IB separately, it is likely that the statistically significant relationship between ADHD symptoms and noticing is a spurious correlation (i.e., false-positive or Type I error) that does not reflect a true relationship and is not generalizable. This is further evidenced by the omnibus likelihood test for the Trial 2 model being statistically insignificant, and by the other five trials not showing similar relationships in their data.

With the third hypothesis, I predicted that ADHD symptom severity would be associated with improved performance on the primary tasks. The results of the binary logistic regression analysis of dynamic video task data supported this hypothesis, but neither the analyses of the combined repeat IB measure nor by the trial-level analysis of repeat IB data supported it. Finally, I predicted that noticing the UE would negatively affect performance on the primary tasks, and that the magnitude of this effect would decrease as a function of ADHD symptom severity. There was not strong support for these hypotheses in the observed data. The addition of noticing the UE as a predictor did not improve the fit of any model, nor did the addition of an ADHD symptom * noticing interaction. Further, these main effects and interactions were not significant in any model. Nonetheless, examination of the marginal means plot for the expected interaction in the dynamic video did look as predicted. That is, at low levels of ADHD symptoms, noticers were less likely than participants who were inattentionally blind to provide a correct response, and this difference was not apparent at higher levels of ADHD. While this interaction was not statistically significant, the observed directionality is consistent with findings from Grossman et al. (2015), who showed that task performance of participants with ADHD was less impacted by noticing, compared to controls. Panagiotidi et al. (2017a) noted a similar lack of performance trade-off associated with higher levels of ADHD traits.

Beyond the findings related to the central hypotheses of this study, there were several incidental findings. First, I found that high scores on a trait-based measure of spontaneous mind wandering were associated with a decreased likelihood of providing an accurate response in the cup tracking task, whereas trait deliberate mind wandering was not. This observation is consistent with the literature on trait and state levels of mind wandering and their relationships with cognitive performance; trait level measures of mind wandering have been shown to predict state level incidence of mind wandering during tasks (e.g., Dias da Silva et al., 2020; Seli et al., 2016). Trait spontaneous mind wandering, but not deliberate mind wandering, is predictive of attentional control and working memory capacity during task performance (Robinson & Unsworth, 2018). While trait mind wandering's relationship to object tracking performance has not yet been investigated, object tracking performance has been shown to be predicted by working memory capacity (e.g., Oksama & Hyönä, 2010), which is related to spontaneous mind wandering (Robinson & Unsworth, 2018). As such, the observation of spontaneous mind wandering predicting cup tracking performance aligns with this body of literature and further suggests that participants with high trait spontaneous mind wandering may have been actively mind wandering during the cup tracking task, leading them to lose track of the correct cup. To confirm this, future studies should investigate the role that trait spontaneous mind wandering plays in object tracking tasks specifically.

A second incidental finding was that participants' depression symptom severity as measured by the DASS-42, was associated with increased odds of noticing in the dynamic video IB task. Further, while the effect was not statistically significant (p=.07), the magnitude and direction of the observed effect suggests depression could be associated with a decreased likelihood of providing a correct response to the main task. This could indicate that in the observed sample, participants with higher depression subscale scores were not as engaged and attentive to the main task, thereby making them more likely to notice the UE and could be reflective of impairments to sustained attention typical of depressive states(see Snyder & Hankin, 2019 for a review). This finding contrasts with the results of Bredemeier et al. (2014), in which self-reported levels of negative affect, anhedonic depression, anxious arousal, and worry were not directly associated with noticing. While Bredemeier et al., did not use the DASS to measure these constructs, they did measure anhedonic depression using the homonymous scale from the Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al., 1995), which has significant overlap in content with the DASS depression subscale and has been used to assess the convergent validity of the DASS (e.g., Osman et al., 2012). This discrepancy may be the result of cohort effect as the data used in this study was collected between January and May of 2022, during the COVID-19 pandemic. The pandemic has had significant negative effects on the general stress levels and mental health of students (e.g., Anderson et al., 2022), with students' mental health being more impacted by the pandemic than non-students (Bonsaken et al., 2022). Stressors and other factors specific to the pandemic could impacting this samples' self-report ratings and task performance in unknown ways. Interestingly, similar effects of depression or mind wandering tendency were not observed on any trial of the repeat IB task, which is arguably more cognitively demanding. This incongruence between IB task types is further suggestive that the tasks are not measuring the same constructs, but it could just as easily be reflective of the poor reliability of the repeat IB task masking any potential relationships that could have been observed. Similarly, given that the omnibus likelihood test of the model was not statistically significant, it is possible and likely that the observed relationship between noticing and DASS-42 depression scores is a spurious false-positive and not meaningful.

