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INVESTIGATING MIND WANDERING IN UNIVERSITY AND COMMUNITY SAMPLES

by

Dragana Ostojic

A Dissertation  
Submitted to the Faculty of Graduate Studies  
through the Department of Psychology  
in Partial Fulfillment of the Requirements for  
the Degree of Doctor of Philosophy at the  
University of Windsor

Windsor, Ontario, Canada

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INVESTIGATING MIND WANDERING IN UNIVERSITY AND COMMUNITY SAMPLES

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April 9, 2018

## **Declaration of Originality**

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## Abstract

Mind wandering is a commonly experienced phenomenon that has been the focus of more research over the past few decades. In keeping with changing terminology used to characterize the experience, our understanding of the construct continues to evolve. The current dissertation, composed of three separate studies, sought to build on these recent advancements by adding to our understanding of 1) the assessment of mind wandering, 2) the association between mind wandering and symptoms of attention disorders, and 3) how mindfulness training may impact mind wandering frequency.

Study one used ecological momentary assessments (EMA) to investigate the utility of three measures of mind wandering (i.e., Mind Wandering Questionnaire (MWQ), and the Mind Wandering – Spontaneous (MW-S) and Deliberate scales (MW-D) in a university sample ( $N = 100$ ). Results showed that reporting more mind wandering episodes during the EMA data collection was associated with higher scores on two mind wandering measures (MWQ and MWS), but was not significantly correlated with the MW-D score. The findings highlighted the benefit of using EMA to validate self-report measures designed to capture mind wandering.

The second study examined the relation between symptoms of attention difficulties (i.e., Attention Deficit/Hyperactivity Disorder (ADHD) symptoms and Sluggish Cognitive Tempo (SCT) symptoms) and mind wandering in a group of university students ( $N = 161$ ). Hierarchical regression analyses were done in an effort to identify the unique contribution of the different symptom dimensions on trait levels of mind wandering. Endorsement of Sluggish Cognitive Tempo symptoms was found to be a consistent predictor across the different measures of mind wandering, with symptoms of ADHD also predicting the MWQ and MW-S scores. The findings reaffirm the association between mind wandering and attention difficulties.

Lastly, building on research demonstrating the positive impact of mindfulness training on attention, the third study was designed with the aim of examining if participation in a mindfulness intervention is associated with reduced self-reported mind wandering and if endorsement of ADHD symptoms can help predict change in mind wandering post-training. Twelve participants recruited from a community in Southwestern Ontario participated in an instructor-led eight-week mindfulness intervention, with the results showing no decrease in self-reported mind wandering following the intervention. ADHD symptom endorsement was also not found to be a significant predictor of change in mind wandering. Importantly, the findings were interpreted with consideration of the recruitment difficulties encountered and insufficient power resulting from the small sample size.

In sum, the results from the three studies provide evidence in support of the use of self-report measures of mind wandering, and demonstrate the importance of examining the association between mind wandering and attention disorder symptoms. The findings also reaffirm the need to differentiate between spontaneous and deliberate mind wandering and highlight the potential clinical implications.

## **Acknowledgments**

My graduate studies have been a period of great personal and professional development and I owe a debt of gratitude to the many individuals who were instrumental during these formative years. First, I would like to express my gratitude to my advisor (Dr. Carlin Miller) and my committee members (Dr. Christopher Abeare, Dr. David Ledgerwood, and Dr. Elizabeth Donnelly) for their mentorship and advice with regards to both my dissertation research and career goals. I am very appreciative of the guidance you provided. Second, my academic accomplishments would not have been possible without the support of my family and friends, with special mention to my husband (Jeffrey), parents (Arijana and Predrag) and brother (Tomislav). I will be forever thankful for all the support and encouragement you provided throughout my studies. I would also like to express my thanks to my peers who I have had the pleasure of studying and training with over the past seven years. This journey would have been much more difficult without your unwavering support, reassurance and inspiration. Finally, I would like to thank the research assistants who were involved in these studies. Your contributions are greatly appreciated.

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## CHAPTER 1

### Literature Review

Most readers can recall an experience of unexpectedly discovering that their thoughts have drifted away, without awareness, from the text they are reading to daydreaming. This experience of having our thoughts wander from a task we are engaged in to our internal thoughts or feelings is an universally experienced phenomenon commonly referred to as mind wandering (Smallwood & Schooler, 2009). In fact, mind wandering, also described as task-unrelated-thought or stimulus independent thought, is estimated to comprise 30 percent of our thoughts (McVay, Kane, & Kwapil, 2009) or as much as half of our waking time (Smallwood & Schooler, 2009; Killingsworth & Gilbert, 2010). Despite its ubiquitous nature, the study of “self-generated mental activity” has not been the focus of scientific inquiry until relatively recently (Callard, Smallwood, Golchert, & Margulies, 2013, p. 1). Expanding on research conducted to date, the main goal of this dissertation was to build on recent developments in the conceptualization and assessment of mind wandering, as well as add to our understanding of the relationship between mind wandering and attention disorder symptoms. Moreover, in light of research demonstrating the benefit of mindfulness intervention in improving attention difficulties, the final study was developed to explore if mindfulness training was associated with reductions in self-reported mind wandering.

### Historical Foundations of Mind Wandering

The twenty-first century has seen a revival of scientific interest in the study of “self-generated mental activity” (i.e., mind wandering; Callard et al., 2013, p. 1; Smallwood & Schooler, 2006). This reflects a dramatic change in the research climate and a shift in psychological research away from exclusive focus on goal-directed thought and behaviour

(Callard et al., 2013). In fact, this lag in research on self-generated mental activity has been suggested to be at least in part due to the prominence of behaviourism in psychological research during the second half of the twentieth century, with the dominance of this approach leading to the disregard of the topic by prominent senior psychologists and prestigious journals (Callard, Smallwood, & Margulies, 2012; Callard et al., 2013). Relatedly, it has been argued that the research emphasis placed on examining external tasks contributed to inaccurate assumptions being made about self-generated mentation (Callard et al., 2012).

Although generally neglected by the research community prior to the first decade of the twenty-first century, a few researchers conducted foundational research on the topic during this time. Jerome L. Singer is considered the “father of daydreaming” (Kaufman, 2013). He along with his graduate students, John Antrobus and Kenneth Pope, conducted pioneering work on this topic (Callard et al., 2013; Singer & Antrobus, 1963). Additionally, Eric Klinger extended our understanding of daydreaming and fantasy (Callard et al., 2013), while Leonard Giambra must also be acknowledged for his work on the relations between age and daydreaming or task unrelated thought (Giambra, 1989; Giambra, 1993). Finally, other isolated researchers continued this work in the late 1990s and merit recognition (e.g., Einstein & McDaniel, 1997). Therefore, the study of mind wandering, although in its relative infancy in contrast to other areas of cognitive psychology, is indebted to the foundational work of these researchers.

### **Distinguishing Mind Wandering from Related Constructs**

Since 2006, the use of the term “mind wandering” has seen an unprecedented increase suggesting that a) there is growing research on the topic, and b) the field characterized by mixed terminology has increasingly accepted the use of this term over others (Callard et al., 2013). But, paralleling the fragmented early research on self-generated mental activity, the existent literature

continues to reflect the use of a broad array of terms reflecting self-generated thoughts, as well as different aspects of the psychological processes underlying mind wandering (Callard et al., 2013). As such, clarification of the terminology is helpful.

The umbrella category of “self-generated mental activity” includes many related constructs, such as mind wandering, task-unrelated thoughts and images, daydreaming, mind pops, and fantasy (Callard et al., 2013; Giambra, 1995; Smallwood & Schooler, 2006; Kvavilashvili & Mandler, 2004). Although they all occur independently of perceptual/environmental input, these phenomena vary in many ways, such as in the extent of volitional control employed (i.e., how aware one is that they are engaging in this form of self-generated thought; Callard et al., 2013). Notably, this grouping of overlapping and adjacent but separable constructs may lead to confound within the literature, and, as such, is worth parsing out.

For instance, the terms mind wandering and daydreaming have been used interchangeably to refer to the same construct, and correspondingly, at times have been assessed using the same measure (e.g., Daydream Frequency Scale; Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013). Yet, daydreaming is commonly conceptualized as “stimulus-independent thought” that occurs in the *absence of any ongoing task* and may be reflected in the endorsement of items such as “When I have time on my hands I daydream”, or “On a long bus, train, or airplane ride, I daydream” (Mrazek et al., 2013, p. 1). The above examples are sample items from the Daydreaming Frequency Scale, illustrating the possible inappropriateness of these items to evaluate the construct of mind wandering when conceptualized as stimulus-independent thought that reflects “a redirection of attention *from a task*” (Mrazek et al., 2013, p. 2; Smallwood & Schooler, 2006). This distinction is significant because having a greater tendency

to daydream does not imply a difficulty with maintaining one's thoughts on a task (Mrazek et al., 2013). Notably, consistent with the definition of *task* in cognitive science, task in this context refers to activity that relies on environmental input and/or is associated with an external output, such as driving a car, performing a vigilance task or reading the newspaper (Smallwood & Schooler, 2015). As such, self-generated thought that is task-unrelated will interrupt the performance of that ongoing task (Smallwood & Schooler, 2015). Despite this notable difference in meaning, it should be noted that the terms continue to be used by many as closely analogous (e.g., Smallwood, Obonsawin & Heim, 2003).

Alike to differentiating between self-generated thought that occurs during an ongoing task versus that which does not, some authors have attempted to tease apart stimulus-independent thought that is related to the task versus that which is not (e.g., McVay, Kane & Kwapil, 2009; Smallwood, Baracaia, Lowe, & Obonsawin, 2003). That is, some have made efforts to distinguish between self-generated thoughts that include thoughts about how one is performing on the task or how long the task will last (i.e., task-related interferences; Smallwood, Baracaia, et al., 2003), versus task-unrelated thoughts that indicate the presence of mind wandering. These include thoughts about things such as personal concerns, the recall of memories, and future planning (Stawarczyk et al., 2011). As such, mind wandering episodes reflect "situations in which [conscious] awareness departs from the processing of task stimuli" (Smallwood, Obonsawin & Heim, 2003, p. 171).

Finally, stimulus-independent thought (i.e., task-related interference and task-unrelated thoughts) needs to be distinguished from stimulus-dependent distraction that may also occur during task performance (Stawarczyk et al., 2011). This form of distraction differs from the constructs discussed previously in that it relies on sensory/perceptual input. Notably, however,

what makes it a form of distraction is that the sensory/perceptual input is not associated with the ongoing task but rather from irrelevant “exteroceptive and interoceptive perceptions”, such as noises in the environment and perception of hunger, respectively (Stawarczyk et al., 2011, p. 371).

In summary, in addition to addressing the subtle nuances in the meaning of terms thought to reflect self-generated thought, it is also important to distinguish between: 1) types of stimulus-independent thought, namely task-related interferences versus task-unrelated thoughts; and 2) task/stimuli dependent versus task/stimuli independent forms of distraction that may occur during the task (Stawarczyk et al., 2011). Consideration of these possible forms of distraction during task performance allows the reader to better understand how complete task focus may be compromised.

### **Defining Mind Wandering**

Recognizing the mixed terminology in the literature, mind wandering in this document is defined as self-generated thoughts that are task-unrelated and occur during a task or activity. In other words, mind wandering reflects a “situation in which executive control shifts away from a primary task to the processing of personal goals” (Smallwood & Schooler, 2006, p. 946).

Further, it is understood as being made up of an onset phase (i.e., shift of attention to off-task thought) and a maintenance phase (i.e., continuation of the off-task thought; Randall, Oswald & Beier, 2014). This definition is consistent with that used in other research (e.g., McVay & Kane, 2010, Smallwood & Schooler, 2006, Smallwood & Schooler, 2015, etc.), and is in line with the distinction made between mind wandering and related constructs, as discussed above.

Correspondingly, mind wandering is conceptualized as interfering with ongoing performance

and as such, its experience has been linked to increase performance errors, both under laboratory conditions and in the field (McVay, Kane & Kwapil, 2009).

Gambria (1995) emphasized the importance of considering intention in conceptualizing mind wandering. As such, he argued mind wandering, or as he labeled it task-unrelated images and thoughts, might reflect a spontaneous or deliberate shift in attention. Specifically he noted, “TUITs [task unrelated images and thoughts] may occupy awareness because they capture our attention – an uncontrolled shift – or because we have deliberately shifted our attention to them – a controlled shift” (Giambra, 1995, p. 2). This dichotomy he attributed to differences in level of control in informational processing and the role of motivation. In particular, he argued that deliberate mind wandering episodes, whether they precede or follow a voluntary attentional shift, rely on “higher order control in information processing or be motivationally determined” (p. 2). In contrast, spontaneous (i.e., involuntary shifts as labeled by Gambria, 1995) mind wandering is thought to be less determined by motivation and involves “lower orders of control in information processing” (p.2). Due to being less controlled, spontaneous mind wandering was suggested to be more detrimental. Moreover, he reported that despite a greater prevalence of deliberate mind wandering over spontaneous mind wandering, individuals frequently engage in mind wandering without recognition (Giambra, 1995, Smallwood & Schooler, 2006).

Guided by the distinction made by Giambra (1995) between spontaneous and deliberate mind wandering, other researchers have also emphasized the need to distinguish between mind wandering which reflects a deliberate versus spontaneous shift in attention away from an ongoing task (Carriere, Seli, & Smilek, 2013, Seli, Carriere, & Smilek, 2015; Seli, Risko, & Smilek, 2016a). Similarly, others have emphasized the importance of taking into account that mind wandering often occurs without meta-awareness (Smallwood & Schooler, 2006,

Smallwood & Schooler, 2015). For example, even when participants are asked to be attentive to lapses in attention, they fail to avoid experiencing mind wandering (Smallwood & Schooler, 2006). Thus, spontaneous mind wandering (i.e., mind wandering that occurs without intention) can be viewed as distinct from volitional mind wandering.

### **Content of Mind Wandering**

Paralleling the interest in examining when and how frequently mind wandering occurs, the content of mind wandering episodes has received growing research attention (Smallwood & Schooler, 2015). Not surprisingly, the content of mind wandering is eclectic, reflecting a wide range of possible experiences that vary in several variables (e.g., temporal orientation, valence, self or other relevance, etc.; Gorgolewski et al., 2014; Ruby, Smallwood, Engen, & Singer, 2013; Smallwood & Schooler, 2015). Despite this, several general patterns have been observed.

Research examining the temporal focus of mind wandering has revealed that when mind wandering, individuals frequently do not spend time thinking about the present, but instead have their thoughts oriented toward the past or the future (Baird, Smallwood, & Schooler, 2011; Smallwood, Nind, & O'Conner, 2009; Smallwood & Schooler, 2015). In fact, cross-cultural research has revealed that there is a future-oriented bias (i.e., prospective bias) to mind wandering, and that this is evident both under stringent laboratory conditions and ecologically valid settings (Song & Wang, 2012, Smallwood & Schooler, 2015). This seems to be especially true for simpler tasks (e.g., those tasks that are less reliant on working memory and do not depend on continuous monitoring, whereas the association between task complexity and mind wandering oriented toward the past was less consistent (Smallwood et al., 2009). Similarly, interest in the task seems to influence the temporal orientation. Smallwood, Nind and O'Connor (2009) showed that those engaged in a reading comprehension task were less likely to experience

mind wandering episodes, but those uninterested and with no previous experience with the content of the reading were more likely to experience future-oriented mind wandering. Notably, however, those uninterested in the task but with previous experience with the content of the reading were more likely to have task unrelated thoughts that are focused on the past. These findings support the idea that temporal focus of the task-unrelated-thoughts is worth considering (Smallwood & Schooler, 2015).

Although, mind wandering has been linked to unhappiness (Killingsworth & Gilbert, 2010, Poerio, Totterdell, & Miles, 2013) the content of the mind wandering episodes has shown to significantly influence happiness (Ruby, Smallwood, Engen, et al., 2013). Specifically, decreased mood was correlated with task unrelated thoughts that were past-oriented and other-related, even if the task-unrelated-thoughts were positive (Ruby, Smallwood, Engen, et al., 2013). On the other hand, increased positive mood was associated with thoughts that were future-oriented and self-related, even if the task-unrelated thoughts were negative. Reflecting the heterogeneous association between mood and mind wandering, the authors concluded that “our data underline that unhappiness and SGT [self-generated thought] are inextricably linked” and that “occurrence of certain kinds of SGT may constrain rather than prolong negative mood” (p. e77554). In all, there is growing recognition that task-unrelated thoughts vary along the positive to negative affect continuum, and that this variance may depend on several factors (e.g., temporal orientation; Ruby, Smallwood, Engen, et al., 2013).

Considering one’s personal experience with mind wandering, it is likely not surprising to the reader, that the content of mind wandering is often associated with what is of concern to the person and those who they affiliate with (Baird, Smallwood & Schooler, 2011; Smallwood & Schooler, 2015; Gorgolewski et al., 2014). Experience thought sampling has shown that these

concerns may be related to the past, present or future, or not be associated with any time frame (Smallwood, O'Connor, Sudberry, Haskell, & Ballantyne, 2004). Further, a positive link between heart rate and task-unrelated thought supports the conclusion that the content of mind wandering has personal salience to the person (Smallwood, O'Connor, et al., 2004). The increase in heart rate shown to accompany task-unrelated thought has been explained with reference to the fact that processing of personal concerns leads to an increase in body metabolism (Antrobus, 1999 as referenced in Smallwood, O'Connor, et al., 2004). Finally, corroborating this finding, the presentation of personally salient information has been shown to lead to greater off-task thinking under laboratory conditions (Antrobus, Singer, & Greenberg, 1966 as cited in Smallwood, O'Connor, et al., 2004).

Similar to the importance of self-relevance in guiding the content of mind wandering, future-oriented mind wandering is thought to be goal-directed (Baird et al., 2011). That is, autobiographical planning (i.e., future planning that is in line with personal goals) entails much of prospective mind wandering. In contrast, this does not seem to be true for off-task thought that is oriented towards the past (Baird et al., 2011). Converging evidence comes from studies showing that one can induce prospective mind wandering with a brief period of self-reflection (Smallwood, Schooler, Turk, Cunningham, Burns, & Macrae, 2011). Importantly, in line with these findings, autobiographical memory is thought to significantly contribute to the content of future-oriented mind wandering (Baird et al., 2011).

Before concluding the discussion on the content of off-task thoughts, it is important to recognize that mind wandering may come in the form of images or words, paralleling the distinction between imagery and inner speech (Gorgolewski et al., 2014). Notably, both past and future-oriented thought was significantly associated with thinking in the form of words and

images, although thoughts directed toward the future were more associated with ‘verbal thoughts’ relative to thoughts directed toward the past (Gorgolewski et al., 2014, p. 8). Moreover, self-generated thoughts can vary in their specificity, with older age linked to the experience of more specific thoughts (Gorgolewski et al., 2014). Vague thoughts, in comparison, were associated with the experiencing of negative thoughts.

In summary, the content of mind wandering can be conceptualized along two main dimensions – temporal orientation (e.g., past-, present-, future- focused), and valence (e.g., positive or negative; Gorgolewski et al., 2014; Smallwood & Schooler, 2015). Further, it can take the form of visual and verbal thoughts, and varies in its specificity (e.g., vague or specific; Gorgolewski, et al., 2014). Much of the research on mind wandering conducted to date, however has not included explicit differentiation across these dimensions. This reflects an important focus for future work.

### **Defining Mind Wandering as a Trait**

The proclivity to experience mind wandering episodes has been described by some as stable character trait (Callard et al., 2013; Diaz et al., 2014; McVay et al., 2009). That is, although there are contextual variables that influence the likelihood that mind wandering will occur, such as boredom, mood, and sleepiness, there are thought to be individual differences in the tendency to mind wander (McVay et al., 2009, Unsworth, McMillan, Brewer, & Spillers, 2012). In other words, “whatever variables, aside from WMC [working memory capacity], contribute to high levels of mind wandering during laboratory tasks (e.g., personality, emotion, psychopathology, goals, recent life events), they assert their influence very broadly across people’s everyday lives and activities” (McVay et al., 2009, p. 861). Support for this claim comes from both our theoretical understanding of mind wandering, as well as empirical findings.

Gambria (1995) suggested that spontaneous mind wandering might reflect underlying individual differences in the length of interval until the next involuntary shift of attention (i.e., “natural rhythm of our information processing biological apparatus”, p. 2). He thus implied that: 1) eventually these involuntary shifts in attention are unavoidable, and 2) individuals with shorter intervals are more likely to experience mind wandering. Notably, he explained that what influences the length of the interval may depend on both endogenous (e.g., biological variability) and exogenous (e.g., environmental context) influences. In line with this hypothesis, thought-probe estimates of task-unrelated thought were shown to be consistent across different test points, suggesting that individual variability in mind wandering is consistent across retest conditions (Giambra, 1995; McVay & Kane, 2010).

The trait-like nature of mind wandering can also be understood with reference to the executive-attention theory of working memory capacity (McVay & Kane, 2010). According to this theory, unwanted mind wandering periods reflect lapses in executive control, specifically errors in goal maintenance (Kane et al., 2007; McVay & Kane, 2009; although see Smallwood & Schooler, 2006 for an alternative theory of mind wandering, the decoupling hypothesis). Correspondingly, differences in spontaneous mind wandering frequency are suggested to reflect individual differences in executive control that are stable within the individual (Baird et al., 2011; Kane et al., 2007; McVay et al., 2009; Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013). Importantly, in this context, executive attention is often assessed with measures of working memory capacity, such as complex span tasks (McVay & Kane, 2010). In line with this reasoning, Kane and colleagues (2007) present findings showing that during tasks requiring concentration and substantial effort, those with lower working memory capacity (as estimated based on performance on complex span tasks) experienced more mind wandering; suggesting a

greater inability to “sustain goal-directed thought and behaviour in the face of competition from environmental and mental events” (p. 620). Relatedly, participants with higher working memory capacity were shown to experience a greater amount of future-oriented task unrelated thought, although no significant relationship was found between performance on a working memory task and the general propensity to engage in mind wandering (Baird et al., 2011). It should be noted, however, this relationship is context-dependent, and understanding the consequences and benefits of mind wandering requires consideration of the environment demands (Baird et al., 2011; Smallwood, 2013). Further, a firm causal relationship between mind wandering and executive control has not yet been established. Smallwood & Schooler (2015) describe that it is “unclear whether low executive control causes greater mind wandering, or greater mind wandering during span tasks [measure of working memory] causes lower estimates of control” (p.492).

In another recently proposed theory of mind wandering, Thomson and colleagues (2015) explain mind wandering with reference to the distribution of attention to an event. Specifically they hypothesize that differences in how frequently individuals mind wander may reflect the degree to which they allocate attention to a single event, such that greater mind wandering is associated with a propensity to not exclusively allocate attention to one thing in the external world. Again, inherent in their theory is the assumption that there exist differences in mind wandering at the trait-level.

Finally, further support for the idea that there exist trait-like individual differences in the tendency to mind wander, comes from results showing that those who demonstrate higher prevalence of task-unrelated-thought in a laboratory experimental task, report experiencing a greater number of off-task thoughts in everyday life as measured using experience-sampling

methodology (McVay et al., 2009). Reliable individual differences in mind wandering are also observed across different laboratory tasks and after significant time delays (McVay et al., 2009; McVay & Kane, 2010). Finally, rates of task unrelated thought have been linked to other individual difference factors (McVay & Kane, 2010). For example, individuals who were diagnosed with attention-deficit/hyperactivity disorder (ADHD) in childhood were shown to have more spontaneous task-unrelated thoughts (Shaw & Giambra, 1993).

### **Factors Associated with Mind Wandering**

As described above, there is growing recognition that there exist individual differences in the propensity to engage in off-task thinking. Some of these differences have been attributed to individual characteristics of the person. For example, age has been identified as a factor predicting the propensity to mind wander (McVay, Meier, Touron, & Kane, 2013). Counter to the evidence of age-related decline in cognitive functioning, including decrease in working memory capacity, increasing age has been associated with a decrease in mind wandering (McVay et al., 2013; see Einstein & McDaniel, 1997 for alternate findings which suggest no differences in mind wandering rates across the lifespan). This finding has been demonstrated using retrospective questionnaires given following a laboratory task (Giambra, 1989), as well as, using thought probes delivered intermittingly during laboratory tasks (McVay et al., 2013). Notably, this decrease in mind wandering with increasing age does not necessarily correspond to age differences in task accuracy. Furthermore, despite a decrease in mind wandering, older adults tend to experience greater task related interference (McVay et al., 2013). Moreover, this finding may be confounded by interest in the experimental task, because age differences in mind wandering rate were eliminated on a reading comprehension task when interest in the text was taken into account (Krawietz et al., 2012). Finally, the idea that older adults have fewer current

concerns has been suggested as a possible explanation of why they experience fewer self-generated task-unrelated thoughts (McVay & Kane, 2010). In contrast to the findings for age, gender differences in mind wandering have received little attention, and when evaluated have revealed no stable gender differences (Diaz et al., 2014).

Differences in cognitive ability have traditionally been linked to differences in everyday functional behaviour, including the experience of mind wandering (Kane et al., 2007). As alluded to above, working memory capacity is considered an important moderator of the relationship between task difficulty and the experience of mind wandering (Kane et al., 2007). Relatedly, individual differences in distractibility have also been linked to the propensity to experience mind wandering (Forster & Lavie, 2014). Using behavioural indices of distractibility, Forster and Lavie (2014) show that the tendency to mind wander is positively associated with susceptibility to external distractors, although they are not more susceptible to distractors that are task relevant.

Mind wandering has also been linked to differences in fidgeting, a behavioural index of waning attention (Carriere et al., 2013). Carriere and colleagues (2013) reveal evidence for a positive association between the tendency to experience spontaneous mind wandering and the propensity to display fidgeting behaviour, as demonstrated using questionnaire data. Importantly, this relationship did not hold true for deliberate mind wandering, which conceptually may be more akin to daydreaming.

The relationship between personality variables and mind wandering has not received much research attention. In attempting to explain the temporal stability of their measure of mind wandering, the Amsterdam Resting-State Questionnaire (ARSQ), Diaz and colleagues (2014) examined personality effects using the Cloninger's Temperament and Character Inventory.

Although they could not explain much of the variance in the factors of the ARSQ, they did report that Self-Directedness, a character trait associated with adaptivity to change and self-regulation, was significantly correlated with many of the factors of the measure. Further research is needed to disentangle the contribution of personality variables in explaining trait-levels of mind wandering.