Despite both the observed reliability of this task being insufficient to draw strong conclusions in correlational research and the theoretical disagreement surrounding the construct of IB itself (as discussed below), this study nevertheless demonstrated that inattentional blindness can be induced in the same participants more than once in the same testing session, as evidenced by both the average participant reporting the UE in less than half of the IB trials (see Table 4) and by the statistically significant correlations in noticing observed in 30% of possible trial pairings (see Appendix F). This aligns with the findings of Ward & Scholl (2015), where it was first demonstrated that sustained inattentional blindness for dynamic, moving tasks can be induced multiple times in the same participants within a single test session, an effect that had not yet been replicated until the present study. The only other known study that produced multiple instances of inattentional blindness across trials (Webster et al., 2018) used static images as stimuli rather than dynamic, moving targets.

Limitations & Future Directions

The results of this study are somewhat inconclusive; partial support was found for some hypotheses, one set of potentially spurious findings directly contradicted the predictions of the second hypothesis, and the majority of the results were null. While this study presents some intriguing, unexplained findings, the ability to generalize these results beyond this sample to the broader study of ADHD is limited; indeed, any interpretation of these findings that involves generalizing beyond this sample is questionable due to the limitations discussed below.

The results of the reliability analysis could be understood as an example of the ‘reliability paradox’ in adapting experimental paradigms for use in individual differences (i.e., correlational) research (Goodhew & Edwards, 2019; Hedge et al., 2018). The poor observed reliability in noticing may be a result of the task being based on a paradigm optimized for experimental research (i.e., Most et al., 2001), wherein the goal was to maximize within-subject or group-level differences and minimize between-subject variability in service of demonstrating and manipulating a robust, reliable experimental effect. This core principle of good experimental design stands in opposition to the construction of tasks sensitive to individual differences which require reliability at the level of the subject (i.e., test-retest and internal consistency reliability) rather than reliability of the effect itself. Indeed, Hedge et al., (2018) demonstrated in an influential paper that these types of reliability are not only dissociable but *mutually antagonistic;* that is, the core features that make for a robust experimental effect are detrimental to reliable measurement from a psychometric perspective. More simply, actions taken to increase reliability in one domain will compromise reliability in the other, and vice versa. The stimulus design used in the present study, and particularly the visual features of the UE, can be taken as an example of this. The UE stimuli used in this study were constructed to differ randomly between trials in an attempt to minimize the influence of individual stimulus features, such as colour or trajectory, on participants’ overall pattern of responses as well as to limit their between-trial learning and expectations so that the effect of interest (i.e., inattentional blindness) would occur repeatedly in the same participants. The very features that made this effect robust across trials (e.g., variations in colour, shape, trajectory, etc.) had a likely damaging effect on the task's reliability at the subject level, between individual trials, leading to poor inter-item reliability and thereby substantially inflating the standard error when modelling individual difference effects.

Goodhew & Edwards (2019) expand on Hedge et al.'s (2018) work and make several recommendations for adapting experimental paradigms for use in individual differences research. While it is not certain that the reliability paradox can explain why the observed scale reliability was so poor for the repeat IB task, further research should strongly consider how recommendations by Goodhew & Edwards (2019) could be applied to the study of inattentional blindness in order to improve our ability to reliably detect individual differences therein. Notably, follow up studies on these constructs can incorporate a longitudinal design in order to assess test-retest reliability of these measures and to evaluate if any of the state or trait-based constructs measured here by self-report are predictive of later performance on these tasks.

Problems with internal reliability have deleterious effects on statistical power and limit the maximum strength of correlation that can be observed, and highly unbalanced proportions in dichotomous variables can similarly truncate correlations as well as leading to unstable estimates (Tabachnick & Fidell, 2013). While the initial power analysis conducted for this study suggested that 114 participants would be sufficient to detect a small effect, the potential for binary variables to show such highly unbalanced proportions in the observed data was not accounted for in these estimates. The sample size obtained in this study was likely insufficient to detect the effects I hypothesized, and if this study were to be repeated it should be increased by at least a factor of three to account for the low cell counts and poor reliability.

Another potential limitation with this study is that the primary counting task may have been too difficult for most participants. This is suggested by the observed data, given that very few were able to provide a reasonably accurate count on any trial after the initial demonstration. Past research using the Most et al. (2001) paradigm has typically limited the number of tracked objects to four, a convention that is likely a holdover of early IB stimulus design being informed by classic research (e.g., Pylyshyn & Storm, 1988) which has shown that, on a 2D display, human observers can accurately track an average of 4 moving objects among identical distractors. IB studies that have directly manipulated task difficulty have generally found that participants are less likely to notice the UE when engaged in a more challenging primary task, and this has been generally attributed to the effects of perceptual load and other task-specific cognitive demands (e.g., Cartwright-Finch & Lavie, 2007; Simons & Chabris, 1999). Following from this theory, this more difficult task should have led to increased rates of IB over what is typically seen in research using the Most et al., (2001) paradigm. Testing this is outside the scope of the present study, but one would at least expect an observed difference in IB between trials with 8 and 11 targets, the latter being expected to have lower rates of noticing. Statistically significant frequency differences in this direction were observed in only 4 out of 9 possible comparisons, suggesting task difficulty, or at least number of targets, was not predictive of noticing in most trials of this task. Given that the primary task performance differed as expected for most trials with 8 vs. 11 targets, it is tempting to assume that that participants were adequately engaged in the task, but low accuracy could also be the result of random responding or other response sets that reflect low engagement. Buetti & Lleras (2016) have demonstrated that distractibility for task-irrelevant visual stimuli is a function of task engagement (i.e., participant motivation) more so than difficulty. The differential effects of primary task difficulty and engagement could be assessed in future studies, perhaps using oculomotor capture methods similar to Buetti & Lleras (2016).

While online data collection for performance-based and cognitive tasks have generally been found to provide acceptable data quality in self-selected uncompensated participants (e.g., Germine et al., 2012; Huber & Gajos, 2020), these results could nevertheless be potentially confounded by the unstandardized administration of tasks sensitive to lapses in attention and other state-based or environmental factors (e.g., Beanland et al., 2011; Becker & Leinenger, 2011; Buerti & Lleras, 2016; Schofield et al., 2016) . Notably, participants in this study were free to complete these tasks on whatever device they chose with no restrictions on the time of day or environment that the tasks were completed in, which could add noise to the data and increase standard errors for regression coefficient estimates. Further, the compensation used in this study (i.e., bonus points in psychology courses) could cause unknown issues with participant motivation and engagement. Repeating this study with an uncompensated self-selected sample of participants could lead to better data quality, or at least larger sample sizes, thereby improving the ability to reliably detect effects.

Similarly, it is possible that the task simply did not have enough trials to enable the reliable measurement of a dichotomous outcome. The single-trial nature of the conventional inattentional blindness paradigm limits the ability to assess reliability, and the range restriction caused by dichotomous operationalization limits power to detect correlations (Kreitz et al., 2016). A larger number of trials not only yields improved reliability but also would increases the range of possible scores, allowing for more sensitive partitioning of variance, as well as decreasing the number of participants needed to reliably observe an effect (e.g., Rouder & Haaf, 2019).

There is, of course, some unique challenge involved in the study of inattentional blindness in this regard. There is contention in the literature over whether the inclusion of repeat critical trials in an IB task fundamentally changes the construct being measured, as many have asserted that with the inclusion of even one additional critical trial the unexpected event is no longer *truly* unexpected, and therefore the measurement of IB becomes confounded by divided attention or other unknown effects (e.g., Kretiz et al., 2015; Redlich et al., 2020). Yet, given that it has been established that attentional set is one of the driving cognitive processes underlying the inattentional blindness phenomenon (e.g., Most et al., 2005; Most & Astur, 2006), rather than inattentional blindness being definitionally contingent on not having any expectations at all, perhaps having *incorrect* expectations about a potential UE could suffice to induce the same phenomenon (i.e., Ward & Scholl, 2015). After all, it could be argued that in many 'real world' applications of the inattentional blindness paradigm, in the naturalistic or simulated study of distracted driving for example, participants *should* be expecting that an 'unexpected' event could occur while completing the primary task as a matter of routine safe driving practices. From this perspective, a definition of inattentional blindness that precludes any level of expectation has questionable external validity. That being said, concerns about the addition of critical trials compromising internal validity in experimental study of IB are surely warranted to the extent that there is a real risk of reducing the robustness of the effect if between-subjects variability caused by divided attention or other processes cannot be readily partitioned out. As noted above, actions taken to minimize between-subject variability and isolate the effect of interest are necessarily in conflict with those required to make a task more sensitive and reliable in detecting individual differences (Hedge et al., 2018). While addressing this ontological distinction is beyond the scope of this study, it is a distinction that will require substantive interrogation as topics investigated using the inattentional blindness paradigm continue to expand into the realm of individual differences and correlational research.