Finally, mind wandering has also been associated with clinical presentations, including schizophrenia symptoms (Shin, Lee, Jung, Kim, Jang, & Kwon, 2015), depressive symptoms (Hoffmann, Banzhaf, Kanske, BERPohl, & Singer, 2016), and ADHD symptoms (Franklin et al., 2014; Shaw & Giambra, 1993). Whereas a problem with attention is a common symptom across different psychiatric disorders, our understanding of how the propensity to experience mind wandering may be altered in various clinical groups is deficient, and is likely to vary based on the clinical condition. For example, the higher prevalence of mind wandering among individuals diagnosed with major depressive disorder is hypothesized to be linked to the increased propensity for pathological rumination and worry in this group (Hoffmann et al., 2016), whereas the relation between mind wandering and schizophrenia has been attributed to the functional connectivity of neural regions, including increased activity of the default mode network, and decreased activities in the frontoparietal network and salience networks (Shin et al., 2015). As such, future work is needed to tease apart the unique contribution of clinical symptoms in predicting mind wandering frequency.

### **Measuring Mind Wandering**

The scientific study of mind wandering is complicated by the difficulty in accurately measuring its occurrence and observing its resulting consequences (Smallwood & Schooler, 2015). The spontaneous nature of mind wandering makes the direct manipulation of mind

wandering unfeasible, and thus complicates the examination of causal relationships. Relatedly, given the internal manifestation of mind wandering and the difficulty in observing its resulting consequences, much of what is known about mind wandering is dependent on the accurate and unbiased recall and representation of the experience by the participant (Schooler & Schreiber, 2004; Smallwood & Schooler, 2015). In addition to the difficulties inherent with gathering and interpreting data collected via introspection, a further concern is that by querying/questioning the researcher may unintentionally alter the mind wandering experience (Smallwood & Schooler, 2006). For example, one may increase the frequency of mind wandering episodes by asking the research participant to monitor the occurrence of task-unrelated thought, as has been demonstrated in thought suppression studies (Baird, Smallwood, Fishman, Mrazek, & Schooler, 2013). Notably, however, there is some evidence to suggest this concern may not be warranted (McVay & Kane, 2010; Smallwood & Schooler, 2006).

These challenges in the study of mind wandering have been in some ways overcome with the application of existing knowledge on mind wandering and the utilization of different techniques. For instance, although it is not possible to directly manipulate mind wandering, it is possible to increase the likelihood that it will occur by manipulating the environmental conditions (Smallwood & Schooler, 2015). This has been evidenced by experimentally inducing states of unhappiness, craving, and alcohol intoxication or modifying the motivation to engage with the laboratory paradigm (Sayette, Reichle & Schooler, 2009; Sayette, Schooler, & Reichle, 2010; Smallwood & O'Connor, 2011; Smallwood & Schooler, 2015). Similarly, by varying the cognitive load and/or perceptual input of an experimental task, one may be able to manipulate the likelihood that mind wandering will occur (Smallwood & Schooler, 2015). Finally, utilization of objective measures that have been associated with mind wandering, such as

electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and measurement of pupil dilation, have been utilized to corroborate subjective measurements of mind wandering, and may one day be used in isolation to evaluate the presence of mind wandering without the need to disturb participants (Barron et al., 2011; Franklin, Broadway, Mrazek, Smallwood & Schooler, 2013; Smallwood & Schooler, 2015).

Self-report measures have been an invaluable tool in our understanding of mind wandering, and although likely unfeasible, the ideal self-report would produce an accurate report of the onset and termination of a mind wandering episode (Giambria, 1995). In addition to the commonly cited draw-backs of self-report measures, including but not limited to recall bias and social desirability, self-report is further problematic in the assessment of mind wandering because asking a person to reflect if they are mind wandering leads to the end of that mind wandering episode (Giambria, 1995). Similarly, as mentioned above, measures that rely on introspection may inadvertently alter the mind wandering episode (Schooler & Schreiber, 2004; Smallwood & Schooler, 2015). Finally, measures which require retrospective recall, such as thought listing, may be negatively affected by recall bias and/or accurate awareness (Smallwood & Schooler, 2006).

That said several questionnaires have been developed to help evaluate trait levels of mind wandering. Their utility relies on the premise that there exist individual differences in mind wandering (Mrazek, Phillips, et al., 2013). Although there is growing acknowledgment of individual differences in mind wandering (McVay & Kane, 2010; Mrazek, Smallwood, et al., 2012) scale development has been slow to follow. Paralleling the disjointed use of terminology to label task-unrelated thought, as well as the interchangeable use of related but distinguishable constructs to refer to the experience of mind wandering, different scales have been used to

evaluate trait levels of mind wandering (Mrazek, Phillips, et al., 2013). Examples include the use of the daydream subscale of the Imaginal Process Inventory (also referred to as the Daydream Frequency Scale; Giambra, 1995), the Attention Related Cognitive Errors Scale (Cheyne et al., 2006) and the Mindful Attention and Awareness Scale (Brown & Ryan, 2003). As reflected in the titles of these measures, these scales lack face validity in directly measuring mind wandering, and measure related constructs such as daydreaming, everyday failures in attention, and mindfulness (Mrazek, Phillips, et al., 2013). More recently, several questionnaires have been developed with the aim of more directly assessing mind wandering frequency. These include the Mind Wandering – Deliberate and Spontaneous Scales (Carriere et al., 2013), the Mind Wandering Questionnaire (Mrazek, Phillips, et al., 2013), the Amsterdam Resting-State Questionnaire (Diaz et al., 2013), and the Mind Excessively Wandering Scale (Mowlem et al., 2016). It is important to note that the use of scales is subject to the same limitations as other self-report measures described above, and level of introspection (Schooler & Schreiber, 2004; Smallwood & Schooler, 2015). Nevertheless, they represent a convenient and indispensable way to assess mind wandering frequency. Further, convergent validity with other measures of mind wandering, such as probe-caught mind wandering during laboratory tasks (Mrazek et al., 2013), provides valuable evidence in support of the utility and validity of self-report in the measurement of mind wandering (Schooler & Schreiber, 2004). Finally, Randall and colleagues (2014) show that thought probes are “no more effective than are scales designed to catch retrospective reports of directed-thought” (p. 1425).

Mind wandering research has benefited extensively from laboratory methods, primarily the use of thought probes (Smallwood & Schooler, 2006). Typically, during an experimental task, individuals are asked to evaluate whether they were mind wandering at different points of

the task (Smallwood & Schooler, 2006). This may occur by interrupting the participant during the task to ask them to report on their inner experience (known as probe-caught mind wandering) or by asking the participant to self-monitor and report when they experience a mind wandering episode (known as self-caught mind wandering; Smallwood & Schooler, 2006). Importantly, self-caught mind wandering relies on meta-awareness, and thus this type of thought probe may be useful in providing an estimate of how well individuals can detect mind wandering when paired with probe-caught estimates (Schooler et al., 2011; Smallwood & Schooler, 2015). Probe-caught mind wandering, on the other hand, does not rely as heavily on self-monitoring and can be further differentiated based on who determines whether the task is on or off-task. More specifically, in one type, participants are first informed on how to recognize mind wandering, after which, while performing an experimental task they are interrupted at regular intervals and asked if their thoughts were on task or off-task during that period (referred to as self-classification probe method; e.g., Giambra, 1995). In contrast, in the experimenter-classified probe method participants are not asked to classify their thoughts but are asked to report what they are thinking right before the unpredictable probe; responses which will later be categorized by the experimenter (Smallwood, Obonsawin, & Reid, 2003; Smallwood & Schooler, 2006). Notably, “both sampling methods produce good estimates of mind wandering frequency” (p. 947).

Similar to the thought probes that occur during an experimental task, ecologically valid estimates of mind wandering frequency have been collected using experience-sampling procedures. For this methodology, electronic devices, primarily pagers or palm pilots, are used to collect probe-caught episodes of mind wandering in the participant’s everyday life (Killingsworth, & Gilbert, 2010; Smallwood & Schooler, 2006). These probes may be delivered

following random or quasi-random timing, with longer intervals between probes being associated with greater report of mind wandering (Smallwood & Schooler, 2015). When alerted by the probe the participant is asked to answer questions about their thoughts and related factors (e.g., current context and mood), typically by responding to a dichotomous question (e.g., Had your thoughts wandered from the activity? Yes/No) or by selecting from several options (e.g., thoughts were off-task and thinking about something positive; Killingsworth & Gilbert, 2010; McVay et al., 2009). Importantly, this methodology has several advantages including the ability to assess the content of interest in real-time, avoiding difficulties with retrospective bias or inaccurate completion of daily diaries (e.g., when participants forget to do the diary one day and complete it retrospectively; Moskowitz & Young, 2006; Stone & Shiffman, 2002). Relatedly, the experimenter is able to examine the phenomenon in the natural environment of the participant. In contrast, a noteworthy disadvantage is that this type of methodology is considered to be more time consuming and thus increases the participant's research burden (Moskowitz & Young, 2006). Further, given that the data is collected in the absence of the experimenter, it can be difficult to confirm the accuracy of the data, a caveat applicable to most self-report data (Moskowitz & Young, 2006). An additional concern is that EMA methodology may induce reactivity (Lukasiewicz et al., 2007).

As mentioned above, several physiological techniques, including measures of pupil dilation and eye movement have been implemented as objective indices of mind wandering (Smallwood & Schooler, 2015). These measures may be applied along side subjective measures (described above) with the aim of corroborating introspections (i.e., self-report) with the underlying experience (Schooler & Schreiber, 2004). Similarly, fMRI and EEG recordings taken during the rest-state have been used to inform on the neural underpinnings of self-generated

thought (Diaz et al., 2013). Further, examination of the thoughts and feelings experienced during the resting-state have been used to develop questionnaires aimed at quantifying this experience (e.g., Amsterdam Resting-State Questionnaire), as well as to help inform the content of mind wandering thoughts (Diaz et al., 2013). Importantly, physiological measures accompanying self-caught reports of mind wandering need to be interpreted with caution, because the accompanying change in activity temporally linked with the self-report of mind wandering (e.g., as reflected in EEG recordings) may correspond to the recognition that the person was mind wandering and now must redirect their focus, rather than corresponding to the state accompanying mind wandering (Smallwood & Schooler, 2006).

In conclusion, although the subjective experience of mind wandering presents a challenge for empirical study several measures and techniques have been developed to accurately capture this cognitive phenomenon. Taking into consideration the strengths and weaknesses of each methodology, there is growing recognition that use of triangulation is encouraged (Schooler & Schreiber, 2004). Triangulation refers to the implementation of multiple different approaches (e.g., methods, theories) to address a research question, with the aim of increasing reliability of the findings (Heale & Forbes, 2013). Correspondingly, research showing that different methodologies yield parallel findings across different settings provides support for the validity of the mind wandering construct (Randall et al., 2014).

### **Theories of Mind Wandering**

Although there is some agreement on the definition of mind wandering, the reasons why and how mind wandering occurs continue to be debated issues. This includes the role of executive processes in the initiation and maintenance of off-task thought. Notably, it is important to recognize that a comprehensive theory of mind wandering should attempt to explain

two key components: 1) what factors contribute to an attentional shift away from a state of external focus to self-generated thought (and vice versa); and 2) how is attention to external or internal targets maintained (Smallwood, 2013). This effort is complicated by the spontaneous nature of mind wandering, the lack of direct experimental control over the phenomenon, and the imprecise estimate of when the mind wandering episode began (Smallwood, 2013). For example, the difficulty in determining when a mind wandering episode began makes it challenging to provide an accurate estimate of the frequency of shifts from on-task to off-task thought and the length of each externally and internally focused state (Smallwood, 2013).

**Current concerns hypothesis.** The current concerns hypothesis was first proposed by Klinger and colleagues (1973 as cited in Smallwood, 2013) and relies on the assumption that the mind is attracted to the most salient stimuli. As such, according to this hypothesis mind wandering will occur because the weaker salience of external stimuli causes the mind to focus inward, on self-generated thought that is focused on the personal goals and interests of the individual (Smallwood, 2013). In other words, “mind wandering occurs more frequently when self-generated thought has higher incentive value than incoming perceptual information” (Smallwood, 2013, p. 523). Notably, the idea that current concerns play an important role in understanding mind wandering is not unique to this hypothesis, and has been incorporated in other models of mind wandering (e.g., McVay & Kane, 2010; Smallwood & Schooler, 2006).

The three next hypotheses rely on an understanding of executive control, and therefore this construct is worth defining. Executive control is commonly conceptualized as the capacity to regulate one’s attentional control, including directing attention and recovering from lapses in focus (Randall et al., 2014). Given that in mind wandering one’s task-related thoughts are disrupted by task-unrelated thoughts, executive control theory has been used in understanding

mind wandering, with a failure in executive control being considered the culprit leading to mind wandering episodes (Randall et al., 2014). Theories that rely heavily on the theory of executive control often examine how differences in working memory capacity are associated with attention tasks that rely on controlled processes (Randall et al., 2014).

**Decoupling hypothesis.** The decoupling hypothesis rests on two key ideas: 1) internal, self-generated mental activity is distinct from externally stimulated mentation, and 2) the same mental processes, primarily those that are domain general (e.g., executive control) are shared by both types of thought (Smallwood, 2013). As such, mind wandering reflects a redistribution of attention from an external task to internal, self-generated thought, because both types of thought (i.e., external task focused thought and self-generated internal thought) vies for attentional focus (Randall et al., 2014). In other words, mind wandering reflects a shift in executive resources away from a task that would originally be allocated to the task (Smallwood & Schooler, 2006). Correspondingly, it is thought to lead to poor performance only on tasks that require controlled processing and meta-awareness because mind wandering requires limited resources (e.g., not enough resources available for monitoring; McVay & Kane, 2010; Smallwood & Schooler, 2006). This may seem puzzling given that mind wandering often occurs unintentionally, but is explained by Smallwood and Schooler with the idea that “mind wandering can occur against our best intentions because the automatic activation of a personally relevant, but task-unrelated, goal has temporarily drawn our attention away from the primary task” (Smallwood & Schooler, 2010, p.953).

According to this hypothesis, these common mental processes that coordinate both internal and external generated thought, such as executive control, do not determine whether mind wandering occurs, but rather play a role in the maintenance of mind wandering following a

priming episode (Smallwood & Schooler, 2006; Smallwood, 2013). Interestingly, this idea that executive control plays a role in sustaining a mind wandering state is controversial and has been pitted against mind wandering theories that argue that mind wandering represents a mental state that does not involve these processes (see below; McVay & Kane, 2010; Randall et al., 2014).

Support for the conceptualization of mind wandering as reflecting a decoupling of attention from an ongoing task has come from electroencephalogram (EEG) derived event-related potentials (ERPs; Smallwood & Schooler, 2015). Specifically, Barron and colleagues (2011) examined the amplitude of the ERPs referred to as P3a (an ERP that is associated with the processing of distractor information) and P3b (an ERP associated when attention is focused to a task). In support of the decoupling hypothesis, those who engaged frequently in mind wandering during a task, as measured using a retrospective measure of mind wandering (i.e., Dundee Stress State Questionnaire) had smaller amplitudes on both ERPs than those who demonstrated high task focus, showing reduced orienting to and processing of both task and distractor information. Notably, this finding is in line with the ERP findings of Smallwood and colleagues (2008), who report decrease attention to the environment with mind wandering.

Further support for the decoupling hypothesis comes from research examining the association between aging and mind wandering propensity. As would be predicted by this account of mind wandering, older adults were less likely to mind wander compared to younger adults, because their smaller working memory capacity would not have residual attentional resources available to allocate to mind wandering (Krawietz et al., 2012). This finding is in contrast to that predicted by the executive control account which would suggest older adults would show an increase in mind wandering compared to their younger counterparts because of their smaller working memory capacity (Krawietz et al., 2012).

**Executive failure hypothesis.** The executive failure hypothesis suggests that mind wandering stems from a failure in attention or executive control that is needed to sustain attention on a task, and thus is conceptualized as a form of distraction (McVay & Kane, 2010; Randall et al., 2014). In other words, according to McVay and Kane (2010), “mind wandering reflects a failure of the executive-control system to adequately combat interfering thoughts that are generated and maintained automatically (i.e., unintentionally and without consuming executive resources but potentially controllable)” (p. 189). Thus, the executive failure hypothesis posits executive control is used to thwart the occurrence of mind wandering, both proactively (linked to dorsolateral prefrontal cortex activity) and reactively (linked to anterior cingulate cortex activity; McVay & Kane, 2010). Further, under this hypothesis, higher-order goal related thoughts (e.g., getting into graduate school), that comprise an abstract level of construal, are considered the “default mode of processing” (McVay & Kane, 2010, p. 190). This abstract level of construal is suggested to activate many other related concepts leading to a greater number of off-task thoughts, which in turn increases the likelihood of an occurrence of mind wandering (McVay & Kane, 2010). It should also be noted that this perspective on mind wandering is also labeled as the Control Failure x Concerns hypothesis (McVay & Kane, 2010).

In contrast to the decoupling hypothesis, this framework does not assume that task-unrelated thought uses domain-general processes but rather implies that resources are not needed to shift attention to off-task thought or to sustain the mind wandering episode (Smallwood, 2013; McVay & Kane, 2010). Importantly, both hypotheses incorporate the role of an individual’s current concerns and goals in understanding mind wandering (aligned with Klinger’s current concerns theory). In fact, McVay and Kane (2010) note that understanding how individuals differ in mind wandering requires consideration of 1) executive control, 2) existence and

importance of current concerns/goals (stemming from default network activity described below), and 3) likelihood that said concerns will be triggered by the environmental cues.

Evidence for this hypothesis stems from work examining how between and within individual differences in executive control are associated with mind wandering frequency, as well as the impact of contextual variables such as fatigue and alcohol use. For example, individuals with high working memory capacity, commonly used as a proxy for executive control ability, demonstrate less frequent occurrence of mind wandering; which is counter to what is predicted if mind wandering require executive resources. Similarly, mind wandering frequency has been shown to increase with fatigue (Smallwood et al., 2004; McVay & Kane, 2009) and alcohol use (Sayette et al., 2009), yet this is counter to what would be predicted if executive resources (which diminish with fatigue and alcohol intoxication) are needed for mind wandering. In contrast, McVay and Kane (2010) argue that these empirical findings are in line with what is predicted if mind wandering is the result of executive control failure. Further, proponents of this hypothesis suggest that evidence used to support the claim of Smallwood and Schooler (2006), can be reinterpreted. For instance, the decrease in mind wandering noted on demanding tasks was explained as due to division of limited executive resources, but according to McVay and Kane (2010) can instead be explained as occurring due to more top-down processes associated with executive functioning preventing the onset of off-task thought (noting that under this conceptualization, demanding tasks elicit greater executive control).

The default network, described in greater detail below, has also been incorporated by this account of mind wandering (Randall et al., 2014). More specifically, McVay and Kane (2010) propose that the “basic function of the default network is to continuously evaluate life goals and discrepancies and that it automatically generates the content of mind wandering episodes” (p.

193). In line with this thinking, the default network is suggested to integrate novel information and set predictions that guide thoughts and behaviour that are consistent with higher-order goals. This is consistent with the proposed role of the default network in self-projection (Buckner & Carroll, 2007, McVay and Kane, 2010). Importantly, they do not argue that default network activity is synonymous with mind wandering, but rather that “bottom-up, environmentally cued processes of the default network continue without conscious direction, automatically generating thoughts that sometimes enter awareness as mind wandering episodes” (McVay & Kane, 2010, p.194).

**Meta-awareness hypothesis.** As reflected in the name, the meta-awareness hypothesis rests on the importance of self-monitoring in recognizing when one’s thoughts have drifted off-task and correcting this shift in attention (Smallwood, 2013; Randall et al., 2014). Further, those with greater awareness of their mentation are thought to have better control and regulation of their attention, decreasing the likelihood of experience mind wandering episodes. Thus, the extent of meta-awareness plays an important role in determining if mind wandering will occur (Smallwood, 2013).

**Reconciling the theories.** Utilizing a process-occurrence framework, Smallwood (2013) argues that a “meaningful dissociation” between the four hypotheses can be established by differentiating whether they explain why the onset of mind wandering occurs, or how it is maintained. Although recognizing the differences between the hypotheses, he suggests that all but the decoupling hypothesis address the *why* question, whereas the decoupling hypothesis attempts to explain the *how* question (Smallwood, 2013; Randall et al., 2014). In other words, whereas the current concerns hypothesis, the executive failure hypothesis and the meta-awareness hypothesis all attempt to explain why task unrelated thought was initiated or later

regulated, the decoupling hypothesis attempts to explain how mind wandering is maintained (Smallwood, 2013). The implication of this is that the different hypotheses (especially the decoupling and executive failure hypotheses) instead of providing conflicting accounts of mind wandering can be reconciled by recognizing they address different aspects of mind wandering. Further, it is important to remember that although the hypotheses may suggest different predictions for the same aspect of mind wandering, they may later be proven to be complementary (Smallwood, 2013).

In addition to the reframing suggested above, recent efforts have also been made to incorporate existing knowledge on resource allocation into theories of mind wandering with the aim of helping understand how contextual variables, such as task complexity, influence the relationship between resource availability, task-related and task-unrelated thought, and performance on a task (Randall et al., 2014). By extension, it is suggested that such a theoretic framework may supplement our understanding of when mind wandering is most likely to occur and when it will be most detrimental. In fact, Randall and colleagues (2014) demonstrated the utility of integrating the existing accounts of mind wandering with executive control theory and resource theories by showing using a meta-analysis that they were able to obtain a more nuanced understanding of mind wandering. They specifically reported that for mind wandering that occurs during a primary task: 1) individuals with greater amount of resources are less likely to experience mind wandering episodes; 2) task performance is negatively impacted by the occurrence of off-task thought; and 3) task complexity and task length are important factors to consider. Further, they showed evidence in support of the idea that working memory capacity is associated with mind wandering (i.e., lower working memory capacity associated with increased mind wandering; Randall et al., 2014); thus showing support for McVay and Kane (2010)

executive failure hypothesis, although it does not go against the other hypotheses either (Randall et al., 2014). In fact, competing hypotheses may be reconciled by considering the influence of context (a factor suggested by resource allocation theory).

### **Neurological Underpinning of Mind Wandering**

Over the last decade there has been growing recognition that some regions of the brain become more active as individuals' thoughts become less constrained by external stimuli (Christoff et al., 2009, Mason et al., 2007). These regions include the medial prefrontal cortex, the posterior cingulate cortex/precuneus region, the inferior parietal and the lateral temporal cortices; together referred to as the “default network” (Christoff et al., 2009; Gruberger, Ben-Simon, Levkovitz, Zangen, & Hendler, 2011). The temporal relationship between the activation of these regions and the report of the occurrence of mind wandering episodes during low-demand tasks has provided support, albeit indirect, for the association of these regions with mind wandering activity (Christoff et al., 2009). Further, the decrease activity of this region during cognitively taxing activities inferred its importance during off-task thought (Gruberger et al., 2011). Yet, due to the lack of direct manipulation of mind wandering episodes, and the utilization of retrospective self-report measures of mind wandering following imaging, the conclusion that the default network is involved during mind wandering has been challenged (Gilbert, Dumontheil, Simons, & Burgess, 2007). For example, these authors suggest that activity in this area may instead reflect increased vigilance and scanning of the environment (Gilbert et al., 2007).

Christoff et al. (2009) provided more direct empirical evidence for the involvement of the default network during mind wandering. Using experience sampling conducted during fMRI scanning they confirmed previous findings showing that neuroanatomical areas associated with

the default mode network (e.g., medial prefrontal cortex) were recruited during mind wandering. Further, as predicted, they showed that the executive network region (e.g., dorsal anterior cingulate cortex and the dorsolateral prefrontal cortex) was also active during mind wandering periods, and that greater activation in these regions is noted when individuals are not aware that their thoughts have become off-task (i.e., when individuals lack meta-awareness). This dual activity of the executive system and default network was hypothesized to be beneficial because it allows for multiple brain areas to be active simultaneously, such that executive functioning can occur without interfering with the positive outcomes that may follow mind wandering, such as creativity. Notably, although these findings support the idea that executive resources are needed for mind wandering, McVay and Kane (2010) suggest an alternative interpretation. They stress the importance of understanding the role of awareness in triggering executive control, and of teasing apart how neural activity differs during task unrelated activity versus during rest. They also use empirical evidence showing decreased activation in the areas responsible for attention-control during attentional lapses to support their argument that executive control is needed to prevent task unrelated thoughts from gaining consciousness (McVay & Kane, 2010). Future research is needed to elucidate the relationship between these neural structures and the onset and maintenance of mind wandering.

There is no doubt that research on mind wandering has been facilitated by the discovery and subsequent research on the default mode network (Callard et al., 2013). Yet, although the close link between the two constructs has promoted research on the other, it may have had an unintended consequence. For instance, it has been argued that conceptualization of mind wandering as stimulus/environment independent thought in contrast to thoughts that are goal related may have led to it being associated with the neural network active in the absence of direct

activity (Callard et al., 2012). Relatedly, this conceptualization may have led to a likely oversimplified understanding suggesting a one-to-one relationship between mind wandering and the default mode network, ignoring the complexity in the neural activity associated with various aspects of self-generated mental activity (Callard et al., 2013). For an example, interest in differentiating between mind wandering that is temporally oriented toward the past from those oriented toward the future, has led to hypothesized differences in the involvement of certain neural regions (Baird et al., 2011).

### **Costs and Benefits to Mind Wandering**

Before examining the advantages and disadvantage of mind wandering, it is important to remember that the consequences of mind wandering need to be understood by taking into account the importance of context and environmental demands (Smallwood & Andrews-Hanna, 2013). Further research is needed to clarify this relationship, and to recognize the limitations in generalizing findings from studies to other contexts (Smallwood & Andrews-Hanna, 2013).

Over the past decade, the examination of the negative consequences of mind wandering has been the focus of research (Smallwood & Schooler, 2015). More recently, however, the benefits of mind wandering have started to be recognized. The fact that the proclivity of the mind to wander is universal suggests that this attentional state must yield some benefit (Smallwood & Schooler, 2015). Notably, whether mind wandering is more costly or beneficial is likely context- and content-dependent (Smallwood & Schooler, 2015). The following discussion will highlight our existing knowledge on the costs and benefits of mind wandering.

**Costs.** The costs of mind wandering have been noted on several estimates of cognitive ability, including on measures of sustained attention, working memory and general intelligence.

Performance on measures of sustained attention, such as the Sustained Attention to Response Task, is compromised during mind wandering episodes, as reflected in greater number of errors (e.g., commissions errors, omission errors, and reaction time variability; Mooneyham & Schooler, 2013). Relatedly, these errors are correlated with scores on self-report measures of mind wandering, and have correspondingly been used to identify mind wandering episodes (Mooneyham & Schooler, 2013). Although as described above, the role of working memory on mind wandering is contentious, mind wandering has been shown to impair performance on working memory tests (e.g., reading span task; Mrazek, Smallwood, Franklin et al., 2012). Similarly, performance on measures of general aptitude/intelligence is negatively impacted by episodes of mind wandering that occur during test performance (Mrazek, Smallwood, Franklin et al., 2012). Interestingly, mind wandering rates during general intelligence testing were associated with retrospective SAT scores (Mrazek, Smallwood, Franklin et al., 2012). Thus, it is important to consider how mind wandering episodes during test performance can hinder accurate estimates of cognitive ability (Smallwood & Andrews-Hanna, 2013).