Conclusion

With the current study I sought to better understand the role of ADHD symptoms in predicting inattentional blindness in university students, and in doing so, I attempted to create a measure of inattentional blindness that would be appropriate to use in an individual differences research paradigm. While this inattentional blindness task was not found to have sufficient scale reliability to meaningfully test individual differences hypotheses, I nevertheless demonstrated that inattentional blindness can be induced in most undergraduate student participants multiple times within the same session. These findings add to the body of research on individual differences in inattentional blindness and to the more general literature on using experimental tasks in individual differences research.

In this study, it was observed that ADHD symptoms did not predict a reduced susceptibility to inattentional blindness and may have even be related to increased susceptibility. Further, depression symptoms were unexpectedly associated with reduced susceptibility. There is a risk that these unanticipated results were simply spurious relationships, but without further research this can not be determined.

The results of this study also show relationships between object tracking in a video-based task and both trait-level spontaneous mind wandering and ADHD symptoms. Overall, the results of this study highlight the need for researchers to develop reliable behavioural measures when studying individual differences, and to consider the influence of related but dissociable trait and state level individual differences constructs, such as mind wandering, ADHD, and depression symptoms, in future research on inattentional blindness and object tracking performance.

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APPENDIX A

Adult ADHD Self-Report Scale

Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page. As you answer each question, place an X in the box that best describes how you have felt and conducted yourself over the past 6 months. Please give this completed checklist to your healthcare professional to discuss during your appointment.	Never	Rarely	Sometimes	Often	Very often
PART A					
How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?					
How often do you have difficulty getting things in order when you have to do a task that requires organization?					
How often do you have problems remembering appointments or obligations?					
When you have a task that requires a lot of thought, how often do you avoid or delay getting started?					
How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?					
How often do you feel overly active and compelled to do things, like you were driven by a motor?					
PART B					
How often do you make careless mistakes when you have to work on a boring or difficult project?					
How often do you have difficulty keeping your attention when you are doing boring or repetitive work?					
How often do you have difficulty concentrating on what people say to you, even when they are speaking to you directly?					
How often do you misplace or have difficulty finding things at home or at work?					
How often are you distracted by activity or noise around you?					
How often do you leave your seat in meetings or in other situations in which you are expected to stay seated?					
How often do you feel restless or fidgety?					
How often do you have difficulty unwinding and relaxing when you have time to yourself?					
How often do you find yourself talking too much when you are in social situations?					
When you're in a conversation, how often do you find yourself finishing the sentences of the people you are talking to, before they can finish it themselves?					
How often do you have difficulty waiting your turn in situations when turn taking is required?					
How often do you interrupt others when they are busy?					

APPENDIX B

Depression Anxiety and Stress Scales – Long Form (DASS-42)

Please read each statement and circle a number 0, 1, 2, or 3 which indicates how much the statement applied to you **over the past week**

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time.
2 Applied to me a considerable degree, or a good part of the time.
3 Applied to me very much, or most of the time.