Mind wandering often happens automatically and without intention or cognitive awareness that one has started to engage in non-task related thought (Mooneyham & Schooler, 2013). This can be detrimental when it occurs during a task, and consequently has frequently been linked to poor task performance, including on tasks that rely heavily on executive control (Smallwood & Schooler, 2015). As described in the opening paragraph of this chapter, mind wandering during reading has been associated with decreased comprehension (Franklin, Smallwood, & Schooler, 2011; McVay & Kane, 2012; Mooneyham & Schooler, 2013; Smallwood et al., 2008). Further, mind wandering has been shown to interfere with behaviours linked to reading, such as eye gaze duration (Reichle, Reinberg, & Schooler, 2010, Mooneyham

& Schooler, 2013) and vocal prosody when reading aloud (Franklin, Smallwood & Schooler, 2011, Mooneyham & Schooler, 2013).

In addition to impaired reading, mind wandering has been shown to compromise comprehension and memory of lecture/reading material increasing the risk for academic problems (Szpunar et al., 2013). As a result, the negative consequences of mind wandering have become a growing concern among employers and educators alike. In fact, some contend that these fluctuations in attention are an “under-recognized” hindrance on academic performance (Smallwood et al., 2007). Within the employment sector, mind wandering has been linked to productivity loss, wasted time, and poorer task performance (Hoogland, 2011). Notably, Randall and colleagues (2014) show that mind wandering has greater negative consequences for tasks that are more complex, demonstrating how detrimental mind wandering can be in demanding real-world tasks (e.g., air traffic control).

The decoupling of attention that is thought to occur during mind wandering can have even bigger consequences when it occurs during activities that require constant attention and monitoring, such as driving. An illustration of this comes from a study examining predictors of car crash responsibility (Galera et al., 2012). As was predicted, mind wandering just before the crash, the content of which was retrospectively described as highly distracting or disruptive by the drivers, was shown to be an independent predictor of crash responsibility. Importantly, this relationship held after controlling for common confounding variables, such as age, sex, time of day, location and type of vehicle. Further, common forms of external distraction, including sleep deprivation, alcohol or drug use, and negative mood were also linked to car crash responsibility. This study highlights that mind wandering during demanding tasks outside of the laboratory can have significant negative consequences, including impacting driver safety.

In addition to poor task performance, mind wandering has also been linked to emotional stress and negative mood (Killingsworth & Gilbert, 2010; Smallwood et al., 2009). Killingsworth and Gilbert (2010) showed by utilizing ecological momentary assessments that not only does mind wandering occur frequently, but individuals report feeling less happy when they mind wander, and having pleasant thoughts was not associated with better mood when compared with thoughts about ongoing activity. Further, they show that mind wandering is the cause of the negative mood and not linked to the content of the mind wandering. Interestingly, this relationship between mind wandering and negative mood may not be so simplistic. For instance, mind wandering episodes that are of high interest were linked to improvement in mood when compared to mood following on-task performance (Franklin, Mrazek et al., 2013). Finally, mind wandering thoughts with ruminative/perseverative properties have been linked to mood psychopathology, suggesting 1) the need to consider the role rumination plays in the relationship between mood and mind wandering, and 2) mind wandering may be most costly when it is cognitively inflexible (Ottaviani, Shapiro, & Couyoumdjian, 2013; Smallwood & Schooler, 2015).

**Benefits.** As mentioned above, despite the recognized negative consequences of mind wandering, there is growing understanding that mind wandering is associated with some positive functions. Not only does it provide respite during monotonous and repetitive task, reducing the likelihood of negative mood which often follows such activity, but it has also has been associated with the development of identity, emotion regulation, planning for the future and problem solving, among other benefits. Notably, investigation into the advantages of mind wandering has lagged, and only more recently been given attention by the research community (Mooneyham & Schooler, 2013).

It has been suggested that mind wandering may play a role in maintaining our sense of identity (Stawarczyk et al., 2011) and may help form memories about the self (Smallwood & Andrews-Hanna, 2013). Relatedly, it may facilitate the integration of one's experiences leading to the creation of one's life story (Smallwood & Schooler, 2015). This is important because by encouraging meaning mind wandering may promote well-being (Smallwood & Schooler, 2015).

As mentioned earlier mind wandering has been shown to have a prospective-bias, meaning that when mind wandering individuals tend to think about the future (Smallwood & Schooler, 2015). This aspect of mind wandering coupled with the fact that the content of mind wandering thoughts typically relate to the individual's current concerns suggests that mind wandering may help with planning and preparing (Mooneyham & Schooler, 2013). That is, mind wandering may be beneficial because it allows the person to spend time planning and anticipating the future. This anticipatory process has been referred to as autobiographical planning (Baird et al., 2011; Mooneyham & Schooler, 2013). Interestingly, a period of self reflection prior to the onset of an experimental task was shown to lead to an increase in future-oriented mind wandering, lending support to the idea that the autographical memory system is important for the anticipation of future events (Galera et al., 2012; Smallwood, Schooler, Turk et al., 2011). Relatedly, mind wandering has been associated with problem solving in interpersonal situation (Ruby, Smallwood, Sackur & Singer, 2013).

Similar to the advantages conferred by prospective thinking, mind wandering has also shown to be associated with beneficial decision-making. More specifically, mind wandering that occurs during undemanding tasks was associated with less extensive delay discounting (Smallwood, Ruby, & Singer, 2013). In other words, mind wandering during a non-challenging task was associated with greater patience and resistance against choosing an immediate reward

over a larger, delayed reward. Thus, there is growing awareness that mind wandering plays a role in personal goal maintenance (Smallwood, Ruby, et al., 2013; Smallwood & Schooler, 2006).

Anecdotal accounts have long hinted that there exists a link between mind wandering and creativity (Baird et al., 2012). Stories about many scientific discoveries, such as the discovery by Greek Philosopher Archimedes on how to measure the volume of an irregular shaped object (the Archimedes principle), suggest that engaging in task unrelated thought can be helpful in yielding solutions to previously unresolved problems (Baird et al., 2012). In fact, the well-established incubation effect, which refers to the benefit in creative problem solving which occurs following a break, lends further support for idea that there is an association between mind wandering and creativity (Sio & Ormerod, 2009). Correspondingly, Baird and colleagues (2012) show that for repeated-exposure problems, greater amounts of mind wandering which occur during an undemanding task leads to better performance on a creativity task. This is in comparison to doing a demanding task during a break, resting during the pause or not taking a break. In other words, the incubation effect was only observed when an undemanding task was done during the break, which facilitated the experience of mind wandering. Further, they suggest that there may exist individual differences in this relationship. A corroborating finding shows a similar benefit of mind wandering in social problem solving (Ruby, Smallwood, Sackur, et al., 2013).

In addition to these benefits, it has been argued that mind wandering may have other possible advantages. For example, mind wandering may allow for attentional cycling between streams of thought (e.g., processing sensory information, thinking about future events) allowing for multitasking and maintenance of several goals (Mooneyham & Schooler, 2013). Second, mind wandering may assist with learning by creating a break from the task enabling dishabituation, which in turn provides an opportunity for the person to return to the task with

renewed attention (Mooneyham & Schooler, 2013; Smallwood & Schooler, 2015). Third, mind wandering may provide relief from tedious and boring tasks, and may help decrease the perceived time spent on such tasks (Mooneyham & Schooler, 2013). Finally, some have suggested that the benefits of mind wandering may be analogous to dreaming, and facilitate preparedness for prospective hurdles or problems (Smallwood & Schooler, 2015).

In line with research highlighting the benefits of mind wandering, the high proportion of time spent mind wandering suggests that there are evolutionary benefits to mind wandering. Corballis (2013) proposes that mental time travel defined as the ability to think about past events and imagine future ones, is a key feature of mind wandering and may have played an important role in the evolution of language. He proposes that a greater capacity for mental time travel would have allowed for more reflection on the past and future-oriented planning, and the evolutionary benefit of being able to communicate this information to others would have played a role in language development. Mind wandering was also hypothesized to explain the generative property of language (i.e., that a finite number of elements can create an infinite number of outputs; Corballis, 2013). Of note, this theory is in contrast to the language development theories advocated by Chomsky and others that suggest the evolution of language occurred in a single step (Corballis, 2013). Supporting an evolutionary origin to mind wandering, the default mode network (i.e., the neural network associated with mind wandering) has been identified in different species, including rats (Lu et al., 2012) and other primates (Mantini et al., 2011).

### **Future Directions**

Despite being a universally experienced phenomenon, due to its subjective-nature mind wandering has proven to be challenging to investigate empirically. Although the limitations of introspection should not limit the study of these experiences, it is important to remember that the

“inscrutability [of empirical study] means that empirical investigations of subjective experience must necessarily be grounded in humility, cognizant that any account is open to alternative interpretations” (Schooler & Schreiber, 2004, p. 18). In fact, this multifaceted construct yields itself to interdisciplinary study, which in turn would be facilitated by the use of consistent terminology and conceptualizations (Callard et al., 2013). This interdisciplinary approach can help expand our understanding of the construct, including how and why mind wandering occurs, as well as integrate different theories to provide a more comprehensive understanding of this phenomenon (Callard et al., 2013; Smallwood, 2013).

The next three chapters outline the three independent studies that make up the dissertation document. The first study was designed to examine the utility of existing mind wandering measures in evaluating the frequency of mind wandering using ecological momentary assessment methodology in a non-clinical sample. The second study built on the first by utilizing the recently developed measures of mind wandering to examine the relationship between different symptom dimensions of ADHD and trait levels of mind wandering, as well as between symptoms of Sluggish Cognitive Tempo and mind wandering. The final study aimed to explore the relationship between mindfulness and mind wandering by examining the utility of an instructor-led mindfulness intervention in reducing mind wandering symptoms among teachers and parents of children with ADHD symptoms. Of note, each study was designed to serve as a semi-independent manuscript submission. As such, the reader should anticipate that the chapters will include some overlapping content.

## CHAPTER 2

### Study I

#### **Using ecological momentary assessments to evaluate extant measures of mind wandering**

Behavioural research has long relied on use of self-reports (Baldwin, 2000; Reis 2012). Yet, self-report data is often viewed as an inferior source of information due to the potential for measurement error and reporting bias (Baldwin, 2000). Notably, however, the reliability of the data is contingent on the clearness of the question (Baldwin, 2000). In fact, many of the limitations of self-report data (e.g., measurement error, consistency across data collection) are not unique to this type of research tool, and different types of self-report measures are not equally susceptible to these drawbacks. Further, this type of measurement can be an invaluable tool when examining phenomenon which cannot be independently measured, such as when studying introspective experiences (Baldwin, 2000; Reis 2012).

Self-report data is used to collect information about a range of subjective and objective topics, including but not limited to demographic variables, questions about attitudes and beliefs, and the frequency of specific behaviours (Stone & Shiffman, 2002). Self-report data can be collected using a variety of methods. Many times, individuals are asked to provide global or summary estimates on the construct of interest (e.g., Do you get stressed easily? How frequently do you find yourself stressed per week, on average?; Shiffman, Stone, & Hufford, 2008; Shiffman, 2009). Such questions require the participant to survey their memory for occasions in which the target construct occurred, and to provide a summary estimate in order to answer the question (Shiffman, 2009). Further, to answer the question, participants have to make a judgment on whether what they retrieved from memory matches what the question asks. This type of self-report is not only subject to the limitations of memory that accompany retrospective recall (Stone

& Shiffman, 2002), but also the “emphasis on global assessments can keep us from seeing and studying dynamic changes in behaviour over time and across situations, from appreciating how behaviour varies, and is governed, by context, and from understanding cascades of behaviour, or interactions with others or with our environments that play out a sequence of events over time”(Shiffman et al., 2008; p. 3).

Although retrospective questionnaire measures are most typically associated with self-report methodology, there is an increasing focus on methods—such as ecological momentary assessments (EMA) – which may better balance the strengths and drawbacks of self-report data collection. EMA is a broad term used to describe a data collection method that provides an opportunity for participants to report on the target symptoms or behaviours temporally close to when they occur, thus potentially reducing the drawbacks of retrospective recall (Shiffman, 2009; Stone & Shiffman, 2002). Further, these reports of immediate experience do not ask the participant to provide a summary estimate of the target behaviour; instead EMA data collected across time can be aggregated to provide a more accurate estimate (Shiffman et al., 2008; Stone & Shiffman, 2002). The data points can also be examined separately to evaluate change across time and environmental context for each participant (Shiffman et al., 2008), potentially revealing relationships that are not apparent when incorporating only self-report measures that assess global estimates (e.g., Kamarck et al., 2007); although reverse findings have also been reported (e.g., Oishi & Sullivan, 2006). Notably, it has been suggested that EMA data may be even more valuable when one is interested in identifying within-person differences (i.e., ‘day-to-day’ changes), whereas use of global measures may be more helpful when one is interested in tapping into the participants’ subjective experience (Shiffman et al., 2008). Finally, by assessing the

target symptom/behaviour in the environment they typically occur, EMA increases the generalizability of the findings (Shiffman et al., 2008).

EMA does not reflect a single methodology. For instance, EMA can include the use of prompts to randomly time sample target behaviour, as has traditionally been described under the term of Experience Sampling Method (ESM; Stone & Shiffman, 2002); but it can also be used for event recording (Stone & Shiffman, 2002; Shiffman et al., 2008). EMA can be employed in the collection of both subjective experiences (e.g., cravings) and objective events (e.g., physical activity; Dunton, Liao, Intille, Spruijt-Metz, & Pentz, 2011; Stone & Shiffman, 2002). Further, the complexity of the data collection can vary, with data collected once a day (e.g., end-of-the-day diaries) to every couple of hours (e.g., stratified sampling; Stone & Shiffman, 2002). Relatedly, the data can be collected using a range of technologies, such as paper-and-pencil daily diaries, palm pilot PDAs, and mobile devices (Berkman, Giuliani, & Pruitt, 2014; McVay et al., 2009; Shiffman et al., 2008; Stone & Shiffman, 2002). Even though the methodology can vary across these different dimensions, all of the methods: 1) incorporate the collection of multiple data points; 2) aim for a high temporal resolution by assessing the target event close in time; and 3) obtain ecologically valid data by examining the behaviour in the context it naturally occurs (Shiffman et al., 2008).

As described, EMA assessments have numerous advantages over other assessment methods. Importantly, however, this methodology also has drawback. First, EMA assessments rely on self-report; as such, they are subject to many of the same shortcomings as other forms of self-report (Shiffman et al., 2008; Reis 2012). For instance, it can be difficult to confirm that participants are truthfully answering items during the assessments; although some have attempted to overcome this by corroborating the self-reports with use of biochemical measures

(e.g., Delaney-Black et al., 2010). Second, given the large number of assessments, a high compliance rate can be difficult to achieve, as can ensuring the missed assessment do not reflect a non-random pattern of missing data (Shiffman et al., 2008). Third, this type of data collection can be subject to “deception or self-deception” (Shiffman et al., 2008, p. 20) and misrepresentation (e.g., back-filling items; Shiffman et al., 2008; Smallwood & Schooler, 2015). Finally, it has been argued that EMA assessments may select out potential participants (e.g., the elderly) and that those who agree to participate may not reflect a representative sample of the population of interest.

Despite these limitations, momentary assessments have broad applicability in both clinical and research settings. For example, daily diaries have long been incorporated in different models of psychotherapy (e.g., cognitive behaviour therapy, Beck, 2011; Thiele, Laireiter, & Baumann, 2002). Further, there is early evidence showing that brief “in the moment” interventions delivered via EMA methodology can be beneficial (Carter et al., 2007). In research, EMA methods have been incorporated across areas of study (e.g., Beal & Weiss, 2003; Fleeson, 2001; Moskowitz & Young, 2006; Thiele et al., 2002). Correspondingly, EMA methods, described under different names (e.g., Experience Sampling Method, self-monitoring, ambulatory monitoring), have been designed to answer a wide range of research questions (e.g., Shiffman et al., 2008, Shiffman, 2000). For example, measures of subjective states have traditionally been the emphasis of the Experience Sampling Method (Shiffman et al., 2008), including research examining internal states such as mind wandering.

### **Mind Wandering and EMA**

Over the last few decades there has been growing interest in the study of mind wandering, defined as “self-generated mental activity” that occurs during a task but is task-

unrelated (Callard et al., 2013, p. 1; Smallwood & Schooler, 2006). This shift in research attention in part reflects a move from the historical focus on behaviourism and interest in “goal-focused external processing” (Callard et al., 2012, p. 1; Callard et al., 2013). This lag also recognizes the challenges of conducting research into mind wandering. That is, experimental research in this area is made difficult because of the lack of ability to observe transitions between mental states, the “spontaneous” nature of the experience, and the dependence on self-report (Smallwood & Schooler, 2015, p. 492), and has been further complicated by use of mixed terminology (e.g., daydreaming). Finally, it also parallels the advances in research methodology that permit the closer investigation of internal states.

The analysis of the content of thoughts was initially conducted using introspection (Callard et al., 2012). Correspondingly, use of self-report questionnaires has represented a convenient and indispensable way to assess mind wandering frequency. Notably, paralleling the disjointed use of terminology to label task-unrelated thought, as well as the interchangeable use of related but distinguishable constructs to refer to the experience of mind wandering, different scales have been used to evaluate trait levels of mind wandering (Mrazek, Phillips, Franklin et al., 2013). Whereas some of these measures lack face validity in assessing mind wandering directly (e.g., the Attention Related Cognitive Errors Scale (Cheyne et al., 2006), more recently several questionnaires have been developed to directly assess mind wandering frequency. Examples include the Mind Wandering – Deliberate and Spontaneous Scales (Carriere et al., 2013), the Mind Wandering Questionnaire (Mrazek, Phillips, Franklin et al., 2013), the Amsterdam Resting-State Questionnaire (Diaz et al., 2013), and the Mind Excessively Wandering Scale (Mowlem et al., 2016).

Complementing the use of self-report questionnaires, mind wandering in the laboratory setting has most commonly been captured via thought sampling (Smallwood & Schooler, 2006). This includes probe-caught methods, that rely on probes that interrupt the participant during an ongoing task and ask them to report on whether their thoughts were on-task or off-task, as well as self-caught methods which rely on meta-cognition, and ask the participant to monitor their thoughts for periods of mind wandering (Smallwood & Schooler, 2006; 2015). In regards to probe-caught methods, participants can be asked to survey their experience during the interval between probes for instances of mind wandering which were defined prior to initiating the task (i.e., “self-classification method”, e.g., Giambra, 1995; Smallwood & Schooler, 2006) or to report on their immediate experience right before the probe with the role of the experimenter being to code the self-report data for instances of mind wandering (“experimenter-classified probe method”; Smallwood & Schooler, 2006, p.947; e.g., Smallwood, Obonsawin, & Heim, 2003). Relatedly, participants can be requested to respond to a question inquiring what they were thinking about at the time of the probe by selecting one of the multiple choice options that fits their experience best (e.g., McVay et al., 2009). In addition to probe- and self-caught probes, mind wandering can be captured using questionnaires that are completed after the task (i.e., “retrospective method”, Smallwood & Schooler, 2015, p. 492, e.g., Smallwood, O’Connor, & Heim, 2005) or by asking participants following a task to simply describe their experience, with no reporting guidelines put in place (i.e., “open-ended method”, Smallwood & Schooler, 2015, p. 492). Importantly, the different methods can be incorporated simultaneously into studies to provide a comprehensive understanding of mind wandering (e.g., Sayette et al., 2009).

Although laboratory studies have been instrumental in advancing our understanding of mind wandering, so have studies conducted in natural settings (e.g., Killingsworth & Gilbert,

2010). These more ecologically valid studies rely on EMA methodology (or as frequently referred to as experience sampling methods) to examine mind wandering episodes. Typically, participants are probed and asked to report on their momentary experience, by indicating their responses on a palm pilot, mobile phone or a related device (e.g., McVay et al., 2009; Killingsworth & Gilbert, 2010). Attention failures have also been recorded using daily diaries (e.g., Unsworth et al., 2012). This methodology has been an invaluable tool in the study of mind wandering.

### **The Present Study**

While appreciating that mind wandering data obtained using self-report questionnaires versus EMA are theoretically different (Reis, 2012), convergent validity with other measures of mind wandering, such as probe-caught mind wandering during laboratory tasks (Mrazek, Phillips, Franklin et al., 2013), provides valuable evidence in support of the utility and validity of self-report in the measurement of mind wandering (Schooler & Schreiber, 2004). As such, the aim of the present study was to apply EMA methodology to help validate the utility of novel measures of mind wandering, primarily the Mind Wandering Questionnaire (MWQ; Mrazek, Phillips, Franklin et al., 2013) and the Mind Wandering – Spontaneous and Deliberate measures (Carriere et al., 2013). Although the validity of the MWQ measure has been examined using probe-caught methods during a laboratory task (Mrazek, Phillips, Franklin et al., 2013), no comparable analyses have been conducted using experience sampling in the natural environment for any of the examined measures. Further, to my knowledge, no research to date has examined these three mind wandering measures simultaneously. Finally, the present study was designed with the intent to add to the growing body of literature demonstrating the applicability and utility of EMA technology in psychological research, by showing that with growing use of smart phone

technology few additional resources and tools are needed to implement this methodology in studies across disciplines.

Given that all measures are conceptually similar (i.e., were designed to capture mind wandering), a positive association with the EMA collected data was hypothesized. Conversely, in line with the proposition that mind wandering and mindfulness reflect nearly opposite constructs, an inverse relation of scores on the mind wandering measures (both questionnaire and EMA data) with mindfulness scores was predicted. Finally, given recent efforts to examine the potential importance of distinguishing between deliberate and unintentional mind wandering (Seli, Risko, & Smilek, 2016a; Seli, Risko, Smilek, & Schacter, 2016), separate examination of these hypotheses across measures of deliberate and unintentional mind wandering was planned.

## **Methods**

### **Participants**

One hundred (76 female) participants were recruited via the existing participant pool system within the Department of Psychology at the University of Windsor. This is consistent with the proposed sample size determined following review of the sample sizes used in comparable studies (Franklin et al., 2014; McVay et al., 2009). All participants were between the ages of 18 to 34 years of age (mean age = 20.75 years, standard deviation (*SD*) = 2.83), and met the following inclusion criteria: a) had a working cell-phone that was able to receive and send text messages; b) were willing to provide their cell-phone number to the researcher for the purpose of participating in the study; and c) were enrolled with mobile phone plans that include unlimited texting. No restrictions on participation were made based on gender, race, socio-economic status, marital status, or neighbourhood of residence. The only exclusion criterion was lack of English literacy. Table 1 describes the characteristics of the sample.

## **Procedure**

The study protocol was composed of two parts. Phase I included the information session and data collection of the self-report measures, whereas Phase II was the EMA data collection process.

**Phase I.** Following the informed consent process, which included a detailed explanation of the EMA data collection process, participants were asked to provide their mobile phone numbers in order to participate in Phase II. They were informed that the identifying information linked to those numbers would only be accessible to the primary investigator and her research supervisor (Dr. Carlin Miller). They were also provided with an operational definition of mind wandering which they were instructed to use in order to guide their responses during the EMA data collection process. Texting safety instructions were reiterated (see Appendix I for a copy of the information handout given during Phase I), and ample time was given to address questions and concerns. Following this, participants were asked to complete a series of questionnaires in random order: (1) demographics form, (2) Mind Wandering Questionnaire, and (3) Mind Wandering Spontaneous (MW-S) and Mind Wandering Deliberate (MW-D). This session lasted approximately 30 minutes, and participants were compensated 0.5 bonus points for their time and effort.

**Phase II.** The EMA data collection process was designed with the assistance of the Web Services Group at the Information Technology Services at the University of Windsor. Software from Twilio, a commercial SMS company, was used to collect the data. Data collection took place over a span of 7 days (including weekends), allowing thought samples to be collected on all days of the week. This is consistent with what has been done in previous studies (e.g., Killingsworth & Gilbert, 2010; McVay et al., 2009).

Time-based EMA sampling was selected for this study. This decision was made after considering that the aim of the study was to capture mind wandering experience as it occurs across the day without interest in mind wandering episodes that are limited to a particular context. Further, understanding that mind wandering episodes may go unrecognized by the participant, use of event-based scheduling would be limited because that requires the participant to recognize and report when the target event occurred (Shiffman et al., 2008).

Due to the potential that a mind wandering episodes may be brief and infrequent, and to ensure a representative sample of mind wandering episodes was captured, a relative high sampling density was chosen (Shiffman et al., 2008; Stone & Shiffman, 2002). Importantly, the interest in gaining a high temporal resolution was balanced with concern for the burden placed on the participant in completing numerous daily assessments (Stone & Shiffman, 2002). In regards to the scheduling of assessments, a stratified random schedule was chosen (i.e., variable sampling within predetermined periods of time). This parallels what has previously been done in the study of mind wandering (e.g., Killingsworth & Gilbert, 2010; McVay et al., 2009; Song & Wang, 2012). In addition to providing a representative sample of mind wandering episodes, this schedule of assessments increases the likelihood that the sampling is distributed evenly throughout the day (Shiffman et al., 2008). Moreover, it ensures that the participant cannot anticipate when they will be asked to provide a response, as is the case when using a fixed sampling schedule (Shiffman et al., 2008).

Across the seven-day data collection period, participants received identical text messages that asked: “Are you thinking about something other than what you’re currently doing?” (Killingsworth & Gilbert, 2010, p. 932). They were informed to respond to the text message by choosing one of the following options: ‘(a) completely on-task; (b) mostly on-task; (c) both on

the task and unrelated concerns; (d) mostly on unrelated concerns; or (e) completely on unrelated concerns' (Mrazek, Smallwood, Franklin et al., 2012; Mrazek, Phillips, Franklin et al., 2013). As was discussed during Phase I of the study, participants were instructed to respond to the prompt (i.e., text message) by "taking immediate stock of their thoughts upon the [text] and to report on only those thoughts" (McVay et al., 2009). To ensure a representative sample, participants were randomly texted six times a day from 9 a.m. to 9 p.m. (recommended by T. Conner, personal communication, March 9, 2015). The 12-hour time period between 9 a.m. to 9 p.m. was split into six equal two-hour time slots, and a single text message was sent during each time slot. A random-number generator computer program was used to select when the text message will be sent during each time slot. Upon completion of the data collection period, individuals were rewarded 2.5 bonus points towards their participant pool credit.