1. I found myself getting upset by quite trivial things	**0**	**1**	**2**	**3**
2. I was aware of dryness of my mouth	**0**	**1**	**2**	**3**
3. I couldn't seem to experience any positive feeling at all	**0**	**1**	**2**	**3**
4. I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)	**0**	**1**	**2**	**3**
5. I just couldn't seem to get going	**0**	**1**	**2**	**3**
6. I tended to over-react to situations	**0**	**1**	**2**	**3**
7. I had a feeling of shakiness (e.g., legs going to give way)	**0**	**1**	**2**	**3**
8. I found it difficult to relax	**0**	**1**	**2**	**3**
9. I found myself in situations that made me so anxious I was most relieved when they ended	**0**	**1**	**2**	**3**
10. I felt that I had nothing to look forward to	**0**	**1**	**2**	**3**
11. I found myself getting upset rather easily	**0**	**1**	**2**	**3**
12. I felt that I was using a lot of nervous energy	**0**	**1**	**2**	**3**
13. I felt sad and depressed	**0**	**1**	**2**	**3**
14. I found myself getting impatient when I was delayed in any way (e.g., lifts, traffic lights, being kept waiting)	**0**	**1**	**2**	**3**
15. I had a feeling of faintness	**0**	**1**	**2**	**3**
16. I felt that I had lost interest in just about everything	**0**	**1**	**2**	**3**
17. I felt I wasn't worth much as a person	**0**	**1**	**2**	**3**
18. I felt that I was rather touchy	**0**	**1**	**2**	**3**
19. I perspired noticeably (e.g., hands sweaty) in the absence of high temperatures or physical exertion	**0**	**1**	**2**	**3**
20. I felt scared without any good reason	**0**	**1**	**2**	**3**
21. I felt that life wasn't worthwhile	**0**	**1**	**2**	**3**
22. I found it hard to wind down	**0**	**1**	**2**	**3**
23. I had difficulty in swallowing	**0**	**1**	**2**	**3**
24. I couldn't seem to get any enjoyment out of the things I did	**0**	**1**	**2**	**3**
25. I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)	**0**	**1**	**2**	**3**
26. I felt down-hearted and blue	**0**	**1**	**2**	**3**
27. I found that I was very irritable	**0**	**1**	**2**	**3**
28. I felt I was close to panic	**0**	**1**	**2**	**3**
29. I found it hard to calm down after something upset me	**0**	**1**	**2**	**3**

30. I feared that I would be "thrown" by some trivial but unfamiliar task	**0**	**1**	**2**	**3**
31. I was unable to become enthusiastic about anything	**0**	**1**	**2**	**3**
32. I found it difficult to tolerate interruptions to what I was doing	**0**	**1**	**2**	**3**
33. I was in a state of nervous tension	**0**	**1**	**2**	**3**
34. I felt I was pretty worthless	**0**	**1**	**2**	**3**
34. I was intolerant of anything that kept me from getting on with what I was doing	**0**	**1**	**2**	**3**
36. I felt terrified	**0**	**1**	**2**	**3**
37. I could see nothing in the future to be hopeful about	**0**	**1**	**2**	**3**
38. I felt that life was meaningless	**0**	**1**	**2**	**3**
39. I found myself getting agitated	**0**	**1**	**2**	**3**
40. I was worried about situations in which I might panic and make a fool of myself	**0**	**1**	**2**	**3**
41. I experienced trembling (e.g., in the hands)	**0**	**1**	**2**	**3**
42. I found it difficult to work up the initiative to do things	**0**	**1**	**2**	**3**

APPENDIX C

Mind Wandering Deliberate (MW-D) and Spontaneous (MW-S) Scales

For the following statements, please select the answer that most accurately reflects your everyday mind wandering.

(MW-D)

1. I allow my thoughts to wander on purpose.

Rarely						A lot
1	2	3	4	5	6	7

2. I enjoy mind-wandering.

Rarely						A lot
1	2	3	4	5	6	7

3. I find mind-wandering is a good way to cope with boredom.

Not at all true						Very true
1	2	3	4	5	6	7

4. I allow myself to get absorbed in pleasant fantasy.

Rarely						A lot
1	2	3	4	5	6	7

(MW-S)

5. I find my thoughts wandering spontaneously.

Rarely						A lot
1	2	3	4	5	6	7

6. When I mind-wander my thoughts tend to be pulled from topic to topic.

Rarely						A lot
1	2	3	4	5	6	7

7. It feels like I don't have control over when my mind wanders.

Almost never						Almost always
1	2	3	4	5	6	7

8. I mind-wander even when I'm supposed to be doing something else.

Rarely						A lot
1	2	3	4	5	6	7

APPENDIX D

Stimulus Characteristics of Repeat IB Task

Table D1

Stimulus Characteristics for Each Trial of the Repeat IB Task

					UE Characteristics			
Block	Trial	N	C	Colours	Colour	Shape	Distance	Direction
Demo	1	4		Black/**White**				
1	1	8		Black/**Pink**				
	2	11		**Green**/Pink				
	3	11		Black/**White**	Grey	Cross	30% below	H - L
2	1	8		Green/**Pink**				
	2	11		**Black**/White				
	3	8		**Black**/White	Yellow	Cross	60% Below, 60% Left	D – U/L
3	1	8		**Pink**/Green				
	2	11		**Black**/White				
	3	8		Black/**White**				
	4	8		Dark Pink/**Light Pink**	Peach	Diamond	25% Below	H - L
4	1	8		Pink/**Green**				
	2			Light Pink/**Dark Pink**	Blue	Diamond	50% Left	D – U/R
5	1	11		Black/**White**	White	Cross	60% above	H - L
6	1	11		Pink/**Green**				
	2			**Black**/White	Red	Cross	0%	H - R

Note: Bolded colour indicates the colour of the target. UE = unexpected event H = horizontal, D = diagonal, R = right, L = left, U = up.