## **Measurement**

**Demographics questionnaire.** Demographic information (e.g., gender, date of birth, race/ethnicity, marital status) was collected using a demographics questionnaire. Additional information about the participants' medical history (e.g., clinical diagnoses received, current medication use) and developmental histories was also collected in order to address additional research questions (not included in the present study). Appendix A includes a copy of the demographic questionnaire.

**Mind Wandering Questionnaire (MWQ).** The MWQ was developed by Mrazek and colleagues (2013), and is designed to serve as a measure of trait levels of mind wandering. Utilizing the following definition of mind wandering "the interruption of task focus by task-unrelated thought" (p. 3), the measure is composed of 5 items, with respondents asked to respond on a 1-6 Likert scale. A total MWQ scores is calculated by adding the ratings for the five items.

The measure is reported to have good internal consistency and homogeneity. The mean MWQ score for all participants was calculated to be 17.46 ( $SD = 4.35$ ), with scores ranging from 8 to 26. The 5-item scale was shown to have acceptable internal consistency ( $\alpha = 0.763$ ; Table 2). Refer to Appendix B for a copy of the measure.

**Mind Wandering: Spontaneous (MW-S) and Mind Wandering: Deliberate (MW-D).**

The MW-S and MW-D scales were designed to provide measures of trait levels of deliberate and spontaneous mind wandering, respectively (Carriere et al., 2013; Seli, Carriere, & Smilek, 2015). The scales provide unique measures of mind wandering as they make the important distinction between spontaneous mind wandering (i.e., “unintentional drifting of one’s thoughts from a focal task toward inner, task-unrelated thoughts” (Seli, Carriere et al., 2015, p.751) and deliberate mind wandering (i.e., “intentional or deliberate shift in attention toward internal thought” (Seli, Carriere et al., 2015, p. 751)). Each scale is made up of four items, with responses provided on a 7 point Likert scale. A mean total score was calculated for both scales as reported previously (Seli, Risko, & Smilek, 2016b). Carriere (personal communication, October 29, 2015) reported that the measures have been shown to have a substantial degree of face, convergent and discriminant validity. Examination of the scores for each scale revealed a mean total score of 3.58 ( $SD = 1.28$ , range = 1.0 – 6.50) for the MW-S, and a mean total score of 3.70 ( $SD = 1.28$ , range = 1.0 – 6.75) for the MW-D. Cronbach’s alpha values for the MW-S and MW-D scales were 0.862 and 0.807, respectively. Table 2 includes the descriptive statistics for the two measures. Appendix C includes a copy of the MW-S and MW-D.

**The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003).** The MAAS is a 15-item trait measure of mindfulness that examines one’s ability to focus their attention to the present moment across a number of areas of daily functioning. A score for the scale is

obtained by calculating a mean score across the items, with higher values thought to reflect more trait mindfulness. The psychometric properties have been reported to be excellent, and the measure has been validated for use with university students. The mean MAAS score for the sample was 3.82 ( $SD = 0.86$ , range = 1.33 – 5.73), and the Cronbach's alpha was calculated to be 0.896 (Table 2). A copy of the measure is included in appendix D.

**EMA data.** The information collected via EMA can be an instrumental tool in identifying individual differences (Shiffman et al., 2008). This is done by collecting and combining the scores from multiple thought samples from the participant and thereby obtaining a potentially reliable estimate of one's typical mind wandering frequency. As was done by Mrazek, Phillips, Franklin et al. (2013) and others (Jha et al., 2017; Rooks et al., 2017), a mind wandering score was calculated by finding the mean of the probes answered. In order to compute a mean score, each of the five possible response options was given a numerical value ranging from one to five (i.e., “completely on-task” = 1; “completely on unrelated concerns” = 5). Correspondingly, higher mean scores denoted greater mind wandering frequency.

Review of the relevant literature revealed a lack of a consistently used response latency threshold for the experience sampling data. That is, there was no response time latency value that was consistently used across studies to indicate which text responses would be considered valid; indeed, information regarding which latency threshold was used was frequently omitted from the description of methods in the studies reviewed. As such, following consultation (T. Conner, personal communication, February 23, 2017; M. Killingsworth, personal communication, March 17, 2017) and review of the literature, four different cut-offs were chosen: 5 minutes, 20 minutes, 30 minutes, and any time latency. The chosen response time latencies reflect either time

thresholds described in previously published work (e.g., Dunton et al., 2011; Kane et al., 2007), or reflect expert suggestion to be as liberal with the threshold as possible.

### **Statistical Analysis**

All data analyses were done using the Statistical Package for Social Science (SPSS Version 22) for Mac. The commonly applied threshold of  $p < 0.05$  was used to indicate statistical significance.

### **Analysis of Missing Data**

The data were evaluated for patterns of missingness before conducting subsequent analyses. The three mind wandering questionnaires (MWQ, MW-S, and MW-D) had no missing values on any of the items. Examination of the MAAS revealed minimal missing data; the amount missing calculated using the complete case method and the sparse matrix method were 2% and 0.13%, respectively. Specifically, two participants each had one item missing on the measure, with the items being different (i.e., item 5 and item 12). In addition, Little's MCAR test was conducted, revealing that the null hypothesis was not rejected ( $\chi^2 = 15.628$ ,  $df = 28$ ,  $p = 0.971$ ). In sum, inspection of the missing data indicated that the data points were at least Missing at Random (MAR). The two missing values were then imputed using the expectation-maximization procedure.

### **Data Cleaning and Analysis of EMA Data**

Prior to analyzing the data, the data were reviewed for incomplete responses, responses completed at wrong times, and data too close in sequence, as well as identifiable response patterns (e.g., consistently identical responses). Due to the nature of the responses elicited, no incomplete responses were received, but on the rare occasion that a response did not fit one of

the possible response options ( $n = 2$ ; e.g., answering “w” which is not a valid response option and likely was meant to indicate response option “e”), participants spontaneously sent a follow-up response correcting their previous answer. The mean response rate was 12.6 min ( $SD = 9.9$  min, range = 1 – 52 min). Due to the technology used, the time stamp was not sensitive enough to identify anyone who “responded too quickly”. However, examination of the participants’ response times revealed that the majority of participants did not respond within the minute of when they received the text message. Visual inspection of the data revealed that one participant had very long response latencies ( $M = 109.8$  min,  $SD = 144.1$  min), and tended to respond to several text messages in quick succession. Due to poor compliance during Phase II of the data collection, that individual was removed from all subsequent analyses, resulting in a new sample size of 99 participants.

A “compliance rate” for the EMA data collected during Phase II was calculated. Consistent with what was done by Killingsworth and Gilbert (2010), the compliance rate reflected the proportion of text-responses sent that received a response. For instance, a 50 percent compliance rate indicated that the participant responded to only 21 of 42 possible text messages. An average compliance rate was calculated for the whole sample for each of the previously identified response latency thresholds. An intra-class correlation (ICC) statistic for the EMA mind wandering data were also calculated separately for each response time latency threshold (see Table 3), reflecting the proportion of variance attributable to between-person differences. As depicted in the table, more of the variance in mind wandering captured is attributed to observation-to-observation differences.

Comparison of the mind wandering EMA scores across time of day did not reveal significant findings. More specifically, a one-way repeated measures analysis of variance

(ANOVA) revealed that there was no significant effect for time of day (i.e., morning (9 a.m. to 1 p.m), afternoon (1:00 p.m. to 5 p.m.) or evening (5 p.m. to 9 p.m.) on mind wandering reported during the EMA data collection ( $F(2,97) = 0.64, p = .53$ ). The same pattern of findings was obtained when morning was categorized as reflecting time between 9 a.m. and 12:00 p.m., and the afternoon period reflected time between 12:00 p.m. and 5 p.m. Similarly, there was no significant difference in self-reported mind wandering collected during the work week ( $M = 2.33, SD = .42$ ) versus on the weekend ( $M = 2.33, SD = .58$ );  $t(98) = -.31, p = .76$ ).

### **Between-Person Analysis**

Correlation analyses were conducted to evaluate the convergent validity between the mind wandering questionnaires and the aggregated mind wandering scores obtained using EMA. Additionally, as proposed, analyses between the mind wandering measures and mean score obtained from the MAAS were performed. Importantly, before proceeding with these analyses the assumptions of the Pearson product moment correlation were examined. All assumptions, including presence of continuous data, normality, linearity, homoscedasticity, and absence of outliers, were met for all variables used. Normality was evaluated by visual inspection of the Q-Q plots and histogram, using tests of normality (i.e., Shapiro-Wilks test), and inspection of the kurtosis and skewness values. The assumptions of linearity and homoscedasticity were examined using visual inspection of scatterplots, performed separately for each pair of variables. Lastly, identification of possible outliers was done using visual inspection of box-plots, and by applying the outlier labeling rule (Hoaglin, Iglewicz, & Tukey, 1986; Hoaglin & Iglewicz, 1987). No outliers were identified on any of the variables of interest.

## Results

### Compliance Rates

Table 3 includes the descriptive statistics for the compliance rates calculated separately for each response latency threshold. As illustrated in the table, the mean compliance rates increased with greater response threshold leniency. Additionally, the range in the number of responses considered valid varied greatly across the four time cut-offs used. For instance, under the most stringent response time latency, for one participant, only one response out of 42 possible responses was considered valid.

To ensure that response compliance did not vary with respect to mind wandering frequency, the number of responses received was correlated with both mind wandering questionnaire scores and the aggregated EMA mind wandering score. This set of analyses revealed no significant associations, suggesting that compliance with the EMA protocol did not systematically vary on the basis of one's proneness to mind wander. Notably, there was a medium-sized, inverse relation between the number of responses and response latency ( $r = -.39$ ,  $p < .001$ ), indicating that those who responded to a greater proportion of the prompts also responded more quickly.

### Correlation Analyses

Table 4 includes the correlation analyses conducted with only the self-report questionnaires. As displayed, there was a significant positive correlation between the MWQ and the MW-S scale ( $r = .629$ ,  $p < 0.001$ ), with both of these measures negatively correlated with the MAAS ( $r = -.642$ ,  $p < 0.001$ ;  $r = -.523$ ,  $p < 0.001$ , respectively). Importantly, the MW-D scale was not significantly associated with any of the other retrospective self-report measures, including the MW-S ( $p = 0.146$ ). This is in contrast to previously reported positive associations

between the MW-S and MW-D scales (Carriere et al., 2013; Seli, Carriere et al., 2015; Seli, Smallwood, Cheyne, & Smilek, 2015).

The analyses conducted with the EMA data revealed a pattern of findings that was consistent irrespective of the response time latency applied to the data. The aggregated mind wandering score calculated from the EMA data was positively correlated with the MWQ and MW-S scores, and negatively associated with the MAAS score. Notably, the aggregated mind wandering score was not significantly associated with the MW-D score. Whereas the pattern of findings did not vary based on the response time latency used, the strength of the correlations did. Generally, the more stringent the threshold applied, the stronger the association. The results of the bivariate correlation analyses for all response time latencies are depicted in Table 5.

### **Discussion**

The present study adds to what is known about three previously published measures of mind wandering, including cross-validation via EMA methodology. As described, more frequent mind wandering reported during daily life experience was associated with higher MWQ and MW-S scores, irrespective of the response latency applied. In short, EMA data collected in participants' day-to-day experience appears to validate self-report measures of trait proneness to mind wandering.

This is consistent with previous research (Mrazek, Phillips, Franklin et al., 2013), which demonstrated convergent validity of the MWQ by utilizing a probe-caught method to capture mind wandering during an experimental task. It is also in line with the results showing that trait levels of spontaneous mind wandering (measured using the MW-S) were positively associated with state-levels of mind wandering (measured using thought probes delivered during an experimental task; Seli, Risko, & Smilek, 2016b). Further, the parallel set of findings obtained

for both MWQ and the MW-S are in contrast to what is predicted based on the suggestion by Mrazek and colleagues (2013). That is, the findings do not support the idea that a combination of the MW-S and MW-D may reflect an “overall mind wandering frequency”, which the authors suggested the MWQ was designed to capture (p. 2). Instead it suggests that the MWQ more closely aligns with unintentional mind wandering in this study.

The results also support the growing literature suggesting the importance of differentiating between intentional and unintentional mind wandering (Seli, Risko, & Smilek, 2016a; Seli, Risko, Smilek, & Schacter, 2016). In the current study, a dichotomy between deliberate and spontaneous mind wandering was reliably demonstrated. Specifically, whereas the MWQ and the MW-S questionnaires were consistently associated with EMA data and the MAAS, the MW-D measure was not associated with any other score. This difference in the pattern of associations between deliberate and unintentional mind wandering has also been reported in relation to task difficulty (Seli, et al., 2016a), to the propensity to fidget (Carriere et al., 2013), and to clinical symptomology (e.g., attention deficit hyperactivity disorder and obsessive-compulsive disorder symptomatology; Seli, Smallwood, et al., 2015; Seli, Risko, Purdon & Smilek, 2017). Whereas the present findings support the importance of making this distinction, it is worth reiterating that in the present study participants were not asked to indicate the intentionality of their mind wandering episodes during the EMA data collection phase. As such, as previously done (Seli et al., 2016a, Seli et al., 2016b), this addition to the protocol may be valuable to include in future research.

Consistent with the conceptualization that mind wandering and mindfulness reflect opposite constructs (Mrazek, Smallwood, & Schooler, 2012), and in line with previous studies examining mind wandering and mindfulness (Mrazek, Phillips, Franklin et al., 2013; Luo, Zhu,

& You, 2016), higher levels of MWQ and MW-S were associated with lower levels of dispositional mindfulness. In contrast, deliberate mind wandering was not related to MAAS scores. This parallels the distinction reported in the relations between the MW-S and MW-D scales and the Five Facet Mindfulness Scale, where the MW-S was associated with all five facets of the measure and the MW-D with only three (Seli, Carriere et al., 2015). Finally, consistent with the pattern of findings reported above, mind wandering as reported via EMA was also associated with lower levels of dispositional mindfulness.

Finally, although the participant's recollected responses and their self-reported real-time experiences of mind wandering were associated irrespective of the response latency applied, the strength of the relationship varied based on the time threshold used. This reflects an important consideration for future research in this area. Explicit disclosure about which response latency is applied and use of a standardized latency threshold (conditional on the target behaviour of interest) may help promote comparisons across studies.

The strength of the significant correlations, albeit moderate and similar to those reported in comparable analyses (Seli et al., 2016b), may be surprising to some readers. These correlations are likely influenced by the complementary nature of the relations between questionnaire-based information and data collected via EMA, and are not theorized to be redundant sources of information (Reis, 2012). That is, although the present results provide supporting evidence that the mind wandering questionnaires corresponds with the mind wandering estimates collected through EMA, the nature of the information obtained is different for each source. The questionnaires reflect retrospective self-report data, whereas the EMA data collection aimed to capture self-report information on mind wandering as it occurred. Studies comparing the aggregated estimates provided using EMA methodology versus those obtained

using assessments relying on recall data have shown inconsistent findings, likely because the “magnitude and direction of recall bias can differ across subjects and settings” (Shiffman et al., 2008, p. 11). Additionally, EMA data typically provide lower estimates of the frequency of an event (Shiffman et al., 2008). Finally, the results complement the findings of Seli and colleagues (2016b), who conceptualized the questionnaires (i.e., MW-S and MW-D) as reflecting trait-levels of mind wandering and their EMA data collected during an experimental task as capturing state-levels of mind wandering. The aggregated EMA data on mind wandering may be able to uniquely “bridge the gap” between self-reported trait mind wandering data and state-specific measures. By deriving a cumulative aggregate of multiple state data points over time, the aggregated EMA data may more closely represent trait-level data while eliminating concerns associated with typical (i.e., self-report) trait measurement. Future work may benefit from further elucidating the strengths and weaknesses of aggregate EMA data as a complement to trait measures.

Several limitations to the present study are worth noting. First, the results are entirely reliant on self-report data. Although efforts to improve confidence in the accuracy of the data collected via EMA was done by using a continuous scale instead of dichotomous response options there is still the possibility that lack of meta-awareness may have negatively impacted the accuracy of the reported experiences (Seli, Jonker, Cheyne, Cortes, & Smilek, 2015). That is, although more nuanced response options would potentially allow participants to more easily describe and categorize their internal thoughts, the accuracy of the self-report is contingent on one’s awareness of one’s own cognitive experience. Further, future research in this area would benefit from explicit assessment of the participants’ confidence in their self-report (Seli, Jonker, et al., 2015). Second, although unlikely, one cannot completely rule out that the answers given in

response to the probes were influenced by completion of the mind wandering questionnaires days prior. Importantly, as noted by Seli and colleagues (2016b), the wording used in the questionnaires does not match the wording used in the probes, decreasing the probability that completing the first phase of the study would have impacted responding within the EMA phase. Third, the technology utilized in phase II of the data collection was not automated, meaning that the researcher had to initiate the sending of each of the 42 prompts at the pre-specified times. To reduce researcher burden and improve standardization across cycles of data collection, automatization of the protocol is recommended. Interestingly, the lack of automatization meant that each participant response was received irrespective of when it was sent (i.e., no pre-determined computerized cut-off was used that would preclude messages from being received after a specified time point). This allowed for the investigation of the impact of applying different response time latencies. Fourth, it must be acknowledged that alike to many other studies in this area, the sample used in the current study represents a cohort of young adults recruited from a university population, who generally display comfort with the use of mobile technology. Consequently, the extent to which these findings would generalize needs to be further investigated. This may be especially pertinent to the discussion of compliance with the described EMA protocol and application of response latencies. Finally, although not the purpose of the present study, the design of the current study did not allow for investigation of the factors that may influence fluctuations in mind wandering across time. This may be worth exploring in future investigations.

In sum, the present study extends previous work (e.g., Seli et al., 2016b) and adds to our understanding of the ability of existing self-report questionnaires to relate to estimates of mind wandering derived from EMA sampling. Further, it is the first study to compare all three existing

self-report measures developed specifically to capture mind wandering, and lends additional support to the importance of differentiating between deliberate and spontaneous mind wandering.

This work has important implications for the applicability of the retrospective self-report questionnaires to capture trait levels of mind wandering, and suggests that the subjective self-reports provide a relatively accurate estimate of one's proneness to mind wander. Given that they are quick and easy to complete, compared to the participant burden associated with participation in EMA data collection, they can be easily added to many research protocols exploring attention variability. Moreover, as demonstrated in this study, use of EMA methodology provides a valuable perspective on capturing the propensity to mind wander. Finally, the study also fits nicely with the growing literature of the applicability of mobile technology in EMA studies. The high compliance rates obtained from the sample add credence to the suitability of this methodology within this area of research.

Table 1

*Demographic Characteristics of the Sample*

<b>Variable</b>	<b>N</b>	<b>% of sample</b>
<b>Gender</b>		
Female	76	76.0
Male	20	20.0
Open ended	2	2.0
Unknown/Did not disclose	2	2.0
<b>Race/Ethnicity</b>		
Aboriginal	1	1.0
Asian	9	9.0
Non-hispanic Black	9	9.0
Caucasian	61	61.0
Arab/Middle Eastern	16	16.0
Other	4	4.0
<b>Year of University</b>		
First year	18	18.0
Second year	18	18.0
Third year	25	25.0
Fourth year	35	35.0
Fifth year or beyond	4	4.0
<b>Education</b>		
High School Diploma	85	85.0
College Degree	9	9.0
Bachelor's Degree	5	5.0
Unknown/ Not disclosed	1	1.0
<b>Marital Status</b>		
Single	57	57.0
In a Romantic Relationship	37	37.0
Married/Civil Union	6	6.0
<b>Employment<sup>a</sup></b>		
Full-time Employed	6	6.0
Part-time Employed	71	71.0
Unemployed	23	23.0
<b>Diagnoses currently endorsed</b>		
Attention deficit/hyperactivity disorder	2	2.0
Seizure disorder	2	2.0
Learning disorder	1	1.0
Mental Health disorder	26	26.0

<sup>a</sup>. Employment rates includes volunteering positions

Table 2

*Descriptive Statistics for the Self-Report Questionnaires*

<b>Measure</b>	<b>Number of Questionnaire Items</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Range</b>	<b>Cronbach's alpha</b>
MWQ	5	17.46	4.35	8.0 – 26.0	0.76
MW-S	4	3.58	1.28	1.0 – 6.50	0.86
MW-D	4	3.70	1.28	1.0 – 6.75	0.81
MAAS	15	3.82	0.86	1.33 – 5.73	0.90

*Note:* MWQ = Mind Wandering Questionnaire; MW-S = Mind Wandering – Spontaneous Scale; MW-D = Mind Wandering – Deliberate Scale; MAAS = The Mindful Attention Awareness Scale

Table 3

*Descriptive Statistics for the EMA Data for Each Response Latency Threshold*

Response Latency	Mean Compliance Rate	Mean Number of responses	Standard Deviation	Range	ICC
5 minutes	62.7%	26.34	6.971	1 - 41	0.295
20 minutes	76.9%	32.30	5.509	9 - 41	0.273
30 minutes	81.0%	34.02	4.919	14 - 42	0.267
Any response latency <sup>a</sup>	91.6%	38.46	3.315	20 - 42	0.286

*Note:* ICC = intra-class correlation coefficient; reflects proportion of variance attributed to person-to-person differences.

<sup>a</sup> Any response latency reflects the most liberal threshold applied. Text responses were excluded from the analysis only if they came after another text message was already sent.

Table 4

*Correlation Analyses Between Mind Wandering Questionnaires and the MAAS*

	MWQ	MW-S	MW-D	MAAS
MWQ	1			
MW-S	.629 *	1		
MW-D	.066	.147	1	
MAAS	-.642 *	-.523 *	-.037	1

*Note:* MWQ = Mind Wandering Questionnaire; MW-S = Mind Wandering – Spontaneous Scale; MW-D = Mind Wandering – Deliberate Scale; MAAS = The Mindful Attention Awareness Scale

\*  $p < 0.001$

Table 5

*Aggregated EMA Mind Wandering Scores on Questionnaire Data Scores by Response Time Latency*

<b>Aggregated EMA mind wandering score per response latency</b>	<b>MW-S</b>	<b>MW-D</b>	<b>MWQ</b>	<b>MAAS</b>
5 minutes	.346***	.089	.345***	-.280**
20 minutes	.337**	.092	.329**	-.270**
30 minutes	.346***	.094	.319**	-.260**
Any response latency <sup>a</sup>	.318**	.034	.254*	-.206*

<sup>a</sup>. Any response latency reflects the most liberal threshold applied.

\* p < 0.05. \*\* p < 0.01. \*\*\* p < 0.001

## CHAPTER 3

### Study II

#### **Examining the Relations Between Mind Wandering and Trait Levels of ADHD and Sluggish Cognitive Tempo symptoms**

It is a universal experience to discover that one's thoughts have unexpectedly drifted away from an ongoing task to internal thoughts, often of personal concern (Smallwood & Schooler, 2009). This experience is most frequently referred to as *mind wandering*, although this term has been used interchangeably with others, such as task-unrelated-thought and daydreaming (Callard et al., 2013; Smallwood & Schooler, 2006). Use of mixed terminology, however, is problematic as it may lead to potential confounds within the literature for these terms do not accurately reflect the same construct (e.g., mind wandering versus daydreaming; Mrazek, Phillips, Franklin et al., 2013). Moreover, it has been argued that mind wandering should not be viewed as a homogenous phenomenon, but rather that there exist different types of mind wandering that differ in the extent of volitional control employed (i.e., differentiating spontaneous/unintentional versus deliberate/intentional mind wandering; Seli, Carriere et al., 2015, Seli et al., 2016b; Seli, Risko, Smilek, & Schacter, 2016). As such, any discussion on mind wandering warrants the use of a clear description of the construct. Similar to previous definitions, in the present study mind wandering was conceptualized as self-generated thought that is independent of perceptual/environmental input, and that occurs during a task or activity (McVay & Kane, 2010).

The likelihood of experiencing a mind wandering episode is influenced by several contextual factors, such as sleep quality, interest in the ongoing activity, and substance use (e.g., Carciofo, Du, Song, & Zhang, 2014; Sayette et al., 2009; Sayette et al., 2010; Unsworth, &

McMillan, 2013). Nevertheless, there is growing recognition that individuals vary in how frequently they mind wander, and accordingly, the propensity to mind wander can be viewed as a stable character trait (Callard et al., 2013; Diaz et al., 2014; McVay et al., 2009). Support for this idea comes from research showing reliable individual differences across laboratory tasks and ecologically valid data collected via experience-sampling techniques, as well as across time (McVay et al., 2009; McVay & Kane, 2010). Further, other individual differences, such as the presence of an attention deficit/hyperactivity disorder (ADHD) diagnosis in childhood, have been linked to a greater occurrence of task-unrelated thought (Shaw & Giambra, 1993). Thus, in recognizing “that variation in mind wandering represents an important individual difference measure” (p. 1) there have been recent efforts to create scales that will capture trait levels of mind wandering (Mrazek, Phillips, Franklin et al., 2013).

Differences in mind wandering frequency have been observed in various clinical groups, although our understanding of these relationships continues to be limited (Smallwood, 2013). For example, examination of mind wandering during different laboratory tasks (e.g., encoding, word-fragment completion, sustained attention) has revealed a positive relationship between task-unrelated-thought and dysphoria (i.e., subclinical depression symptoms; Smallwood, Obonsawin, Baracaia, et al., 2003; Smallwood et al., 2005). This relationship may not be surprising considering that an important function of mind wandering is considered to be problem solving and the processing of personal ongoing concerns, whereas dysphoria can be viewed as perseverative processing of material relevant to the self (Smallwood & Schooler, 2006). Elevations in mind wandering frequency have also been observed in those diagnosed with schizophrenia (Shin et al., 2015). Additionally, central to this study, it has also been hypothesized that mind wandering may underlie a key aspect of ADHD (Seli, Smallwood et al.,

2015). Despite early findings showing greater ADHD symptomatology to be related to mind wandering, only few studies have examined this relationship to date (Franklin et al., 2014; Seli, Smallwood, et al., 2015; Shaw & Giambra, 1993). The noted difficulties with attention in ADHD, primarily difficulties with control of attention, have been proposed to help explain the occurrence of more frequent mind wandering in this clinical group (Smallwood, 2013).

Importantly, whereas elevations in mind wandering may be a common symptom across the different disorders, it is unlikely that the same causal factors help explain greater mind wandering in the different clinical groups, as suggested by the process-occurrence framework (Smallwood, 2013).

### **Attention Deficit/Hyperactivity Disorder**

ADHD is a neurobehavioural developmental disorder affecting approximately 3-4% of the global adult population (APA, 2013; Fayyad et al., 2007; Miller, 2012). It is defined as a “persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development” (p. 59) and is differentiated across 4 different possible subtypes (i.e., Combined type, Predominantly Inattentive, Predominantly Hyperactive-Impulsive, and Other Specified ADHD; APA, 2013). Currently, the diagnosis of ADHD for those 17 years of age or older, requires the presence of five symptoms that cluster within either the *inattention domain* (e.g., ‘difficulty sustaining attention in tasks or play activities’, ‘mind seems elsewhere, even in the absence of any obvious distraction’) or the *hyperactivity/impulsivity domain* (e.g., ‘often fidgets’, ‘often has difficulty waiting his or her turn’) for a diagnosis of either the Predominantly Inattentive or Predominantly Hyperactive-Impulsive subtypes, respectively (APA, 2013, p. 59-60). Five symptoms within both domains must concurrently be present to warrant the diagnosis of the Combined subtype. Notably, however, the usefulness of subtyping ADHD may not be

valuable given some indication that the subtypes lack stability over time and that based on genetic studies ADHD may be better conceptualized as a single dimensional phenotype (Acosta, Arcos-Burgos, & Muenke, 2004; Lahey, Pelham, Loney, Lee, & Willcutt, 2005; Valo & Tannock, 2010). Further, it has been argued that the existing DSM categorization does not identify different subtypes of ADHD, but rather reflects different variations in ADHD severity (Barkley, 2012).

ADHD is most frequently diagnosed in childhood, yet symptoms of ADHD have been shown to persist into adulthood with many children not “outgrowing” the disorder (Barkley, Fischer, Edelbrock, & Smallish; 1990; Kalbag & Levin, 2005; Halperin, Trampush, Miller, Marks, & Newcorn, 2008). As such, there is growing appreciation that the definition of ADHD must also reflect the presentation of symptoms more commonly seen in older youth and adulthood (e.g., ‘making careless mistakes when working on a boring or difficult project’; Barkley, 2011; Kessler, 2005). Correspondingly, efforts have been made to develop rating scales that better capture symptoms in adulthood (e.g., Barkley Adult ADHD Rating Scale-IV; Barkley, 2011).

The existing DSM-5 criteria identify necessary thresholds that warrant a diagnosis of ADHD (APA, 2013). Nonetheless, the current polythetic model of ADHD suggests that ADHD symptoms form a continuum of symptom severity, with an ADHD diagnosis representing an extreme on the spectrum (Lubke, Hudziak, Derks, van Bijsterveldt, & Boomsma, 2009). This means that every individual can be placed somewhere on this continuum, and even those with a large number of symptoms, but at a subclinical level, may still have difficulties typically associated with ADHD (Overbey, Snell, & Callis, 2011; Whalen, Jamner, Henker, Delfino, & Lozano, 2002). In fact, ADHD has been described as “an extreme on the quantitative

manifestation of normal behaviour” (Acosta et al., 2004, p. 3). Additionally, incorporating ADHD symptoms that fall within a continuum in research studies rather than using dichotomous categories, has been suggested to allow for more sensitive analyses (Overbey et al., 2011).

Consistent with previous studies, it then follows that research examining ADHD symptoms may be conducted using non-clinical samples (e.g., Franklin et al., 2014; Rodriguez & Span, 2008; Shaw & Giambra, 1993).

### **Sluggish Cognitive Tempo**

The conceptualization of ADHD across the different DSM editions has changed “from motoric disinhibition in DSM-II (hyperkinetic reaction), inattention in DSM-III (attention-deficit disorder, ADD), and both inattention and hyperactivity in the DSM-III, DSM-IV” and DSM-5 (Woo & Rey, 2005, p. 344). Currently, as described, the subtype classification in ADHD reflects the clustering of behavioural symptoms across two main domains, hyperactivity-impulsivity and inattention (APA, 2013). But, the existing subtypes have been challenged (Penny, Waschbusch, Klin, Corkum, & Eskes, 2009). In fact, some have suggested that a subset of the children categorized within the Inattentive subtype may actually be better described by a second proposed attention disorder: Sluggish Cognitive Tempo (Barkley, 2015); the prospective disorder, however, is currently not included in the DSM-5 or ICD-10 (Barkley, 2015). Further, it has been suggested that Sluggish Cognitive Tempo may not necessarily reflect a separate psychiatric disorder, but may instead have “transdiagnostic utility” (Becker, Leopold, et al., 2016, p. 180).

Sluggish Cognitive Tempo, sometimes referred to as Concentration Deficit Disorder, is understood as a related, but distinct construct from ADHD (Barkley, 2012; Barkley, 2015; Becker, Leopold et al., 2016). The most prominent symptoms include: “daydreaming”, “trouble staying awake/alert”, “mentally foggy/easily confused”, “stares a lot”, “spacey, mind is

elsewhere”, “lethargic”, “underactive”, “slow moving/sluggish”, “doesn’t process questions or explanations accurately”, “drowsy/sleepy appearance”, “apathetic/withdrawn”, “lost in thoughts”, “slow to complete tasks”, and “lacks initiative/effort fades” (Barkley, 2015, p.439). Notably, although there are inconsistencies in what symptoms are included (Becker, Leopold et al., 2016), the first twelve symptoms have been identified as helpful in differentiating Sluggish Cognitive Tempo from ADHD (Barkley, 2015; Penny et al., 2009). Further, although the symptoms likely reflect a single underlying construct, there is evidence to suggest that Sluggish Cognitive Tempo may include both a cognitive and behavioural component (Barkley, 2014; Becker, Ciesielski, et al., 2016; Becker, Leopold, et al., 2016; Penny et al., 2009).

Support for the differentiation of Sluggish Cognitive Tempo from ADHD comes from factor analysis studies which confirm that Sluggish Cognitive Tempo symptoms are distinct and form a dimensional structure that is different from the ADHD dimensions of inattention and hyperactivity-impulsivity (Milich, Balentine, & Lynam, 2001; McBurnett, Pfiffner, & Frick, 2001; Barkley, 2014). And although the dimensions of Sluggish Cognitive Tempo do moderately correlate with the dimensions of ADHD, especially the inattention domain, they are more associated with each other (Barkley, 2014). Further, whereas age and sex differences have been observed in ADHD, parallel differences have not been noted in children with Sluggish Cognitive Tempo (Lee, Burns, Snell, & McBurnett, 2014; Garner, Marceaux, Mrug, Patterson, & Hodgins, 2010). Similarly, whereas ADHD is commonly conceptualized as a disorder of executive functioning (please see Halperin & Schulz, 2006; Sonuga-Barke, Williams, Hall, & Saxton, 1996; and Sergeant, 2005 for alternate explanations) evidence to date suggests this is not the case for Sluggish Cognitive Tempo (Barkley, 2015). This pattern of findings lends support to the idea that Sluggish Cognitive Tempo cannot be conceptualized as an ADHD subtype. In sum, despite

being a helpful construct, our understanding of Sluggish Cognitive Tempo is in its infancy and further research is needed (Barkley, 2015; Penny et al., 2009).

### **Mind Wandering and ADHD Symptoms**

As described above, mind wandering has been suggested to reflect a key aspect of ADHD symptomatology. Support for this hypothesis comes from evidence showing that both mind wandering and ADHD share associations with factors such as difficulty with sustained attention (Barkley, 2015), fidgeting behaviour (Barkley, 2015; Carriere et al., 2013), and creativity (Baird et al., 2012). Interestingly, this logic has been used to justify hypotheses linking mind wandering to constructs that have previously been shown to be associated with ADHD (e.g., Baird et al., 2012). Further, individual differences in executive functioning have been linked to the proclivity to engage in mind wandering (McVay & Kane, 2010), while ADHD has also commonly been discussed in terms of executive dysfunction (Barkley, 2015). Other indirect support for this relationship comes from work examining the activity of the default mode network in those diagnosed with ADHD; a distributed neural network thought to be active during mind wandering (Liddle et al., 2011; McVay & Kane, 2010). As such, there is preliminary evidence to suggest an association between mind wandering and ADHD (McVay & Kane, 2010; Seli, Smallwood, et al., 2015, Franklin et al., 2014) although research to date does not suggest a perfect association. Somewhat surprisingly however, very few studies have examined this relationship directly (e.g., Franklin et al., 2014; Seli, Smallwood, et al., 2015; Shaw & Giambra, 1993).

One of the foundational studies evaluating this relationship was a study by Shaw and Giambra (1993). Using probes delivered during a vigilance task, they examined whether a childhood diagnosis of ADHD was associated with the propensity to mind wander in a small university sample (N = 13). Two non-clinical groups served as comparison: university students

who self-reported a high number of ADHD symptoms and university students who endorsed few ADHD symptoms. During the vigilance task, the participants were randomly probed and asked if their thoughts had wandered off-task, and whether this was deliberate or unintentional. Their results showed that those diagnosed with ADHD in childhood reported experiencing more unintentional off-task thoughts than the other two groups, while those who endorsed greater number of ADHD symptoms, despite having no diagnosis, had more unintentional off-task thoughts than those who reported having few ADHD symptoms. Importantly, this pattern of results may be due to an inability to inhibit unintentional mind wandering or because of an inability to recognize when one's thoughts have wandered off task (i.e., lack of meta-awareness; Franklin et al., 2014).

Franklin and colleagues (2014) also examined the association between mind wandering and ADHD symptoms, while incorporating measures of meta-awareness, executive functioning and creativity as well. Using laboratory tasks and experience sampling methodology utilizing personal digital assistants (PDA) in a university non-clinical sample, the authors show that “ADHD symptomology is related to mind wandering during lab tasks (as measured directly via thought probes and indirectly through SART errors) and in daily life” (p. 6). They further report that this relationship between detrimental mind wandering in daily life and ADHD symptoms is partially mediated by meta-awareness. While addressing an important gap in the literature, some caution in interpreting these findings may be warranted. Notably, this study used composite scores of ADHD symptoms, which may confound findings given the multi-dimensional nature of ADHD (i.e., symptoms within the inattention domain may be more closely related to mind wandering). Similarly, composite scores from several measures (i.e., ARCES, MFS, and IPI-Daydreaming Scale) were used to create a mind wandering score. This is problematic because: 1)

these measures have been argued to not provide a direct assessment of mind wandering but to rather measure related constructs (e.g., everyday cognitive failures, everyday memory failure; Mrazek, Phillips, Franklin et al., 2013), and 2) recent efforts have been made to encourage differentiation of spontaneous versus deliberate mind wandering (Seli, Carriere, et al., 2015).

Seli, Smallwood and colleagues (2015) addressed some of the above listed limitations by examining the relationship between ADHD symptomology and mind wandering in a large undergraduate sample, and by incorporating measures of deliberate and spontaneous mind wandering. In their analyses, they also included a ‘clinical’ group of undergraduate students who self-reported a previous diagnosis of ADHD. Consistent with the findings by Shaw and Giambra (1993), their analyses revealed that spontaneous mind wandering was associated with ADHD symptomology, whereas deliberate mind wandering was not. Of note, however, the authors incorporated a short-versions of a screening measure of ADHD (Adult ADHD self-report scale), thereby not differentiating the ADHD symptoms along the dimensions of inattention versus hyperactivity/impulsivity. This distinction may be important because ADHD symptom dimensions have been linked with different patterns of association (Overbey et al., 2011).

Most recently, Mowlem and colleagues (2016) examined mind wandering in adults with ADHD using a newly validated self-report measure of excessive mind wandering in this clinical group, called the Mind Excessively Wandering Scale. The findings, published post conception of the present study, revealed the importance of mind wandering in accounting for self-reported functional impairment above and beyond the impact of ADHD symptoms. In addition to reported significant correlations between mind wandering and the ADHD symptom dimensions of Inattention and Hyperactivity/Impulsivity, they also noted that improvement in mind wandering occurred in parallel with improvement in ADHD symptoms.

## **The Present Study**

ADHD symptoms have been linked to a greater propensity for mind wandering (Franklin et al., 2014; Mowlem et al., 2016; Seli, Smallwood, et al., 2015; Weyandt et al., 2003). Whereas some studies have examined this association directly, it remains unclear how this relationship may vary based on ADHD symptom dimensions. That is, given the difficulties characteristic of each symptom dimension (e.g., inattention symptoms versus hyperactivity symptoms), it is conceivable that mind wandering may be more strongly predicted by ADHD symptom dimensions that are more closely tied to inattention difficulties. The lack of research examining this association may be particularly problematic given that “it seems plausible that mind wandering is an important yet under-recognized source of difficulty in the everyday lives of individuals with ADHD symptoms” (Schooler et al., 2014, p. 15). In addition, despite growing recognition of the import of understanding the unique contribution of Sluggish Cognitive Tempo symptoms to a range of behavioural outcomes, to the best of my knowledge, no study to date has examined the relationship between mind wandering and Sluggish Cognitive Tempo directly.

Consequently, the present study sought to address some of the current gaps in the literature and limitations of previous research. This was done by: 1) including recently developed and validated measures of trait levels of mind wandering; 2) examining the unique versus overlapping contribution of the different symptom dimensions of ADHD; 3) exploring the relationship between trait levels of mind wandering and Sluggish Cognitive Tempo; and 4) controlling for contextual variables known to impact the propensity to experience mind wandering. In sum, the current study was designed to add to our understanding of the unique contributions of ADHD symptoms and Sluggish Cognitive Tempo in explaining variance in mind wandering, both spontaneous and deliberate.

Building on previous research, as well as, taking into consideration the differences between the symptom dimensions, it was hypothesized that ADHD symptoms that fall within the inattention domain, along with the Sluggish Cognitive Tempo symptoms, would have the strongest contribution in predicting the three mind wandering total scores. Further, given that differences between spontaneous and deliberate mind wandering have been published previously (Seli, Carriere, et al., 2015; Carriere et al., 2013), it was deemed unlikely that the same pattern of predictors would best account for variance in the different mind wandering scores. But due to limited prior research, no *a priori* hypotheses were proposed in regards to the question of which specific predictors would be significant for each of the different outcome measures.

## Methods

### Participants

Participants ( $N = 161$ , 77.64% female) were recruited via the existing participant pool system within the Department of Psychology at the University of Windsor. The obtained sample size is consistent with what was proposed (i.e.,  $N = 150$ ). This proposed sample size was obtained following an a priori power analysis conducted by incorporating information from the related study by Franklin and colleagues (2014).

Participation was open to anyone registered in the participant pool that was at least 18 years of age ( $M = 20.54$ ,  $SD = 3.89$ , range = 18-58). No restrictions on participation were made based on gender, race, socio-economic status, marital status, or neighbourhood of residence. Exclusion criteria were lack of English literacy and a self-reported history of traumatic brain injury resulting in loss of consciousness. Notably, two participants endorsed history of concussion, with one voluntarily specifying no loss of consciousness. Consequently, only one of the two participants who endorsed previous history of a concussion was removed from the

analyses. In addition, one participant was also removed from the analysis because they did not complete all of the key questionnaires. These exclusions resulted in a final sample size of 159.

The demographic composition of the sample is detailed in Table 1.

## **Procedure**

Data collection was conducted in person using paper-pencil questionnaires during a single session. Following the informed consent process, the participants were asked to complete a series of questionnaires in randomized order. The following questionnaires were in the battery: (1) Demographics form, (2) Barkley Adult ADHD Rating Scale – IV (BAARS-IV), (3) Mind Wandering Questionnaire (MWQ), (4) Mind Wandering Spontaneous (MW-S) and Mind Wandering Deliberate (MW-D) scales, (5) Medical Outcomes Study Sleep Scale and (6) Durham Caffeine Inventory. The sleep and caffeine measures were included in an effort to control for the impact of contextual variables that have been linked to mind wandering. For example, sleep quality has been shown to have a negative association with mind wandering (Carciofo et al., 2014). Poh and colleagues (2016) also present findings that highlight how sleep deprivation can impact mind wandering frequency. Similarly, recognizing the potential impact of caffeine on attention and alertness, a measure of caffeine use was included. This is in line with previous studies of mind wandering that either included a measure of caffeine (Kane et al., 2007) or had asked participants to refrain from caffeine use (Sayette et al., 2009). The data collection lasted approximately 30 minutes, and participants received 0.5 psychology course bonus points following completion of the questionnaires as specified by participant pool policies.

## **Measures**

**Demographics questionnaire.** Demographic information, including general information about identity, such as date of birth, race/ethnicity, marital status, and employment, as well as

information about the participants' medical history (e.g., clinical diagnoses received [i.e., ADHD]) and developmental history was collected. Participants were also requested to provide their current body weight in kilograms because previous studies that have included the caffeine intake measure (i.e., the Durham Caffeine Inventory) have controlled for this variable (Jones & Fernyhough, 2009). See Appendix E for a copy of the demographic questionnaire.

**Barkley Adult ADHD Rating Scale-IV (BAARS-IV; Barkley, 2011).** The BAARS-IV is a self-report measure of current ADHD symptoms with 27 items. The items on the questionnaire were devised with consideration of DSM-IV ADHD diagnostic criteria, but are consistent with the current diagnostic criteria based on the DSM-5 (APA, 2013). The participants were asked to answer items that specified to what extent each item described their behaviour over the past six months. The responses were provided on a Likert-type scale ranging from 1 (Never/Rarely) to 4 (Very Often). From the BAARS-IV, subscale scores for each of the ADHD symptom dimensions were calculated by summing the appropriate set of items: Inattention ( $\alpha = 0.83$ ), Hyperactivity ( $\alpha = 0.76$ ), and Impulsivity ( $\alpha = 0.72$ ). It was also possible to obtain a subscale score for Sluggish Cognitive Tempo. The internal consistency for this subscale was found to be good ( $\alpha = 0.85$ ). Barkley (2011) reports that the measure has satisfactory internal consistency, construct validity, discriminant validity and criterion validity. Table 2 includes descriptive statistics for each subscale.

Despite interest in examining the influence of ADHD symptoms on trait levels of mind wandering, the data analysed was collected from a predominantly non-clinical university sample. Corroborating this characterization of the sample, review of the reported ADHD symptom counts on the BAARS-IV revealed that only seven participants reported meeting the DSM-5 adult ADHD criteria. That is, they endorsed a minimum of 5 symptoms in both or either symptom

domain (i.e., inattention or hyperactivity/impulsivity) by indicating that the symptoms occur at least “often”, they reported that the onset of symptoms began before 12 years of age, and that they experience significant impairment in at least 2 settings (e.g., school, work). No corroboration of the self-report data was possible. Figure 1 illustrates the number of symptoms of endorsed for each of the ADHD dimensions – Inattention and Hyperactivity/Impulsivity.

**Mind Wandering Questionnaire (MWQ).** The MWQ is a recently developed and validated measure of trait levels of mind wandering (Mrazek, Phillips, Franklin et al., 2013). The questionnaire evaluates the frequency of mind wandering, irrespective of whether it is deemed to be deliberate or spontaneous. Defining mind wandering as “the interruption of task focus by task-unrelated thought”, the authors included the following five items in the scale: 1) I have difficulty maintaining focus on simple or repetitive work; 2) While reading, I find I haven’t been thinking about the text and must therefore read it again; 3) I do things without paying full attention; 4) I find myself listening with one ear, thinking about something else at the same time; and 5) I mind-wander during lectures or presentations. Participants are asked to specify to what extent each item describes them, with possible options ranging from Almost Never (1) to Almost Always (6). A mind wandering score was calculated by summing the ratings for the five items. The authors report good internal consistency and homogeneity (Mrazek, Phillips, Franklin et al., 2013). Calculation of Cronbach’s alpha for this scale was found to be 0.82. Table 2 includes descriptive statistics for the measure. See Appendix B for a copy of the questionnaire.

**Mind Wandering: Spontaneous (MW-S) and Mind Wandering: Deliberate (MW-D).** The MW-S and MW-D are both four-item self-report scales designed to examine deliberate and spontaneous mind wandering, respectively (Carriere et al., 2013). The scales were designed with the aim to address the existing gap in the literature about the importance of distinguishing

between trait levels of spontaneous versus deliberate types of mind wandering (Seli, Carriere et al., 2015). Spontaneous mind wandering is defined as “unintentional drifting of one’s thoughts from a focal task toward inner, task-unrelated thoughts” (Seli, Carriere, et al., 2015, p.2), and includes the following items: “I find my thoughts wandering spontaneously”, “I find my thoughts tend to be pulled from topic to topic”, “It feels like I don’t have control over when my mind wanders”, and “ I mind-wander even when I’m supposed to be doing something else” (Carriere et al., 2013, p. 22). In contrast, deliberate mind wandering is conceptualized as reflecting an “intentional or deliberate shift in attention toward internal thought” (p. 2), and is made up of these four items: “I allow my thoughts to wander on purpose”, “I enjoy mind wandering”, “I find mind wandering is a good way to cope with boredom”, and “I allow myself to get absorbed in pleasant fantasy” (Carriere et al., 2013, p.22). Both measures are scored using a 7-point Likert scale with possible options ranging from ‘rarely’ to ‘a lot’ for most items. For item 3 on the MW-S the options range ‘almost never’ to ‘almost always’, while for item 3 on the MW-D the possible options range from ‘not at all true’ to ‘very true’. For both scales, the responses from all four items were averaged, with higher values indicating greater frequency of spontaneous or deliberate mind wandering (Carriere et al., 2013). The measures are reported to have adequate psychometric properties and reliability (Seli, Carriere, et al., 2015). Internal consistency for both measures was found to be 0.86 for both the MW-S and MW-D (See Table 2 for descriptive statistics). Appendix C includes a copy of the MW-S and MW-D.

**Medical Outcomes Study Sleep Scale (MOS-SS).** The sleep scale, is part of a larger MOS health status questionnaire that evaluates six aspects of sleep over the past four weeks: time it takes to fall asleep, amount of sleep each night, maintenance of sleep, sleep-related respiratory problems, perceived adequacy of sleep, and sleepiness/drowsiness (Smith &

Wegener, 2003). For most items, the participant was asked to answer items using a Likert scale, with possibilities ranging from ‘All of the Time’ (1) to ‘None of the time’ (6), with the raw values later recoded in order to have scores ranging from 0 to 100. For the other items, the participants were asked to select what category best fits their sleep pattern and/or to estimate the average number of hours slept each night. Three scales deemed most relevant to the present study (i.e., sleep adequacy, sleep somnolence; and sleep problems index I) were calculated by averaging the scores from the appropriate set of items (Spritzer & Hays, 2003). Higher scores reflect greater impairment for the sleep somnolence and sleep problems indices, whereas lower scores reflect a greater problem for the sleep adequacy scale. Moreover, a sleep quantity score was also obtained, which only reflects the response given to item 2 of the measure. The internal consistency, variability, face validity, and discriminant validity are all reported to be satisfactory (Smith & Wegener, 2003). Cronbach’s alpha for each of the three scales was found to be 0.72, 0.69, and 0.65, respectively (Table 2).

**Durham Caffeine Inventory (DCI).** To collect information regarding caffeine consumption, the Durham Caffeine Inventory (Jones & Fernyhough, 2008) was used. The measure is designed to incorporate different categories of drink and food that include caffeine, such as coffee, tea, soft drinks, energy drinks, caffeine tablets, and chocolate. Respondents are asked to select the typical frequency of use of the item over the past year, with the possible responses typically ranging from (1) none/less than one per week to (12) 8+ per day. An average caffeine intake score for each item on the measure was calculated by taking into account the caffeine content of each item, and multiplying this value by the amount it is consumed on an average day. The individual scores are summed to obtain a total average intake score, which was in turn divided by the individual’s reported weight (in kilograms). This allowed for the

calculation of the average amount of caffeine consumed for each kilogram of body weight. The measure has been included in published studies that have been done with non-clinical/undergraduate samples (Crowe et al., 2011; Jones & Fernyhough, 2008). A copy of the Durham Caffeine Inventory and the scoring protocol were obtained following correspondence with a co-author (C. Fernyhough, personal correspondence, October 6, 2015). No information regarding psychometrics of the measure were available for review. The descriptive statistics for the Durham Caffeine Inventory is included in Table 2.

### **Statistical Analyses**

All analyses were conducted using the Statistical Package for Social Science (SPSS 22.0) for Mac, with the standard threshold of  $p < 0.05$  used to designate statistical significance.

In order to examine the unique contribution of ADHD and Sluggish Cognitive Tempo symptoms to trait levels of mind wandering, three separate hierarchical regression analyses were planned, with each of the mind wandering measures (i.e., MWQ, MW-D, and MW-S) serving as dependent variables. Hierarchical regression analysis was chosen because it allows for the examination of how much the major independent variables add to the prediction “over and above” the nuisance variables entered earlier (Cohen et al., 2003; Tabachnik & Fidell, 2006, p. 138).

For each of the three-step hierarchical regression analyses the plan was to follow the same hierarchical ordering of variables. In the first block, because mind wandering frequency has been reported to vary with age (Carriere et al., 2013; Diaz et al., 2014) the intention was to enter age first, if correlated with the outcome variable, in order to control for this potential confounding variable. Given that gender differences in mind wandering have not been identified, gender was not included the analyses. In line with this decision, no significant

difference in the endorsement of ADHD symptoms between genders was found in the current sample, both when examining total scores and symptom counts. Next, the plan was to enter the sleep and caffeine use variables in the second block of the hierarchical regression, as these variables may contribute to one's alertness and attention, with possible implications for experiencing mind wandering episodes (Carciofo et al., 2014; Wu, Lien, Chang, & Yang, 2014; Ottaviani et al., 2014). In block three, the ADHD variables (Inattention, Hyperactivity, and Impulsivity symptoms), as well as the Sluggish Cognitive Tempo variable were entered. The hierarchical order was determined by considering removal of confounding variables and research relevance (Cohen et al., 2003). Importantly, if the proposed variables were found to not correlate with the mind wandering measure they were not included in the analysis.

### **Missing Data**

Examination of the absence of data, including the pattern of missingness, was performed first. The amount of missing data calculated using the complete case method (McKnight et al., 2007) revealed that for the 161-participant dataset, the response rate was 27.33%. Closer examination of the cases that were missing data showed that most only had a few items omitted ( $M = 2.00$ ,  $SD = 1.65$ , range: 1 – 8), and only one participant had more items incomplete (27) due to not answering the entire BAARS-IV questionnaire. The participant who had not completed the BAARS-IV was removed from all subsequent analysis. Analysis of missing data using the sparse matrix method (i.e., amount of data not available within the whole matrix of data points) revealed a negligible overall-item-non-responses rate of 1.03%. Calculation of the sparse-matrix-to-complete-case ratio, which reflects the average amount of missing information for each participant who has incomplete items, yielded a value of 0.037 or 3.76%. No patterns

within the missing data were observed, suggesting a messy missing data pattern, which may be indicative that the data is missing completely at random (MCAR; McKnight et al., 2007).