APPENDIX E

Description of Auditory and Audiovisual 'Filler' Tasks

Auditory Time Perception Task (adapted from Cheng, 2021)

This task consists of a simple forced-choice temporal bisection task with auditory stimuli. Participants are instructed that they will have to categorize auditory stimuli as either *short* or *long* in duration. In the initial learning phase, five examples each of computer-generated tones of the short and long anchor durations are presented in random order. Participants then practice the categorization task. 10 examples each of the long and short anchor duration are presented in random order. Participants indicate their classification by pressing the appropriate key on their computer keyboard. Feedback is then displayed on screen using white text on a grey background, with correct responses being followed by “Correct!” and incorrect responses being followed by “Incorrect!”. In the subsequent test phase, participants classify computer and vocally generated tones of various lengths (600ms, 800ms, 1000ms, 1200ms, 1400ms, 1600ms) as long or short using the same keyboard responses as in the practice phase. Participants will complete 113 trials of this task in each block.

Auditory Lexical Processing Task (adapted from UCLA Psychobiology Lab, 2021)

In this task, participants are simultaneously presented with voice recordings of two monosyllabic rhyming words (e.g., time, mime) and asked to indicate which of the words they heard using a forced choice paradigm. Each block of this task includes 60 trials.

Multimodal Timing Task (adapted from Cannon, 2020)

In this task, participants are asked to continue a sequence of events presented at regular timing intervals. Participants are presented with two identical sequential stimuli (either an auditory ‘click’ or a visual ‘flash’) and asked to press the space bar exactly when they would predict a third click or flash would occur. Participants complete three practice trials for each stimulus type. In the practice trials, participants are instructed that the stimuli will be presented either fast or slow (e.g., shorter or longer interval between stimuli), and that the word “NOW” will appear on the screen at the correct time to press the space bar. After the practice trials, participants are instructed that the “real experiment” is beginning, that the trials will come in a random order, that no feedback will be provided, and that they will get a break every 10 trials. Each block of this task contains 50 trials, plus the 6 practice trials.

APPENDIX F

Correlation Coefficients Between Inattentional Blindness Measures

Table F1

Correlation Matrix of Noticing and Primary Task Accuracy Across Dynamic Video Task and Repeat IB Critical Trials

	Noticing								Primary Task							
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Noticing																
1. Video	—															
2. Trial 1	0.03	—														
3. Trial 2	0.13	0.21*	—													
4. Trial 3	-0.08	0.05	0.13	—												
5. Trial 4	0.02	-0.13	0.12	0.10	—											
6. Trial 5	-0.02	0.04	0.19	0.24*	0.20*	—										
7. Trial 6	-0.15	0.05	-0.01	0.16	0.20*	0.26**	—									
8. Repeat	-0.01	0.08	0.56***	0.59***	0.59***	0.67***	0.42***	—								
Primary Task																
9. Video	-0.14	-0.11	-0.27**	0.06	-0.01	-0.02	-0.10	-0.13	—							
10. Trial 1	-0.07	-0.15	-0.03	-0.04	-0.20	-0.08	-0.22	-0.17	-0.02	—						
11. Trial 2	0.03	-0.21*	0.03	-0.02	-0.11	-0.09	-0.30	-0.12	0.07	0.47***	—					
12. Trial 3	0.06	-0.30**	-0.07	0.01	0.12	0.06	0.04	0.05	0.23*	0.18	0.09	—				
13. Trial 4	0.03	-0.24*	-0.16	0.04	0.06	0.11	-0.00	0.02	0.18	0.16	0.16	0.44***	—			
14. Trial 5	-0.06	-0.13	-0.10	0.04	0.08	-0.01	0.14	0.03	0.11	0.31**	0.26**	0.38***	0.59***	—		
15. Trial 6	0.12	-0.22*	0.01	0.09	0.22	0.11	0.03	0.17	0.12	0.27**	0.23*	0.39***	0.55***	0.66***	—	
16. Repeat	0.03	-0.29**	-0.07	0.04	0.06	0.03	-0.06	0.01	0.16	0.61***	0.50***	0.60***	0.69***	0.81***	0.81***	—