Closer inspection of each proposed predictor variable (i.e., age, BAARS-IV, MOS-SS, and DCI) revealed overall item non-response rates that ranged from 0% to 2.53%. The highest proportion of missing values came from the DCI. This may be in part due to the wording of the questionnaire items. Specifically, 6 of the 15 items that composed the total score on the measure were worded such that an option to indicate no use or very infrequent use was not available. For instance, the most infrequent consumption of solid milk chocolate was “once a week”. As such, it is possible that individuals who left those set of items blank simply did not consume that type of food or drink. Despite effort to encourage participants to write “zero” for those items that did not apply to them, individuals who left *all* of the set of items corresponding to “other drinks” or “chocolate” incomplete were marked as having missing values. Not surprisingly, the DCI questionnaire items missing the greatest proportion of values were (5.0%) were: Cola-type drinks, Red Bull, Solid Milk Chocolate Bars, and Dark Chocolate Bars and Instant Coffee (not part of the two set of items). The remainder of the questionnaires had no more than a few incomplete items across all participants. One exception to that was question 2 of the MOS-SS, which had 5.0% of the sample missing a value for this item.

In regards to the mind wandering measures of interest, very few items were left incomplete. Specifically, for all of the individuals in the dataset, only one value was missing on the MWQ and on the MW-D. There were no missing data points for the MW-S.

Performance of Little’s MCAR test (Missing Completely at Random; Little, 1988) to determine the impact of the missing data, revealed a non-significant result ( $\chi^2 = 1901.16$ ;  $df =$

1919;  $p = 0.610$ ). This analysis, in line with the above visual inspection of the missing values, suggests that the unavailable information is at least Missing at Random (MAR).

### **Imputation of Missing Data**

The missing values were replaced using Expectation-Maximization (EM). This was deemed an appropriate method because of the small amount of missing data and the fact that the missing values were at least missing at random (Tabachnick and Fidell, 2006).

### **Checking of Assumptions**

Prior to interpreting the planned hierarchical regression analyses, the statistical assumptions were verified for each analysis. The assumptions include adequate sample size, independence of observations, normality, linearity and homoscedasticity, and non-multicollinearity.

Hierarchical regression requires adequate sample size. With a sample size of 159 (after removing the participant who did not complete the critical BAARS-IV measure and one participant who met the exclusion criteria), and a maximum of 10 potential predictors, the number of cases per predictor was 15.9. Correspondingly, this sample size falls within the typically recommended criteria of a minimum of 15 to 20 observations for each predictor entered in the model (Austin & Stayerberg, 2015; Tabachnick & Fidell, 2006). Decisively, none of the hierarchical regression analyses had more than 6 predictors (after removing variables not correlated with the outcome variable), resulting in a minimum of 26.5 cases per predictor. Finally, it is also important to note that simulation studies suggest that as few as 2 participants per predictor may be sufficient when conducting a regression analysis (Austin & Stayerberg, 2015). Post-hoc power analysis revealed that the statistical power for each of the models examined exceeded 0.95 (i.e., 1.00 [MWQ], 0.98 [MW-D] and 0.99 [MW-S]), indicating that the

sample size did not compromise power for these analyses. As such, the present sample size was deemed sufficient for the planned analyses.

A second assumption of the conducted set of analyses was the assumption of independence of observations (Field, 2013). Given that each case in the current dataset reflects information obtained from only one participant during a single time point, and taking into consideration that the individuals in the study had no previous relations that should influence responding on the trait questionnaires, there is a strong probability that there was no violation of this assumption. Further decreasing the likelihood of peer influence, participants were not permitted to interact while completing the questionnaires and there was enough physical space between respondents to ensure that the answers provided were not easily visible by other participants.

Next, multiple regression also assumes that there is an absence of outliers and influential observations (Cohen et al., 2003; Field, 2013; Tabachnick & Fidell, 2006). Examination of the absence of outliers and identification of extreme/influential values was conducted by examining the Mahalanobis' distance, leverage and Cook's  $d$  values. For the MWQ analysis, two cases had Mahalanobis' distance values greater than the critical chi-square value (alpha value = .001), and the same two cases were also flagged as extreme values after inspection of their leverage values (leverage values  $> 3(k+1)/N$ , Cohen et al., 2003). All of the Cook's  $d$  values did not exceed the threshold of 1 and none of the cases had standardized residual values greater than  $|3.29|$ . These two cases were removed prior to re-running the regression analysis ( $N = 157$ ). Similarly, three cases were removed for the regression analyses conducted predicting the MW-D and MW-S scores after inspection of the Mahalanobis' distance and leverage values, resulting in a sample

size of 156 for these sets of analyses. Furthermore, none of the cases had standardized residuals values greater than  $|3.29|$  for either analysis.

The assumption of normally disturbed errors was in part determined following inspection of the histograms and P-P plots. This review revealed that this assumption was met for the analyses conducted with the MWQ, MW-D and MW-S as separate dependent variables. Similarly, the assumptions of linearity and homoscedasticity were assessed using visual inspection of the scatterplots (Field, 2013). This revealed that both assumptions were met for each set of analyses. Additionally, the partial plots suggested absence of obvious outliers and homoscedasticity.

Lastly, review of the intercorrelations among the predictor variables and inspection of the collinearity diagnostics was done in order to evaluate whether the assumption of no multicollinearity was met. The bivariate correlations between each set of predictors and outcome variables are listed in Table 3. Notably, none of the correlations were greater than  $\pm .90$  (Tabachnick & Fidell, 2006). In addition, the variance inflation factor (VIF) values did not exceed 10 (MWQ = 1.14 – 2.39; MW-D range = 1.19 – 2.06; MW-S = 1.25 – 2.33), and all tolerance values were above 0.1 (MWQ = 0.42 – 0.88; MW-D = 0.49 - 0.84; MW-S = 0.43 – 0.46; Field, 2013). In sum, there was evidence of an absence of multicollinearity.

### **Results**

Endorsement of current diagnoses was not associated with any of the outcome variables of interest ( $p > .11$ ). Consequently, there was no need to control for these variables or to exclude participants who reported having a current diagnosis.

### **Predicting the MWQ Total Score**

Hierarchical multiple regression analysis were conducted to predict the overall MWQ score. In the proposed hierarchical entry of variables, age was to be entered in block 1, however because it did not correlate with the outcome variable ( $r = -.11, p = .17$ ) it was excluded from the analysis. Similarly, DCI and sleep quantity were also not included due to their non-significant associations with the MWQ total score (DCI:  $r = .12, p = .15$ , and sleep quantity:  $r = -.11, p = .17$ ). Although initially the plan was to enter the three remaining sleep related variables (i.e., sleep adequacy, sleep somnolence, and sleep problems) in block 1, due to large correlations between sleep adequacy and sleep problems ( $r = -.69$ ) and sleep somnolence and sleep problems ( $r = .65$ ), only sleep adequacy and sleep somnolence were entered in block 1. All of the four BAARS-IV subscales were entered in block 2.

The regression model predicting the MWQ score was significant ( $F(6,150) = 21.97, p < .001$ ), and accounted for 46.8% of the variance in MWQ ( $R^2_{adj.} = .45$ ; see Table 4 for a detailed summary of the analysis). This analysis showed that despite the significant correlations, when sleep adequacy (standardized  $\beta = -.03, t(156) = -0.47, p = .64$ ) and sleep somnolence (standardized  $\beta = .08, t(156) = 1.11, p = .27$ ) were added within block 1, they did not make a significant contribution to predicting the MWQ score. Similarly, addition of the hyperactivity (standardized  $\beta = .12, t(156) = 1.55, p = .12$ ) and impulsivity (standardized  $\beta = -.04, t(156) = -0.59, p = .56$ ) subscales of the BAARS concurrently in block 2 were also not significant. The other two BAARS subscales scores significantly predicted the outcome score, with the SCT score of the BAARS-IV having the strongest impact (standardized  $\beta = .42, t(156) = 4.75, p < .001$ ). The partial, part and structured coefficients are listed in Table 5.

### **Predicting the MW-D Score**

Parallel to the above analysis, a hierarchical regression predicting the MW-D score was planned with the same proposed ordering of variables in each block. Due to the fact that age ( $r = -.04, p = .64$ ), DCI score ( $r = -.01, p = .91$ ), sleep quantity ( $r = -.03, p = .73$ ), sleep adequacy ( $r = -.07, p = .41$ ), sleep somnolence ( $r = .15, p = .06$ ), sleep problems ( $r = .09, p = .27$ ), and BAARS hyperactivity subscale ( $r = .14, p = .08$ ) did not correlate with the MW-D score, these variables were discarded as possible predictors. This resulted in the entry of only the three BAARS-IV subscales (Inattention, Impulsivity, and SCT) in the model.

This analysis revealed that although the final model was significant ( $F(3,152) = 7.12, p < .001$ ) both the BAARS-IV Inattention subscale (standardized  $\beta = .15, t(155) = 1.36, p = .18$ ) and the BAARS-IV Impulsivity subscale (standardized  $\beta = -.01, t(155) = -.12, p = .90$ ) were not significant within the model. The BAARS-IV SCT subscale was identified as the only significant predictor with the model accounting for 12.3 % of the variance in MW-D ( $R^2_{adj.} = .11$ ; Table 6). Table 7 includes the partial, part and structured coefficients of the variables included in the regression analysis.

### **Predicting the MW-S Score**

The last multiple regression analysis were conducted to predict the overall MW-S score, following the same proposed hierarchical entry of variables. Age ( $r = -.09, p = .27$ ), DCI score ( $r = -.04, p = .61$ ), sleep quantity ( $r = -.13, p = .10$ ), and sleep adequacy ( $r = -.14, p = .08$ ) were not entered in the initial regression analysis because they were not correlated with the outcome variable. Due to the strong correlation between sleep somnolence and sleep problem ( $r = .65$ ), and given that sleep somnolence (i.e., sleepiness) is hypothesized to be theoretically more

strongly linked to mind wandering, sleep somnolence was entered alone in block 1. Each of the subscales of the BAARS-IV were entered in the second block of the analysis.

This analysis revealed that the model was significant ( $F(5,150) = 16.46, p < .001$ ), and accounted for 35.4% of the variance in MW-S ( $R^2_{\text{adj.}} = .33$ ). As reported in Table 8, sleep somnolence (standardized  $\beta = .08, t(155) = 1.12, p = .26$ ), BAARS-IV inattention (standardized  $\beta = .12, t(155) = 1.16, p = .25$ ) and BAARS-IV impulsivity (standardized  $\beta = -.04, t(155) = -0.56, p = .58$ ) did not make significant contributions. The BAARS-IV SCT score produced the greatest contribution to the model (standardized  $\beta = .37, t(155) = 3.81, p < .001$ ), followed by the BAARS-IV hyperactivity score (standardized  $\beta = .22, t(155) = 2.61, p < .01$ ). The structured coefficients for each variable are listed in Table 9.

### **Repeating the Analysis with the Non-imputed Data and All Variables**

The three sets of analyses were repeated with the non-imputed data to ensure the minimal imputation done did not skew findings. This repeat of the analyses revealed the same pattern of significant findings, with very similar  $R^2$  and regression coefficient values, increasing confidence in the current pattern of findings. Additionally, the same pattern of findings and very similar  $R^2$  values were obtained when all variables, irrespective of whether the bivariate correlations were significant, were entered in the regression analyses.

## **Discussion**

The present study was designed to add to our understanding of the relation between ADHD symptoms and mind wandering frequency. Specifically, building on the few studies that have addressed this question directly (Franklin et al., 2014; Seli, Smallwood, et al., 2015; Shaw & Giambra, 1993), hierarchical regression analyses were conducted in order to identify the unique contribution of each ADHD symptom dimensions on trait levels of mind wandering, both

deliberate and spontaneous. Further, unlike previous work, the potential predictive role of symptoms of a related proposed attention disorder (i.e., Sluggish Cognitive Tempo) was also examined.

The only consistently significant predictor across the sets of analyses conducted was endorsement of Sluggish Cognitive Tempo symptoms. Further, for the regression analyses where multiple predictors were found to be significant, the largest contribution came from the Sluggish Cognitive Tempo variable. This association with mind wandering may in part reflect the similar presentation of attention difficulties between these two constructs. For example, Sluggish Cognitive Tempo is characterized by salient problems with concentration and/or control of attention, including daydreaming, mental fogging, and reported feeling ‘spacey’ (Adams, Milich, & Fillmore, 2010; Barkley, 2015). In fact, it has been proposed that Sluggish Cognitive Tempo may reflect pathological mind wandering (Barkley, 2014). Notably, the present findings do not explain to what extent the proposed dimensions of Sluggish Cognitive Tempo (i.e., cognitive-inattentive versus behavioural-motoric; Barkley, 2014; Becker, Ciesielski, et al., 2016) may be responsible for the observed association between the two related constructs. Moreover, due to the paucity in our understanding of the underlying etiology of Sluggish Cognitive Tempo, and given the absence of previous studies examining this relationship directly, it is hard to provide conclusive reasoning to help explain the present findings. Further research is warranted.

In accordance with the positive significant correlation between the MWQ and MW-S score, both outcome measures were significantly predicted by ADHD symptoms, albeit different dimensions. As predicted, endorsement of inattention symptoms was found to be a significant predictor of mind wandering as measured by the MWQ, in addition to symptoms of Sluggish Cognitive Tempo. This aligns well with the nature of the items on the MWQ, as they are more

descriptive of the inability to maintain attention on a task at hand (e.g., “I have difficulty maintaining focus on simple or repetitive work” and “I do things without paying full attention”). On the other hand, in contrast to what was hypothesized, the hyperactivity symptoms, rather than inattention symptoms, significantly predicted spontaneous mind wandering. This finding may not be surprising when taken in light of the research suggesting that hyperactive symptoms in childhood manifest more as ‘internal restlessness’ in adulthood (APA, 2013; Wayandt et al., 2003). Further, this result is consistent with the findings reported by Carriere and colleagues (2013) who demonstrated a link between everyday fidgeting behaviour and spontaneous mind wandering. They suggested that the “strong pairing of spontaneous thought and spontaneous movement” may be explained by “the presence of an unmeasured third variable underlying them both, potentially in the form of a fundamental, nonspecific instability in all aspects of an individual's experience-whether mental or physical” (p. 29) This “fundamental tendency” was suggested to reflect a default state (Carriere et al., 2013), which fits with the implicated role of the default mode network in mind wandering (Mittner et al., 2014). Finally, disinhibition characteristic of the hyperactivity/impulsivity dimension of ADHD (Barkley, 2003), also aligns well with the proposed idea that inhibition difficulties may help explain the prevalence of mind wandering in this clinical group (Franklin et al., 2014).

In line with the findings of Seli, Smallwood, Cheyne and Smilek (2015), none of the ADHD symptom dimensions were associated with the deliberate mind wandering score. Further, although the Sluggish Cognitive Tempo symptom total was found to be a significant predictor, the amount of variance accounted for by the model was only twelve percent, which is considerably lower than the amount of variance accounted for by the other models. This suggests that the present set of predictors are inappropriate when trying explain the variance in deliberate

mind wandering, and adds credence to the import of differentiating between deliberate and spontaneous mind wandering. Further, the finding that only spontaneous and not deliberate mind wandering was linked to an ADHD symptom dimension, fits well with the argument that “it is the spontaneous, unintentional shifting of attention that seems closely relevant to ADHD symptomatology given that such experiences seem to reflect difficulties in controlled processing, problems with inhibiting distracting information, and unintentional task inattention” (Seli, Smallwood, et al., 2015, p. 630).

Mind wandering has been reported to decrease with age (Jackson & Balota, 2012), however in the current study, age was not found to be associated with mind wandering irrespective of the measure used, and thus it was not entered in any of the analyses. This finding for age may be due to the use of a sample with a relatively constricted age range (90.6% of the participants were between the ages of 18 and 22). Importantly, this limitation raises an important consideration for future work. Although there is evidence to suggest that mind wandering (Jackson & Balota, 2012), ADHD symptoms (APA, 2013; Biederman, Mick, & Faraone, 2000), and Sluggish Cognitive Tempo symptoms (Becker, Leopold, et al., 2016; Barkley et al., 2015) change across development the studies conducted to date have primarily utilized university samples. As such, there is a dearth of research investigating how the examined associations vary with age.

Similarly, none of the contextual variables were found to be significant predictors in the analyzed regression models. This may in part be explained by appreciating the association between these variables (e.g., Sluggish Cognitive Tempo symptoms are associated with sleep difficulties, such as somnolence; Langberg, Becker, Dvorsky, & Luebbe, 2014). Consequently, it may be that that shared variance between the constructs helps explain why the contextual

variables were not significant when entered in the same model with the ADHD and Sluggish Cognitive Tempo symptoms. That is, the variance driving the relation between the contextual variable (e.g., sleep somnolence) and mind wandering may be redundant because it is already accounted for in the model by the relation between Sluggish Cognitive Tempo and mind wandering.

Interpreting the present results within the broader mind wandering literature, the conclusions drawn align well with evidence stemming from functional imaging studies supporting a relationship between mind wandering and ADHD. As mentioned above, mind wandering has been linked to activity in a group of brain regions referred to as the default-mode network, which includes the following key neuroanatomical areas: the medial prefrontal cortex, the posterior cingulate cortex, and the posterior temporoparietal junction (Christoff et al., 2009; Mason et al., 2007). Activity in this neural network has been implicated to reflect a “psychological baseline that emerges when the brain is otherwise unoccupied” (Mason et al., 2007, p. 394), whereas a decrease in activity in the default-mode network is observed with increase task demands (Liddle et al., 2011). Congruently, lowered deactivation of the default-mode network has been associated with increased attentional lapses, leading to poor task performance (Fassbender et al., 2009; Liddle et al., 2011). It follows that insufficient down-regulation of the default-mode network during tasks has been linked to the attentional difficulties characteristic of ADHD (Fassbender et al., 2009; Liddle et al., 2011; Peterson et al., 2009; Sonuga-Barke & Castellanos, 2007). As such, the present findings supporting a link between mind wandering and ADHD fit with what is currently known about the neural underpinnings of mind wandering.

The results, however, need to be interpreted in light of a few limitations. Most notably,

the study exclusively utilized self-report questionnaires to obtain information on ADHD and Sluggish Cognitive Tempo symptoms, as well as trait levels of mind wandering. As such, it is not possible to eliminate all doubt regarding the accuracy of the retrospective reports, or to corroborate the reports by obtaining information from knowledgeable informants (e.g., endorsement of ADHD symptoms by those who know them well). This may be particularly important when measuring some constructs (e.g., Sluggish Cognitive Tempo), as certain informants (e.g., teachers) may be better able to detect these symptoms (Becker, Leopold, et al., 2016). That said the present findings are in line with previous research (Seli, Smallwood, et al., 2015, Shaw & GAMBRIA, 1993), despite use of different measures (e.g., use of the Barkley Adult ADHD Rating Scales versus the Adult ADHD Self-Report Scale) and methodologies (e.g., use of questionnaire data versus probe-caught estimates of mind wandering). In a similar light, following data completion in the present study, two novel measures were designed, one to capture the unique set of Sluggish Cognitive Tempo symptoms (i.e., The Adult Concentration Inventory; Becker et al., 2017), and one to examine mind wandering among adults with ADHD (i.e., The Mind Excessively Wandering Scale; Mowlem et al., 2016). Future studies investigating these constructs in adults should consider use of these newly validated measures. A related potential concern was that the data was obtained from undergraduate students rather than a validated clinical sample. Because only 7 participants endorsed ADHD symptom levels above diagnostic thresholds, and only 2 participants reported having previously been diagnosed with ADHD, it was not possible to examine this ‘clinical’ subsample separately. Thus, building on previous work, which applied the conceptualization of an ADHD clinical group as individuals who provided an uncorroborated report of a previous diagnosis of ADHD (Seli, Smallwood, et al., 2015; Shaw & GAMBRIA, 1993), future research would benefit from examining the link

between mind wandering and ADHD symptoms using a screened clinical sample (e.g., recruiting patients from an ADHD clinic to control for variation in diagnostic practices). This sample selection would also potentially increase access to clinician-rated symptoms to be used in any analyses. Next, there is growing recognition that mind wandering is not a uniform experience and may vary in terms of temporal orientation (e.g., past- or future-oriented; Smallwood, Nind et al., 2009), self- or other-related focus (Ruby, Smallwood, Engen et al., 2013), and meta-awareness (Franklin et al., 2014). As such, parallel to the importance of accounting for the intentionality of mind wandering in understanding the association between the constructs explored, it is plausible that the other facets of mind wandering may play a similar role. The present study was not able to address this, revealing a possible focus for future work.

The present findings are important in several ways. First, adding to the limited research conducted on the Sluggish Cognitive Tempo construct, the dissociable findings between Sluggish Cognitive Tempo and the ADHD symptom dimensions lend further support to the idea that these are distinct constructs. Second, extending on previous work, the relation between spontaneous mind wandering and ADHD symptoms held, even after controlling for important contextual factors, reflecting stability in the association between these variables. Third, in appreciation of recent efforts geared toward developing self-report measures that uniquely capture the mind-wandering construct, this is the first study to date that has compared multiple measures of trait-levels of mind wandering, revealing an important finding for future consideration. Specifically, apart from the consistent role of Sluggish Cognitive Tempo in predicting mind wandering, what significant predictors were left in the final regression models varied based on the outcome measure used. This has important implications for establishing consistency and fostering adequate comparison across studies. Finally, by helping elucidate the

relationship between different types of mind wandering and dimensions of ADHD symptoms, the present study reaffirms the need to focus on spontaneous mind wandering as a potentially important area of difficulty among those with ADHD. More work is needed however to validate the result highlighting the potential role of the hyperactive symptom presentation in this relationship. As others have suggested (Seli, Smallwood, et al., 2015), this in turn emphasizes a potential focus for remediation and intervention among individuals with ADHD.

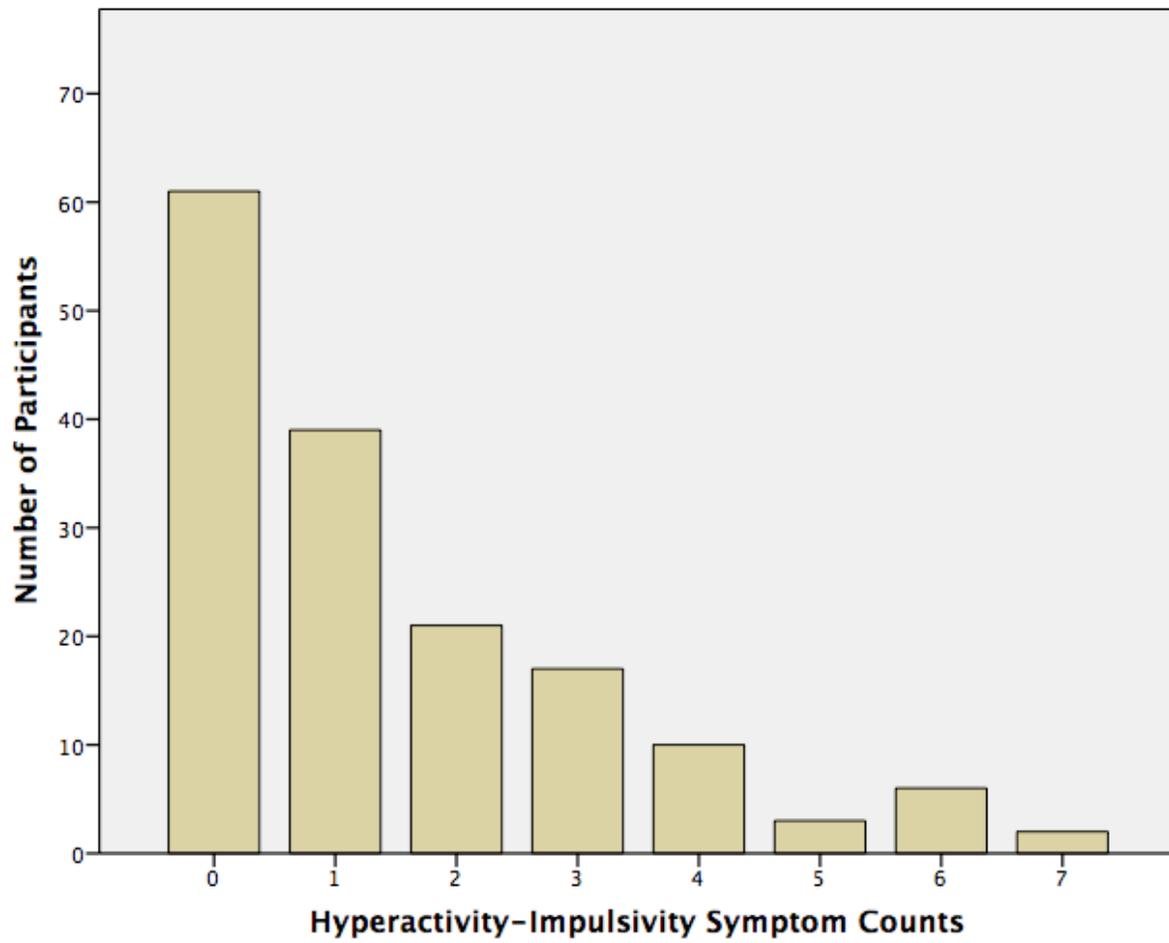


Figure 1a. Number of ADHD inattention symptoms endorsed by participants enrolled in the study.