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

APPENDIX G

Final Linear Regression Model Estimates for Repeat IB Task

Table G1

Model Fit Measures for Binary Logistic Regression Predicting Noticing in Repeat IB Task

							Overall Model Test			
Model	R	R^2	Adjusted R^2	AIC	BIC	RMSE	F	df1	df2	p
1	0.12	0.02	-0.05	348.91	369.83	1.26	0.25	6	94	0.959

Table G2

Model Coefficients for Binary Logistic Regression Predicting Noticing in Repeat IB Task

						95% Confidence Interval	
Predictor	β	SE	t	p	Odds Ratio	Lower	Upper
Intercept	3.32	0.56	5.97	< .001			
Mind Wandering (D)	0.00	0.03	0.08	0.933	0.01	-0.23	0.25
Mind Wandering (S)	-0.02	0.03	-0.52	0.601	-0.07	-0.35	0.20
DASS-42 Depression	-0.01	0.02	-0.56	0.577	-0.11	-0.49	0.28
DASS-42 Anxiety	0.01	0.03	0.16	0.871	0.03	-0.37	0.44
DASS-42 Stress	0.02	0.03	0.75	0.457	0.18	-0.30	0.65
ADHD Symptoms	-.001	0.05	-0.02	0.985	-0.00	-0.29	0.29

Note. Estimates represent the log odds of noticing the unexpected event (UE). (D) = deliberate, (S) = spontaneous, DASS-42 = Depression, Anxiety and Stress Scales, 42-item version, ADHD Symptoms = Adult ADHD Self Report Scale v1.1.

APPENDIX H

Trial-level Modelling of Noticing in Repeat IB Task

Table H1

Coefficient Estimates for Binary Logistic Regression Models Predicting Noticing on Each Trial of the Repeat IB Task

	Trial 1		Trial 2		Trial 3		Trial 4		Trial 5		Trial 6	
	β	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*
Step 1												
(Intercept)	-4.56	*2.40*	0.27	*0.85*	1.36	*0.92*	-0.16	*0.86*	0.69	*0.92*	0.93	*1.64*
Mind Wandering (D)	0.02	*0.11*	-0.01	*0.04*	-0.01	*0.04*	0.04	*0.04*	-0.02	*0.05*	0.05	*0.10*
Mind Wandering (S)	0.09	*0.13*	-0.02	*0.05*	-0.04	*0.05*	-0.02	*0.05*	-0.03	*0.05*	0.07	*0.11*
DASS-42 Depression	0.04	*0.10*	0.01	*0.04*	-0.01	*0.04*	-0.03	*0.04*	-0.02	*0.04*	-0.03	*0.09*
DASS-42 Anxiety	-0.04	*0.15*	0.00	*0.05*	0.02	*0.05*	0.02	*0.05*	0.01	*0.06*	-0.09	*0.11*
DASS-42 Stress	-0.07	*0.13*	-0.01	*0.05*	0.01	*0.05*	0.02	*0.05*	0.07	*0.05*	0.07	*0.10*
Step 2												
(Intercept)	-4.96	*2.55*	0.43	*0.88*	1.32	*0.92*	-0.19	*0.86*	0.69	*0.92*	0.83	*1.63*
Mind Wandering (D)	0.03	*0.11*	-0.00	*0.04*	-0.01	*0.05*	0.03	*0.04*	-0.02	*0.05*	0.04	*0.10*
Mind Wandering (S)	0.18	*0.16*	0.02	*0.05*	-0.06	*0.06*	-0.02	*0.05*	-0.05	*0.06*	0.06	*0.11*
DASS-42 Depression	0.07	*0.10*	0.02	*0.04*	-0.01	*0.04*	-0.04	*0.04*	-0.02	*0.04*	-0.03	*0.09*
DASS-42 Anxiety	-0.04	*0.14*	-0.01	*0.05*	0.03	*0.06*	0.02	*0.05*	0.01	*0.06*	-0.09	*0.11*
DASS-42 Stress	-0.05	*0.14*	0.02	*0.05*	-0.01	*0.05*	0.01	*0.05*	0.06	*0.05*	0.05	*0.11*
ADHD Symptoms	-0.26	*0.20*	-0.16*	*0.08*	0.08	*0.08*	0.03	*0.07*	0.05	*0.08*	0.08	*0.16*

Note. *= p<.05. *β* estimates represent the log odds of noticing the unexpected event (UE). (D) = deliberate, (S) = spontaneous, DASS-42 = Depression, Anxiety and Stress Scales, 42-item version, ADHD Symptoms = Adult ADHD Self Report Scale v1.1.