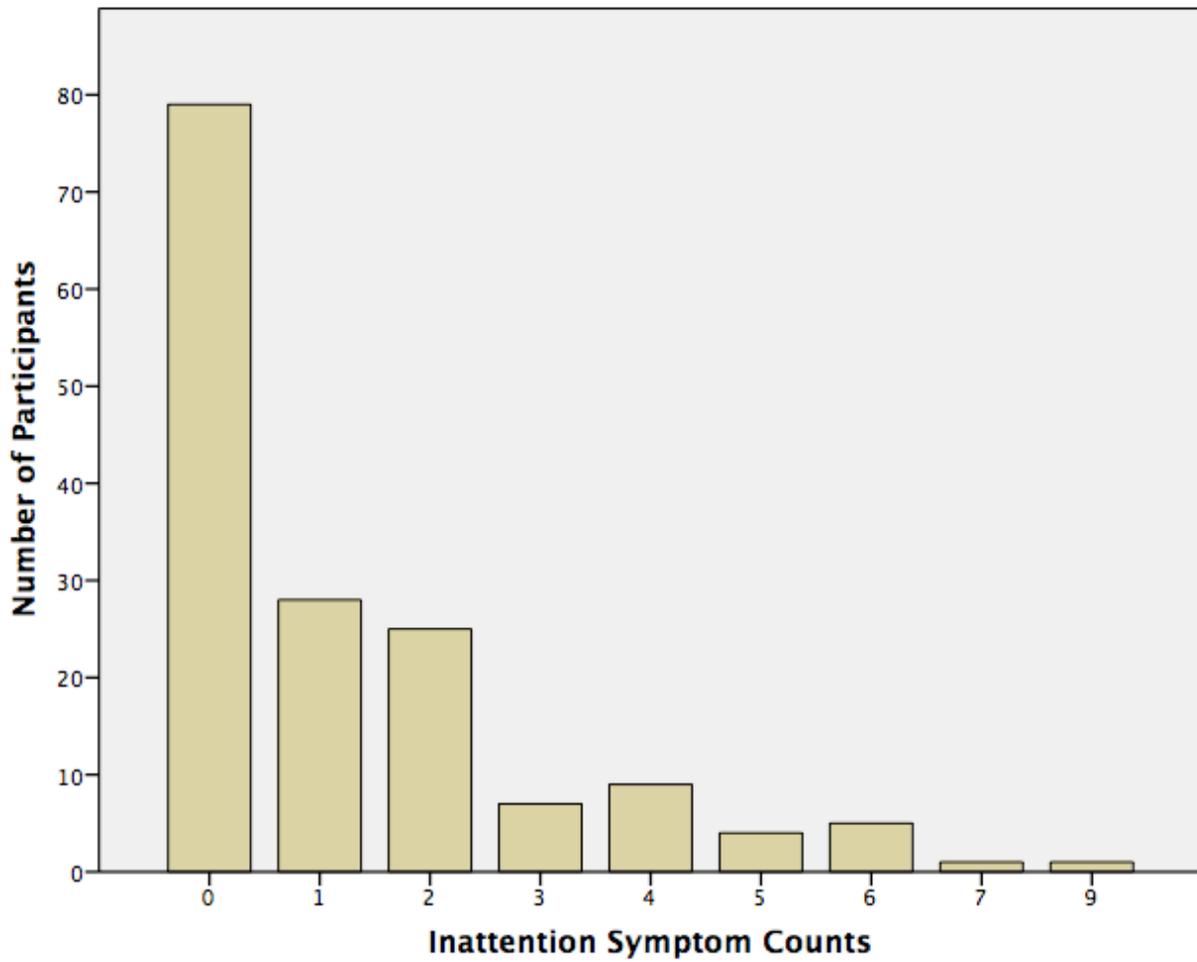


Figure 1b. Number of ADHD hyperactivity-impulsivity symptoms endorsed by the participants enrolled in the study.

Table 1

*Demographic Characteristics of the Sample*

<b>Variable</b>	<b>N</b>	<b>% of sample</b>
<b>Gender</b>		
Female	125	78.6
Male	34	21.4
<b>Race/Ethnicity</b>		
Asian	20	12.6
Hispanic/Latino	3	1.9
Non-Hispanic Black	16	10.1
Caucasian	93	58.5
Arab/Middle Eastern	16	10.1
Other/Mixed Race	10	6.3
Prefer not to answer	1	0.6
<b>Year of University</b>		
First year	36	22.6
Second year	42	26.4
Third year	37	23.3
Fourth year	40	25.2
Fifth year or beyond	4	2.5
<b>Education</b>		
High School Diploma	139	87.4
College Degree	8	5.0
Bachelor's Degree	12	7.5
<b>Marital Status</b>		
Single	102	64.2
In a Romantic Relationship	52	32.7
Married/Civil Union	4	2.5
Missing/Prefer not to answer	1	0.6
<b>Employment<sup>a</sup></b>		
Full-time Employed	15	9.4
Part-time Employed	101	63.5
Unemployed/not volunteering	41	25.8
Missing/Prefer not to answer	2	1.3
<b>Diagnoses currently endorsed</b>		
Attention-deficit/Hyperactivity Disorder	1	0.6
Seizure disorder	2	1.3
Learning disorder	3	1.9
Mental Health disorder	24	15.1

<sup>a</sup>. Employment rates includes volunteering positions

Table 2

*Descriptive Statistics for the Self-Report Measures*

<b>Measure</b>	<b>Number of Items Included in Score</b>	<b>Mean</b>	<b>SD</b>	<b>Range</b>	<b>Cronbach's alpha</b>
DCI	15	2.31	3.27	0.0 – 29.77	N/A
Sleep Quantity <sup>a</sup>	1	6.64	1.50	1.0 – 10.0	N/A
Sleep Adequacy <sup>a</sup>	2	42.26	25.03	0.0 – 100.0	0.72
Sleep Somnolence <sup>a</sup>	3	39.87	22.52	0.00 – 100.0	0.69
Sleep Problems <sup>a</sup>	6	39.99	16.88	3.33 – 86.67	0.65
BAARS-IV Inattention <sup>b</sup>	9	15.12	4.37	9.0 – 31.0	0.83
BAARS-IV Hyperactivity <sup>b</sup>	5	8.80	3.09	5.0 – 18.0	0.76
BAARS-IV Impulsivity <sup>b</sup>	4	6.32	2.21	4.0 – 12.0	0.72
BAARS-IV SCT <sup>b</sup>	9	17.17	5.12	9.0 – 30.0	0.82
MWQ	5	17.45	4.57	5.0 – 29.0	0.82
MW-D	4	3.90	1.39	1.0 – 7.0	0.86
MW-S	4	3.67	1.45	1.0 – 7.0	0.86

*Note:* DCI = Durham Caffeine Inventory Total Score (score was calculated controlling for weight);

<sup>a</sup>Subscales calculated from the Medical Outcomes Study Sleep Scale; <sup>b</sup>Subscales calculated from the Barkley Adult ADHD Rating Scale; MWQ = Mind Wandering Questionnaire; MW-D = Mind Wandering – Deliberate Scale; MW-S = Mind Wandering – Spontaneous Scale

Table 3

*Intercorrelations Between all Proposed Variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	1	.04	.02	.08	-.07	-.04	-.06	-.14	-.01	-0.01	-.11	-.04	-.09
2. DCI		1	-.07	-.09	.22†	.07	.19*	.09	.15	.04	.12	-.01	-.04
3. Sleep Quantity <sup>a</sup>			1	.48‡	-.27†	-.42‡	.24†	-.30‡	-.22†	-.12	-.11	-.03	-.13
4. Sleep Adequacy <sup>a</sup>				1	-.35‡	-.69‡	-.14	-.09	-.06	-.15	-.17*	-.07	-.14
5. Sleep Somnolence <sup>a</sup>					1	.65‡	.34‡	.13	.21†	.42‡	.38‡	.15	.31‡
6. Sleep Problems <sup>a</sup>						1	.31‡	.19*	.21†	.40‡	.30‡	.09	.32‡
7. Inattention <sup>b</sup>							1	.52‡	.37‡	.67‡	.60‡	.32‡	.47‡
8. Hyperactivity <sup>b</sup>								1	.47‡	.38‡	.41‡	.14	.42‡
9. Impulsivity <sup>b</sup>									1	.35‡	.29‡	.16*	.27†
10. Sluggish Cognitive Tempo <sup>b</sup>										1	.63‡	.30‡	.55‡
11. MWQ											1	.31‡	.59‡
12. MW-D												1	.43‡
13. MW-S													1

*Note.* <sup>a</sup> Subscales calculated from the Medical Outcomes Study Sleep Scale; <sup>b</sup> Subscales calculated from the Barkley Adult ADHD Rating Scale; DCI = Durham Caffeine Inventory Total Score (score was calculated controlling for weight); MWQ = Mind Wandering Questionnaire; MW-D = Mind Wandering – Deliberate Scale; MW-S = Mind Wandering – Spontaneous Scale

\*  $p < .05$ ; †  $p < .01$ ; ‡  $p < .001$

Table 4

*Summary of the Hierarchical Regression Analysis Predicting the MWQ Score (N=156)*

	<i>B</i>	<i>SE B</i>	$\beta$	<i>p</i>	<i>R</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$
Step 1					.35	.12	.12
Constant	15.06	1.09					
Sleep Adequacy	-0.01	0.01	-0.05	.57			
Sleep Somnolence	0.07	0.02	0.33	< .001			
Step 2					.68	.47	.35
Constant	6.08	1.33					
Sleep Adequacy	-0.01	0.01	-0.03	.64			
Sleep Somnolence	0.02	0.01	0.08	.27			
BAARS-IV Inattention	0.24	0.10	0.22	.02			
BAARS-IV Hyperactivity	0.18	0.11	0.12	.12			
BAARS-IV Impulsivity	-0.08	0.14	-0.04	.56			
BAARS-IV SCT	0.37	0.08	0.42	<.001			

*Note.* BAARS-IV Inattention = Barkley Adult ADHD Rating Scale – Inattention subscale; BAARS-IV Hyperactivity = Barkley Adult ADHD Rating Scale – Hyperactivity subscale; BAARS-IV Impulsivity = Barkley Adult ADHD Rating Scale – Impulsivity subscale; BAARS-IV SCT = Barkley Adult ADHD Rating Scale – Sluggish Cognitive Tempo subscale.

Table 5

*Correlations of Predictors Entered in the Model With the MWQ Score*

	<b>Zero-Order Correlation</b>	<b>pr</b>	<b>pr<sup>2</sup></b>	<b>sr</b>	<b>sr<sup>2</sup></b>	<b>Structure Coefficient</b>	<b>Squared Structured Coefficient</b>
Sleep Adequacy	-.16	-.04	.002	-.03	.001	-.23	.05
Sleep Somnolence	.34	.09	.008	.07	.005	.50	.25
BAARS-IV Inattention	.59	.19	.036	.14	.020	.86	.74
BAARS-IV Hyperactivity	.39	.13	.017	.09	.008	.57	.32
BAARS-IV Impulsivity	.26	-.05	.003	-.04	.002	.38	.14
BAARS-IV SCT	.64	.36	.130	.28	.078	.94	.88

*Note.* pr = partial correlation, sr = part correlation (or semi-partial correlation)

BAARS-IV Inattention = Barkley Adult ADHD Rating Scale – Inattention subscale; BAARS-IV Hyperactivity = Barkley Adult ADHD Rating Scale – Hyperactivity subscale; BAARS-IV Impulsivity = Barkley Adult ADHD Rating Scale – Impulsivity subscale; BAARS-IV SCT = Barkley Adult ADHD Rating Scale – Sluggish Cognitive Tempo subscale.

Table 6

*Summary of the Hierarchical Regression Analysis Predicting the MW-D Score (N=156)*

	<i>B</i>	<i>SE B</i>	$\beta$	<i>p</i>	<i>R</i>	<i>R</i> <sup>2</sup>
Constant	2.09	0.47			.35	.12
BAARS-IV Inattention	0.05	0.04	0.15	.18		
BAARS-IV Impulsivity	-0.01	0.05	-0.01	.90		
BAARS-IV SCT	0.07	0.03	0.24	.03		

*Note.* BAARS-IV Inattention = Barkley Adult ADHD Rating Scale – Inattention subscale; BAARS-IV Impulsivity = Barkley Adult ADHD Rating Scale – Impulsivity subscale; BAARS-IV SCT = Barkley Adult ADHD Rating Scale – Sluggish Cognitive Tempo subscale.

Table 7

*Correlations of Predictors Entered in the Model with the MW-D Score*

	<b>Zero-Order Correlation</b>	<b>pr</b>	<b>pr<sup>2</sup></b>	<b>sr</b>	<b>sr<sup>2</sup></b>	<b>Structure Coefficient</b>	<b>Squared Structured Coefficient</b>
BAARS-IV Inattention	.31	.11	.01	.10	.01	.88	.77
BAARS-IV Impulsivity	.13	-.01	.00	-.01	.00	.37	.14
BAARS-IV SCT	.34	.17	.03	.17	.03	.97	.94

*Note.* pr = partial correlation, sr = part correlation (or semi-partial correlation)

BAARS-IV Inattention = Barkley Adult ADHD Rating Scale – Inattention subscale; BAARS-IV Impulsivity = Barkley Adult ADHD Rating Scale – Impulsivity subscale; BAARS-IV SCT = Barkley Adult ADHD Rating Scale – Sluggish Cognitive Tempo subscale.

Table 8

*Summary of the Hierarchical Regression Analysis Predicting the MW-S Score (N=156)*

	<i>B</i>	<i>SE B</i>	$\beta$	<i>p</i>	<i>R</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$
Step 1					0.28	0.08	0.08
Constant	2.92	0.23					
Sleep Somnolence	0.02	0.01	0.28	<.001			
Step 2					0.60	0.35	0.28
Constant	0.31	0.40					
Sleep Somnolence	0.01	0.01	0.08	.26			
BAARS-IV Inattention	0.04	0.04	0.12	.25			
BAARS-IV Hyperactivity	0.11	0.04	0.22	.01			
BAARS-IV Impulsivity	-0.03	0.05	-0.04	.58			
BAARS-IV SCT	0.10	0.03	0.37	<.001			

*Note.* BAARS-IV Inattention = Barkley Adult ADHD Rating Scale – Inattention subscale; BAARS-IV Hyperactivity = Barkley Adult ADHD Rating Scale – Hyperactivity subscale; BAARS-IV Impulsivity = Barkley Adult ADHD Rating Scale – Impulsivity subscale; BAARS-IV SCT = Barkley Adult ADHD Rating Scale – Sluggish Cognitive Tempo subscale.

Table 9

*Correlations of Predictors Entered in the Final Model with the MW-S Score*

	<b>Zero-Order Correlation</b>	<b>pr</b>	<b>pr<sup>2</sup></b>	<b>sr</b>	<b>sr<sup>2</sup></b>	<b>Structure Coefficient</b>	<b>Squared Structured Coefficient</b>
Sleep Somnolence	.28	.09	.01	.07	.005	.47	.22
BAARS-IV Inattention	.49	.09	.01	.08	.01	.82	.67
BAARS-IV Hyperactivity	.39	.21	.04	.17	.03	.66	.44
BAARS-IV Impulsivity	.26	-.05	.002	-.04	.002	.44	.19
BAARS-IV SCT	.54	.30	.09	.25	.06	.91	.83

*Note.* pr = partial correlation, sr = part correlation (or semi-partial correlation)

BAARS-IV Inattention = Barkley Adult ADHD Rating Scale – Inattention subscale; BAARS-IV

Hyperactivity = Barkley Adult ADHD Rating Scale – Hyperactivity subscale; BAARS-IV Impulsivity =

Barkley Adult ADHD Rating Scale – Impulsivity subscale; BAARS-IV SCT = Barkley Adult ADHD Rating Scale – Sluggish Cognitive Tempo subscale.

## CHAPTER 4

### Study III

#### **Examining the utility of a mindfulness training on reducing trait levels of mind wandering in an community sample**

Mind wandering, defined as off-task mentation that is self-generated, is a common daily experience (Smallwood & Schooler, 2015). It is frequently described with reference to an anecdotal illustration of the phenomenon: noticing that our mind has drifted away from the passage we are reading without intention (McVay et al., 2009; Smallwood & Andrews-Hanna, 2013). Yet, although the unintentional feature is descriptive of many instances of mind wandering, there is growing evidence that mind wandering can also be deliberate (for review see Seli, Risko, Smilek, & Schacter, 2016). In other words, mind wandering can occur with intention as is witnessed when individuals choose to engage in off-task thought (e.g., engaging in pleasant fantasy; Carriere, Seli, & Smilek, 2013). Correspondingly, individuals can vary in trait levels of both spontaneous and deliberate mind wandering (Seli, Carriere et al., 2015), similar to earlier efforts to examine dispositional mind wandering viewed more homogenously (e.g., McVay et al., 2009; Mrazek, Phillips, Franklin et al., 2013). Notably, this distinction despite being relatively overlooked until recently is important because “these two types of mind wandering are differentially associated with other individual traits and that conflating these types of mind wandering can lead to incorrect general conclusions about mind wandering and its associates” (Seli, Carriere et al., 2015, p.750).

Early efforts have generally concentrated on examining the negative consequences of mind wandering (Ottaviani, & Couyoumdjian, 2013; Smallwood & Schooler, 2015). These include investigations highlighting the potential of mind wandering to disrupt cognitive processing. For

example, periods of mind wandering have shown to interfere with performance on sustained attention tasks (Mooneyham & Schooler, 2013). Similarly, the negative influence of mind wandering on measures of working memory and general cognitive ability and aptitude have also been documented (Mrazek, Smallwood, Franklin et al., 2012; Mrazek, Franklin, Phillips et al., 2013; Smallwood & Andrews-Hanna, 2013; Schooler et al., 2014). Further, it is well acknowledged that mind wandering can be detrimental to everyday task performance such as reading (Franklin et al., 2011; McVay & Kane, 2010; Mooneyham & Schooler, 2013; Smallwood et al., 2008), comprehension of lecture information (Smallwood et al., 2007; Szpunar et al., 2013), and poor job productivity (Hoogland, 2011). This may be especially worrisome for tasks and jobs that require constant vigilance, such as driving (Galera et al., 2012), and in which lapses in attention can have detrimental consequences (e.g., medical decision-making; Smallwood, Mrazek & Schooler, 2011). Finally, negative mood has been associated with mind wandering (Killingsworth & Gilbert, 2010), although this relationship is influenced by content and context (Smallwood & Andrews-Hanna, 2013). In fact it seems that most prefer to be engaged in an activity even one that involves unpleasant stimulation over spending time thinking on their own (Wilson et al., 2014).

Given the recognized negative consequences of mind wandering the motivation to reduce the associated negative outcomes should be clear (Schooler et al., 2014, Smallwood & Schooler, 2015). Correspondingly different strategies have been tried, including attempts to decrease mind wandering by improving engagement in an activity (Smallwood & Schooler, 2015). This is supported by empirical data that show increasing interest in the topic of the reading material as well as motivation to read it can decrease the likelihood of mind wandering; these factors have shown to be predictive of mind wandering during a reading task (Unsworth & McMillan, 2013).

Efforts to improve awareness of the content of ones' thoughts (i.e., meta-awareness) have also been suggested (Smallwood & Schooler, 2015). Lastly, mindfulness-training strategies have gained popularity in diminishing the adverse effects of mind wandering (Schooler et al., 2014; Smallwood, Mrazek, & Schooler, 2011; Smallwood & Schooler, 2015).

Mindfulness, originally stemming from the Buddhist tradition, was initially secularized and introduced into clinical practice by Jon Kabat-Zinn (Baer, 2003; Jankowski & Holas, 2014). Kabat-Zinn (2003) defines it as “the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment” (p. 145). This ability can be fostered via practice with meditation exercises (Baer, 2003). Addressing the absence of an operational definition of mindfulness, Bishop and colleagues (2004) proposed that mindfulness can be viewed as being made up of two components: 1) “self-regulation of attention so that it is maintained on immediate experience”, and 2) judging “one’s experiences in the present moment, [with] an orientation that is characterized by curiosity, openness, and acceptance” (p. 232). As such, irrespective of differences in definition, it is commonly accepted that a key aspect of mindfulness is sustained attentiveness (Mrazek, Smallwood, & Schooler, 2012). Of note, although an increase in mindfulness can be encouraged with training, there exist innate differences within and across individuals (Brown & Ryan, 2003; Walsh, Balint, Smolira, Fredericksen, & Madsen, 2009).

Mindfulness can be disrupted in a number of ways (e.g., impulsive decision-making or rumination; Brown & Ryan, 2003). Similarly, attention diverted from an ongoing task (i.e., mind wandering) can undermine a state of mindfulness (Brown & Ryan, 2003). In fact, mind wandering is frequently referred to as the opposite of mindfulness (Mrazek, Smallwood, & Schooler, 2012; Schooler et al., 2014, Mrazek, Mooneyham, & Schooler, 2014). Support for this idea comes from

research showing that individuals who score high on questionnaire measures of mindfulness show fewer indices of mind wandering on self-report and experimental measures (Cheyne et al., 2006; Mrazek, Smallwood, & Schooler, 2012), as well as from findings demonstrating that expert meditators report fewer episodes of mind wandering (Brandmeyer & Delorme, 2016).

Neuroimaging findings also shed support for this comparison. Whereas activity in the default mode network is observed during mind wandering (Mason et al., 2007), mindfulness training has been reported to lessen brain activity in this region (Tang et al., 2009; Brewer et al. 2011).

Despite growing acknowledgement that mind wandering and mindfulness may be understood as representing opposite ends of a spectrum (Mrazek et al., 2014) only relatively recently has more research attention been given to investigations examining the benefit of mindfulness practice in curbing mind wandering. Mrazek, Smallwood and Schooler (2012) conducted two foundational studies examining the relationship between these two opposing constructs. As theoretically predicted, they show a significant negative relationship between trait mindfulness and trait mind wandering. Of note however, for their measure of trait mind wandering they used the Daydreaming subscale from the Imaginal Processes Inventory, which has been suggested to not accurately measure the construct of mind wandering (Mrazek, Phillips, Franklin et al., 2013). The authors also report findings that a short period of mindfulness training (8 minutes of mindful breathing) can attenuate mind wandering during an experimental task in a group of sixty undergraduate students, in comparison to a period of passive reading or relaxation. In this study, mind wandering was measured indirectly by examining performance on a Go/No Go task (sustained attention to response task (SART); SART errors and response time coefficient of variability).

The utility of mindfulness training in reducing mind wandering during cognitive tasks has also received some attention. Eight 45-minute sessions of mindfulness training spread over two weeks were shown to improve performance on a verbal Graduate Record Examinations (GRE) measure and on a task of working memory capacity (operation span; OSPAN), as well as reduce mind wandering measured using self-caught and probe-caught probes delivered during the GRE task and using a retrospective self-report questionnaire following the OSPAN task (Mrazek, Franklin, Phillips et al., 2013). Mediation analysis revealed that change in mind wandering mediated the change in GRE and OSPAN performance for those participants who reported mind wandering at the baseline assessment. Morrison and colleagues (2014) also report positive outcomes following mindfulness training conducted over 7 weeks; each week participants received 20 minutes of training facilitated by an instructor in addition to 20 minutes of audio-led practice done twice weekly in the laboratory. Specifically, the authors reported better performance on an experimental task (SART) and fewer probe-caught reports of mind wandering following mindfulness training. They concluded that, “the short-form MT [mindfulness training] program herein, may have protected against a propensity for increase mind wandering over the academic semester” (p. 9). More recently, reductions in probe-caught mind wandering and mindless reading have been reported following 3 months of intensive concentration meditation training, as well as after 1 month of intensive insight meditation training (Zanesco et al., 2016). Notably, no trait measures of mindfulness or mind wandering were included in any of the studies.

Prophylactic effects of mindfulness training have also been described. Studies examining military service personnel have demonstrated protective effects of mindfulness training against cognitive decline during the stressful and intense pre-deployment period (Jha, Stanley, Kiyonaga, Wong & Gelfand, 2010; Jha et al., 2015), including preventing increases in mind wandering

assessed using SART (Jha et al., 2017). Comparable findings have been reported among college athletes demonstrating greater engagement during pre-season training (Rooks et al., 2017). Interestingly significant changes in self-reported mind wandering measured using imbedded probes were not found (Jha et al., 2015; Jha et al., 2017; Rooks et al., 2017).

The benefits produced from mindfulness-based interventions have been demonstrated irrespective of the mode of delivery. Whereas the majority of the intervention studies conducted to date have involved either in-person meditation sessions or utilized pre-recorded audio files, reductions in mind wandering following mindfulness training were also demonstrated following an intervention delivered completely online (Bennike, Wieghorst, & Kirk, 2017). Specifically, the authors report reductions in mind wandering (measured using an index of the SART) and improvements in mindfulness (assessed using a self-report measure of trait mindfulness) following a 30-day-online delivery of a mindfulness-based intervention.

In line with the described findings, recent efforts have also been directed at identifying aspects and variants of mindfulness training that may be critical in promoting positive outcomes. Rahl and colleagues (2017) report findings that attributed a decrease in mind wandering (measured using an index of the SART) following 3 days of 20-minutes of mindfulness training to fostering an accepting and nonjudgmental attitude toward one's internal experiences. Interestingly, whereas mindfulness sessions that incorporated acceptance training produced greater reductions in mind wandering than training sessions emphasizing only attention-monitoring (i.e., focusing on the breath and noticing one's internal thoughts and emotions), no comparable improved benefit was obtained when compared to relaxation-training sessions. Additionally, comparisons done between different types of mindfulness training have also suggested that not all content and delivery methods are equal. For example, a study done with

military service members demonstrated that mindfulness training programs that prioritized in class practice of mindfulness exercises over didactic-focused training were associated with greater resilience against declines in attention during the highly stressful pre-deployment period (Jha et al., 2015).

Whereas the above pattern of findings is very promising, it is worth noting that the research on the positive impact of mindfulness training on reductions in mind wandering has not been unequivocal. Banks, Welhaf and Srour (2015) report no decrease in mind wandering following a 15-minute audio-delivered mindfulness meditation training session, when compared to a 15-minute audio-delivered relaxation training session. They also reported no reductions in mind wandering following independent at-home mindfulness practice completed over the span of one week. Importantly, the authors suggest that their obtained pattern of results may in part be due to controlling for participant expectancies by ensuring that the active control condition (i.e., relaxation training) induced the same participant expectancies as the mindfulness training. Similarly, no decrease in mind wandering was also reported in a double-blind intervention study examining the effectiveness of mindfulness training focused on attention training versus mindfulness training that focused on relaxation (Romberg & Haarman, 2016). Finally, although compassion meditation training was reported to result in a decrease in overall mind wandering as measured using daily experience sampling, the change in frequency of mind wandering was not consistently observed when separately examining mind wandering to neutral, pleasant or unpleasant topics (Jazaieri et al., 2016).

### **The Present Study**

Over the past several years there has been increased research dedicated to examining the relationship between mindfulness and mind wandering, as well as the impact of mindfulness

interventions on mind wandering frequency. The current study aimed to add to this literature by examining whether a mindfulness intervention would lead to changes in self-reported mind wandering. As highlighted above, few studies have explicitly measured self-reported mind wandering in this context, and none have employed questionnaires that reflect recent advancements in scale development. Relatedly, whereas Zanesco and colleagues (2016) examined the role of mindfulness training on reductions in tuning and zoning out (i.e., mind wandering with and without awareness, respectively), the importance of differentiating between deliberate versus spontaneous mind wandering to my knowledge has not yet been examined in this context. Consistent with earlier research, mindfulness training in the present study was hypothesized to be associated with a decrease in mind wandering frequency, as reported on trait measures of mind wandering. Moreover, given the previously reported significant positive association between deliberate and spontaneous mind wandering (Carriere et al., 2013; Seli, Carriere et al., 2015), both types of mind wandering were anticipated to decrease following mindfulness training.

Whereas mindfulness training has shown promise in reducing mind wandering within university/non-clinical samples (e.g., Morrison et al., 2014; Mrazek, Franklin, Phillips et al., 2013), its benefits may not translate to individuals who endorse greater clinical symptomatology. For example, mindfulness training may prevent increases in mind wandering, rather than lead to reductions in mind wandering among those who endorsed high trait anxiety (Xu, Purdon, Seli, & Smilek, 2017). Additionally, although mindfulness-based therapies have shown to be helpful in reducing symptoms among individuals with attention deficit/hyperactivity disorder (ADHD), the benefit was reported to be stronger for adults compared to children (Cairncross & Miller, 2016). The authors suggest that this may be due to changes in symptom presentation that occurs with age. Correspondingly, it is worth consideration whether endorsement of these clinical symptoms would

influence the changes in mind wandering that may follow participation in a mindfulness-based training program.