APPENDIX I

Trial-level Modelling of Count Accuracy in Repeat IB Task

Table I1

Standardized Regression Coefficients for Final Models Predicting Trial-level Count Accuracy

	Critical Trial 1 (*n=100)*			Critical Trial 2 (*n=99)*			Critical Trial 3 (*n=101)*		
	β	*95% CI*		*β*	*95% CI*		*β*	*95% CI*	
		*LL - *	*UL*		*LL - *	*UL*		*LL - *	*UL*
Mind Wandering (D)	0.09	*-0.15*	*0.33*	0.01	*-0.24*	*0.25*	0.11	*-0.13*	*0.35*
Mind Wandering (S)	-0.07	*-0.34*	*0.21*	-.001	*-0.28*	*0.28*	-0.17	*-0.45*	*0.11*
DASS-42 Depression	-0.05	*-0.43*	*0.33*	0.02	*-0.36*	*0.41*	0.00	*-0.38*	*0.39*
DASS-42 Anxiety	-0.09	*-0.49*	*0.31*	0.04	*-0.39*	*0.47*	0.05	*-0.35*	*0.46*
DASS-42 Stress	0.25	*-0.22*	*0.73*	-0.13	*-0.62*	*0.37*	-0.02	*-0.50*	*0.45*
ADHD Symptoms	-0.17	*-0.47*	*0.14*	-0.14	*-0.50*	*0.22*	-0.11	*-0.60*	*0.38*
Noticing	-0.86	*-1.93*	*0.21*	0.03	*-0.39*	*0.45*	0.02	*-0.41*	*0.45*
ADHD * Noticing	-0.15	*-0.85*	*0.56*	0.33	*-0.09*	*0.76*	0.13	*-0.35*	*0.61*
	Critical Trial 4 *(n=100)*			Critical Trial 5 (*n=99)*			Critical Trial 6 *(n=99)*		
	β	*95% CI*		*β*	*95% CI*		*β*	*95% CI*	
		*LL - *	*UL*		*LL - *	*UL*		*LL - *	*UL*
Mind Wandering (D)	-0.12	*-0.36*	*0.12*	0.02	*-0.23*	*0.26*	-0.01	*-0.26*	*0.24*
Mind Wandering (S)	-0.17	*-0.44*	*0.10*	-0.09	*-0.37*	*0.19*	-0.10	*-0.38*	*0.18*
DASS-42 Depression	-0.08	*-0.45*	*0.30*	-0.03	*-0.42*	*0.35*	0.11	*-0.28*	*0.51*
DASS-42 Anxiety	-0.04	*-0.44*	*0.35*	-0.19	*-0.61*	*0.23*	-0.30	*-0.71*	*0.11*
DASS-42 Stress	-0.04	*-0.50*	*0.43*	0.07	*-0.42*	*0.55*	0.18	*-0.31*	*0.68*
ADHD Symptoms	0.22	*-0.12*	*0.56*	0.17	*-0.28*	*0.62*	-0.23	*-1.12*	*0.67*
Noticing	0.03	*-0.36*	*0.43*	-0.10	*-0.55*	*0.34*	0.13	*-0.77*	*1.03*
ADHD * Noticing	-0.27	*-0.67*	*0.13*	-0.09	*-0.57*	*0.38*	0.29	*-0.61*	*1.18*

Note. No predictors significant at α .05. (D) = deliberate, (S) = spontaneous, DASS-42 = Depression, Anxiety and Stress Scales, 42-item version, ADHD Symptoms = Adult ADHD Self Report Scale v1.1.

VITA AUCTORIS

Katherine Rose Matchett (Kat) was born in 1991 in London, Ontario. She never graduated high school, dropping out of Windsor's Public Alternative Secondary School in 2009 and obtaining her G.E.D. in 2010. After spending two years in the service industry, she entered Fanshawe College, from which she graduated with a diploma in General Arts & Sciences in 2013. From there she went on to York University to begin an Honours B.A. in Psychology, which was awarded at the University of Windsor in 2019 with Great Distinction. She is currently a candidate for the Master's degree in Psychology at the University of Windsor with plans to graduate in the Fall of 2022.