As such, a second aim of the current study was to explore whether the presence of ADHD symptomology would impact the benefit gained from a mindfulness intervention. Although no explicit recruitment of a clinical group was done, many of the recruited participants were parents of children with ADHD. Taking into account the familial genetic risk factors for the disorder (Franke et al., 2012), it follows that a sample of parents may endorse greater levels of ADHD symptoms, allowing for an *exploratory examination* of the impact of ADHD symptoms on reductions in mind wandering following participation in a mindfulness intervention. Presence of ADHD symptoms was hypothesized to potentially mitigate the benefits yielded by mindfulness training.

### **Methods**

The study was done in the context of a larger research program providing a purpose-driven mindfulness-based intervention, called Mindful Living, to parents and teachers of children with ADHD conducted by the student's supervisor, aspects of which have been published previously (Miller & Brooker, 2017). The larger project and the present study received approval from the university's Research Ethics Board.

### **Participants**

Twelve participants, recruited from a community in Southwestern Ontario, were included in the present study. Participation was open to classroom teachers and parents of children and adolescents (grades K- 8) with a current diagnosis of ADHD. This age criterion was chosen because it reflects when most children and youth receive a diagnosis of ADHD. The majority of

the sample identified as being a parent of a child with ADHD (83.3%). Recruitment was conducted using advertisements in a local parenting magazine, resources available at local schools (e.g., email listserves), by contact with local practitioners (e.g., family doctors), and via programs providing services for those with ADHD. No restriction criteria were applied, but Dr. Carlin Miller made final decisions regarding intervention eligibility, with the primary consideration being the participant's willingness to commit to the full duration of the intervention. It should be noted that the obtained sample size is substantially smaller than the anticipated sample size of 20-25 participants, although two cycles of the intervention were conducted as planned. Despite numerous efforts to increase recruitment (e.g., expanding advertisement of the study), especially in cycle 2, enrolment in the study stalled and ongoing recruitment cycles were cancelled.

As noted above, the present sample reflects two cycles of data collection, with the majority of the participants (91.6%) having been enrolled in cycle 1. Consistent with anticipated participation, 13 out of 14 possible individuals enrolled in the intervention across the two cycles initially agreed to participate in the study. One participant did not complete the post-intervention questionnaires and was subsequently removed from analysis, resulting in a final sample size of 12 participants. See Figure 1 for the CONSORT diagram describing the enrolment in the study, including a breakdown of participant recruitment per cycle.

The participants enrolled in the current study predominantly self-identified as female (83.3%). With regards to racial or ethnic identification, all were Caucasian, and half of the sample reported that they were married or cohabiting. Notably, no married or cohabitating pairs were included in the study. Fifty percent of the sample reported that they graduated from a trade school or college/university. Two participants reported receiving social assistance. Although participation was open to both parents and teachers of children with ADHD, the sample was composed of

primarily parents. The one teacher included in the study did not have any previous contact with any of the parents in the study and was also the parent of a child with ADHD. Notably, none of the participants reported being regular practitioners of mindfulness meditations and denied any previous experience with mindfulness training. A more detailed description of the demographic characteristics of the sample is included in Table 1.

### **Procedure**

The study is a repeated measures design, with non-random assignment (i.e., all interested parents who met eligibility criteria were enrolled in the intervention). Participants were asked to complete a brief set of questionnaires at two different time points (i.e., pre- and post-intervention). Those enrolled in the intervention and who agreed to participate in the study were compensated with a \$5.00 Tim Hortons gift card for their time and effort at each time point.

The mindfulness intervention, Mindful Living, was provided over the course of eight weeks, under the instruction of an experienced mindfulness instructor. Those enrolled in the intervention paid \$75 to participate (fee to cover materials and lunch at day-long silent retreat), and were allowed to decide whether or not to participate in the research. That is, the intervention was conducted independently of the proposed research study, and thus not all those who completed the intervention necessarily participated in the research. Further, the data collection completed for the present study was done separately from the online pre- and post-intervention data collection done as part of the larger project led by Dr. Miller. Only demographic data obtained from the online component was included in the present analyses. Correspondingly, each person involved in the research study signed a separate consent form pertaining only to the current research study.

Mindful Living, like other manualized mindfulness programs (e.g., MAPs Program) is a modified version of Mindfulness-based Stress Reduction (MBSR). Participants met once weekly, for up to 2 hours. In addition to didactic training on mindfulness and ADHD, the program incorporated standard mindfulness practices (e.g., paying attention to the breath). Mindful Living was designed to cultivate understanding of self-perceptions and the importance of differentiating between responding versus reacting. It also promoted working with different emotions, and fostered understanding of positive, negative and neutral affect. In between the weekly instructor-led sessions, participants were asked to engage in daily independent mindfulness practice that they completed with the assistance of an instructional CD (provided during the first session). They were also instructed to complete daily logs of their meditation practice. In the 6<sup>th</sup> week of the program, participants complete a 5.5 hour-long silent retreat. Unlike other programs, Mindful Living also included a psychoeducational component about ADHD in children. A detailed outline of the session content and recommended mindfulness home practice is described in Miller and Brooker (2017).

## Measures

**Barkley Adult ADHD Rating Scale-IV (BAARS-IV;** Barkley, 2011). The BAARS-IV is a self-report questionnaire designed to reflect DSM-IV ADHD symptom criteria. For each item, the respondents were asked to indicate to what extent the item reflects their behaviour over the last six months, with options ranging from 1 (Never/Rarely) to 4 (Very Often). The measure allowed for the calculation of a total ADHD score, individual totals for the three ADHD symptom dimensions (i.e., Inattention, Hyperactivity, and Impulsivity), and a total corresponding to symptoms of Sluggish Cognitive Tempo. Only the total ADHD score ( $M = 32.3$ ,  $SD = 7.1$ , range = 23.0 – 45.0) was used because no *a priori* hypotheses regarding the predictive value of the

symptom dimensions had been made. The measure was reported to have adequate internal consistency, as well as satisfactory criterion, discriminant and construct validity. Cronbach's alpha for the total ADHD score items was 0.86. See Appendix F for a copy of the measure.

To help characterize the sample, endorsement of ADHD symptom counts was reviewed in order to determine how many of the participants reported experiencing symptoms that exceeded clinical cut-offs based on the DSM-5 diagnostic criteria (APA, 2013). Using the following criteria for adults: (a) a minimum of 5 symptoms of inattention and/or a minimum of 5 hyperactivity/impulsivity symptoms reported to occur at least "often", (b) symptom onset reported to have occurred before 12 years of age, and (c) presence of significant impairment in a minimum of 2 settings, only 1 participant met criteria. Several, however, endorsed sub-threshold symptom levels. Importantly, no corroborating evidence or information regarding current or past mental health diagnoses was collected.

**Mind Wandering Questionnaire (MWQ).** Created by Mrazek and colleagues (2013), the MWQ is a measure created to capture trait levels of mind wandering, operationally defined as "the interruption of task focus by task-unrelated thought" (p. 3). The questionnaire is made up of five items answered on 6-point Likert scale (1 = Almost Never; 6 = Almost Always). The sum of the 5 items was used to obtain a mind wandering score. Good internal consistency and homogeneity of the measure has been reported. The Cronbach's alphas for the MWQ scale given pre- and post-intervention were 0.88 and 0.83, respectively (Table 2). Appendix B includes a copy of the MWQ.

**Mind Wandering: Spontaneous (MW-S) and Mind Wandering: Deliberate (MW-D).** Spontaneous mind wandering reflects "unintentional drifting of one's thoughts from a focal task toward inner, task-unrelated thoughts", whereas deliberate mind wandering is operationally

defined as “intentional or deliberate shift in attention toward internal thought” (Seli, Carriere et al., 2015, p. 2). The complementary scales aimed to address this important distinction and are used to identify trait levels of spontaneous (MW-S) and deliberate (MW-D) mind wandering (Carriere et al., 2013; Seli, Carriere et al., 2015). Both scales are made up of 4 questions answered on a scale ranging from 1 to 7, with the mean of the responses used to compute the scale score. Cronbach’s alphas for the MW-S and MW-D scales, calculated for both before and after the intervention, ranged from 0.72 to 0.91. Descriptive statistics for the measures are included in Table 2, whereas a copy of the measures is included in Appendix C.

### **Statistical Analyses**

The Statistical Package for Social Science (SPSS 22.0) for Mac was used to complete the analyses. The threshold of  $p < 0.05$  was applied to indicate statistical significance.

Initially, an analysis of the missing data was completed. This revealed that for all 12 participants, there were no missing values on any of the four administered questionnaires (i.e., BAARS-IV, MWQ, MW-S, and MW-D). As such, no imputation of missing data was required.

### **Paired Sample T-test**

Given the repeated measures design (pre- and post-intervention) conducted on a single group of data (i.e., absence of a control group), a paired sample t-test was performed. This was done independently for each mind wandering measure. Limited recruitment success did not permit analysis by subgroup (e.g., gender). Prior to conducting the analyses, all statistical assumptions of a dependent sample t-test were checked, including normality of the difference scores for each of the measures analyzed, and absence of outliers (Field, 2013). The Shapiro-Wilks test of normality, along with visual inspection of the Q-Q plots, and review of the kurtosis

and skewness values revealed that each of the difference scores adequately approximated the normal distribution. No outliers were identified following examination of the standardized scores (all standardized residuals  $< 3.29$ ; Tabachnick & Fidell, 2006) and using the outlier-labeling rule (Hoaglin, Iglewicz, & Tukey, 1986; Hoaglin & Iglewicz, 1987).

### **Hierarchical Linear Regression**

To help address the question of whether endorsement of ADHD symptomology helped predict the benefit gained from a mindfulness intervention, as reflected in a decrease in mind wandering, a hierarchical linear regression was conducted, with the difference score (i.e., mind wandering score<sub>post-intervention</sub> – mind wandering score<sub>pre-intervention</sub>) used as the outcome variable. Although there exists controversy regarding the applicability of difference or gain scores, several authors have suggested that there are occasions when use of difference scores may be appropriate (Allison, 1990; May & Hittner, 2010; Williams & Zimmerman, 1996). In fact, Dalecki & Willits (1991) describe that when measuring change in a multiple regression, use of a difference score as the outcome variable while controlling for the initial score (e.g., the pre-intervention score) is preferred over use of: (a) the final score controlled for the initial score; or (b) use of residualized scores, even though one obtains the same finding irrespective of the outcome variable chosen. Use of the difference score controlled for the initial score, has also been reported to be equivalent to use of “regressor variable method” (Allison, 1990, p. 94), and is consistent with recommendations to use the post-test scores (May & Hittner, 2010). Further, the reliability of the gain score is not less reliable than the individual scores that compose it when the individual scores do not have equal variances and reliability (Dimitrov & Rumrill, 2003). Both of these criteria were met for all variables explored. Finally, difference scores have been used previously in studies examining changes following mindfulness training (e.g., Bennike et al., 2017; Rooks et al., 2017). As such,

hierarchical regression analysis was planned for each of the outcome variables (i.e., difference score for each mind wandering measure), with the corresponding pre-treatment score entered first, and the predictor variable (i.e., total ADHD score) entered in the second step. The entry order of the variables reflects desire to control for the pre-treatment score.

Prior to conducting the planned analyses, the assumptions of multiple regression were reviewed. First, this type of analysis requires adequate sample size, which is frequently noted to be a minimum of 15 to 20 observations for each predictor variable (Austin & Stayerberg, 2015; Tabachnick & Fidell, 2006). Following this convention, the present sample size would be insufficient to conduct this analysis. Notably, however, recent simulation studies conducted by Austin and Stayerberg (2015) suggest that as few as two subjects per variable may be needed for a linear regression analysis, while appreciating the caveat that use of the adjusted  $R^2$  is preferred when the sample size is low. As such, although the present sample size is not optimal, it did not preclude the analyses from being conducted.

Second, multiple regression assumes independence of observations (Field, 2013). Support for the argument that this assumption may have been met comes from the following: each of the difference scores reflects a value obtained from only one participant, the individuals included in the sample were not related to each other, participants were asked to answer the questionnaires independently of each other, and every effort was made to conceal responses from both the other participants and the intervention instructor. In contrast, because the participants included in the study participated in two cycles of the mindfulness intervention, and although every effort was made to ensure equivalency across the cycles of the intervention, it is possible that the nested data may have resulted in a violation of this assumption. Importantly, Miller & Brooker (2017), report equivalency across waves of data collection, and consequently collapsed the data. Taking these

facts into consideration, while appreciating the small sample size, all 12 participants were retained.

Third, multiple regression assumes normally distributed residuals and absence of outliers and influential observations (Cohen, Cohen, West, & Aiken, 2003; Field, 2013; Tabachnick & Fidell, 2006). Examination of the P-P plots revealed that the assumption of normality was met for each analysis. This conclusion was corroborated by non-significant Shapiro-Wilks' statistics for each outcome variable. Relatedly, for all models evaluated, none of the standardized residuals exceeded the established threshold of 3.29 (Tabachnik & Fidell, 2006), suggesting an absence of outliers. Moreover, no extreme values were identified after inspection of leverage values. With regards to influential observations, none were identified for the analyses pertaining to the MW-S and MW-D (i.e., all Cook's  $d$  values  $< 1.0$ ). One influential observation was identified for the analysis using the MWQ difference score (Cook's  $d = 1.58$ ) as the outcome variable; consequently the subsequent analysis was done without inclusion of the influential observation.

Fourth, a few of the assumptions were reviewed using visual inspection of appropriate plots. Specifically, review of the assumption of linearity and homoscedasticity was done with inspection of the residual plots, which revealed that these assumptions were met for each proposed analysis (Field, 2013). Similarly, examination of the independence of errors was done with visual inspection of the bivariate scatter-plots.

Finally, the assumption of no multicollinearity was evaluated by reviewing the intercorrelations among the predictor variables in each model and examination of the collinearity diagnostics. The bivariate correlations between each set of predictor variables did not exceed the cut-off of  $r = +/- .90$  (Tabachnick & Fidell, 2006). The correlation values ranged from 0.42 to 0.82, with the highest correlation being between the pre-treatment MWQ score and the total

ADHD score. Review of the variance inflation factor (VIF) and tolerance values also did not suggest a violation to this assumption (all VIF values  $< 10$  (range = 1.22 - 3.00), and all tolerance values  $> 0.1$  (range = 0.33 – 0.82); Field, 2013).

## **Results**

### **Paired Samples T-test**

Paired-samples t-tests were performed to determine whether reported mind wandering differed significantly following an 8-week mindfulness intervention. The results revealed that the average mind wandering scores, as measured using any of the three mind wandering questionnaires, were not significantly lower following exposure to the intervention. Table 3 includes the mean and standard deviation scores for each measure pre and post intervention, the summary of the t-test analyses, and the magnitude of the effect (Cohen's  $d$ ). As reflected in the table, although the analyses did not yield significant findings, Cohen's  $d$  values obtained for the MWQ and MW-S analyses suggested small to medium effect sizes.

Recognizing that power was likely compromised by the small sample size, post-hoc power analysis via G\*Power (Faul, Erdfelder, Lang, & Buchner, 2007) was performed, taking into account the means, standard deviations, correlation and obtained effect size. This analysis revealed statistical power of 0.377 for the MWQ. Comparable post-hoc analyses for the MW-S and MW-D revealed power values of 0.0507 and 0.156, respectively. These values are significantly below the cutoff of 0.8 (Field, 2013), suggesting that sufficient power was likely not reached in order to identify any effects.

### **Hierarchical Regression Analysis**

Table 4 includes the correlations for all the variables included in each hierarchical regression analysis.

As described above, the intention was to conduct a hierarchical regression separately for each difference score, however, review of the intercorrelations revealed that the MW-D difference score and the total ADHD score were not correlated ( $r = .247, p = .44$ ). As such, no further analyses were conducted with the MW-D difference scores.

### **Predicting the MWQ Difference Score**

A hierarchical regression analysis was conducted with the initial MWQ score entered in the first step, and the predictor of interest (i.e., total ADHD score) entered in the second step. The final model was not significant ( $F(2,8) = 1.31, p = .32$ ) and the addition of the total ADHD score did not increase the amount of variance accounted for ( $\Delta R^2 = .08, F_{\text{change}}(1,8) = 0.85, p = .38$ ). The summary of the hierarchical regression analysis predicting the change in the MWQ score is listed in Table 5. Post-hoc power analysis via G\*Power (Faul et al., 2007) revealed a power value of 0.16, suggesting insufficient power for the current analysis.

### **Predicting the MW-S Difference Score**

Examination of the hierarchical regression analysis predicting the MW-S difference score revealed that the final model was significant ( $F(2,9) = 13.38, p < .05$ ), but critically the addition of the total ADHD score did not increase the amount of variance accounted for ( $\Delta R^2 = .03, F_{\text{change}}(1,9) = 0.94, p = .36$ ). Table 6 includes the summary of this hierarchical regression analysis. Post-hoc power analysis revealed that the statistical power for the current model was 0.92, indicated that the small sample size may not have compromised power for this analysis.

## **Discussion**

The present study aimed to add to our growing awareness of the benefits of mindfulness training. There were two research questions: 1) Will an 8-week mindfulness training program

result in a significant decrease in self-reported trait levels of mind wandering; and 2) Does the endorsement of ADHD symptoms help predict changes in mind wandering following the intervention. In contrast to the hypothesized findings, no significant decrease in mind wandering across any of the three mind wandering measures was observed. Additionally, endorsement of ADHD symptoms measured using the BAARS-IV total ADHD score was not found to be significantly associated with changes in mind wandering, measured using the MWQ, MW-S or MW-D. Notably, insufficient power resulting from the small sample size likely contributed to the null findings, making any firm conclusions difficult to make.

Although it is not possible to draw any definitive conclusions, the present results lie in contrast to much of the existing literature which suggests that significant changes in mind wandering follow from training in mindfulness (Mrazek, Franklin, Phillips et al., 2013; Mrazek, Smallwood, & Schooler, 2012; Morrison et al., 2014; Zanesco et al., 2016; Jha et al., 2015; Rahl et al., 2017). Interestingly however, the majority of this research has not employed self-report questionnaires of mind wandering, and few of the studies that have examined mind wandering using self-report elicited from prompts embedded within experimental tasks, have not always found support for changes in self-reported mind wandering (e.g., Jha et al., 2015, Jha et al., 2017). As such, replication of this work with a much larger sample is warranted.

To my knowledge, no previous work has explicitly examined how endorsement of ADHD symptoms may influence changes in mind wandering following participation in a mindfulness program. The present work provided an exploratory examination of this research question. Despite the absence of significant findings, it is unlikely that the pattern of findings primarily stems from use of a community sample. Conceptualization of ADHD symptoms as dimensional with clinical thresholds reflecting an extreme end of this continuum allows for the examination of

ADHD symptoms in non-clinical population (Lubke et al., 2009), and has been done previously (e.g., Rodriguez & Span, 2008; Ostojic & Miller, 2014). Further, although the lack of statistical power for the analysis may not have been the case for the analysis pertaining to the MW-S scale, examination of this research question with use of a larger sample (both clinical and non-clinical) is valuable given that mindfulness interventions may yield different results for those endorsing clinical symptomology (Xu et al., 2017).

The present study was limited by several important factors. First, recruitment difficulties not only limited the obtained sample size, but also made it impossible to establish a waitlist control group, as was initially intended. Second, data collected from the two cycles of the intervention were collapsed paralleling what was done by Miller and Brooker (2017). It is important to recognize that this may not have been appropriate in this case because the experience of participants in the two cycles may not have been similar, stemming from the large difference in the number of participants in each cycle of the intervention (i.e., 11 participants versus 3 participants). Third, because the present study design was not a randomized-control trial, even if significant findings were obtained, it would not have been possible to draw causal conclusions. Future research incorporating multiple control groups (e.g., an active control group that elicits the same expectations as the intervention) is needed. Fourth, in line with recent efforts aimed at identifying what factors may be critical in promoting change (e.g., Jha et al., 2015), and in contrast with evidence highlighting the importance of considering time spent practicing (Bennike et al., 2017; Carmody & Baer, 2008; Jha et al., 2010; Jha et al., 2017; Zanesco et al., 2016), this study did not examine the role of engagement in sessions and compliance with homework. Finally, absence of comparison groups precludes any inquiry into what aspects of the intervention (e.g., guided meditation, ADHD-focused didactics) may be most important for causing any

change in the frequency of mind wandering. Addressing these limitations in future work is recommended.

Despite the lack of significant findings, the present study highlights the potential utility of using self-report questionnaires in tracking change in mind wandering resulting from mindfulness training. The self-report questionnaires are quick to complete and consequently, if demonstrated to be useful in future work, could easily be augmented to many research protocols to help monitor changes in self-perceived mind wandering. Further, more work examining the role of self-rated changes is warranted because self-recognized improvements in attention, may help predict greater adherence to the treatment protocol, as well as help identify those participants who will continue to practice the learned skills after completion of the intervention program. This in turn could help explain or account for differences in the examination of long-term outcomes following the intervention.

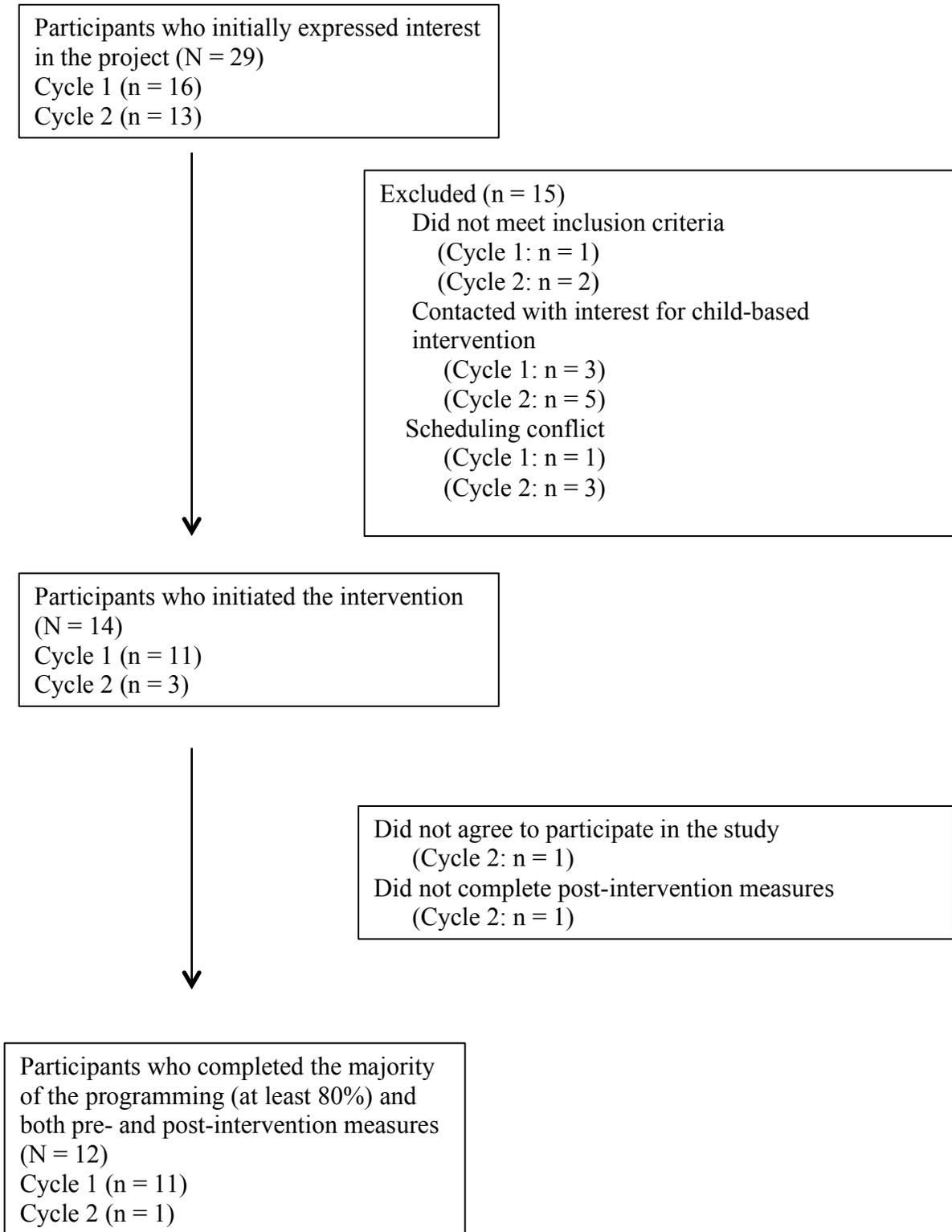


Figure 1. CONSORT depicting each stage of participant recruitment and participation.

Table 1

*Demographic Composition of the Sample*

	Frequency	Percent
<b>Participant Role</b>		
Parent of a child with ADHD	10	83.3
Teacher of a child with ADHD <sup>a</sup>	1	8.3
Unknown/ Not Disclosed	1	8.3
<b>Marital Status</b>		
Single, Never Married	3	25.0
Married	6	50.0
Separated	1	8.3
Divorced	1	8.3
Unknown/ Not Disclosed	1	8.3
<b>Educational Attainment</b>		
High School/ GED obtained	4	33.3
Trade School/College/University	5	41.6
Graduate Degree	2	16.7
Unknown/ Not Disclosed	1	8.3

*Note.* <sup>a</sup> The teacher in the sample was also a parent of a child with ADHD.

Table 2

*Descriptive Statistics for the Self-Report Questionnaires*

<b>Measure</b>	<b>Number of Questionnaire Items</b>	<b>Mean</b>	<b><i>SD</i></b>	<b>Range</b>	<b>Cronbach's alpha</b>
Pre-Intervention MWQ	5	18.42	5.12	7.0 – 25.0	0.88
Post-Intervention MWQ	5	16.75	3.55	12.0 – 23.0	0.83
Pre-Intervention MW-D	4	3.44	1.23	1.3 – 5.3	0.91
Post-Intervention MW-D	4	3.67	1.09	1.8 – 5.3	0.89
Pre-Intervention MW-S	4	3.65	1.36	1.3 – 5.5	0.91
Post-Intervention MW-S	4	3.69	0.87	2.5 – 5.3	0.72
BAARS-IV Total	18	32.3	7.1	23.0 – 45.0	0.86

*Note:* MWQ = Mind Wandering Questionnaire; MW-S = Mind Wandering – Spontaneous Scale; MW-D = Mind Wandering – Deliberate Scale; BAARS-IV Total = Barkley Adult ADHD Rating Scale – Total Score

Table 3

*Summary of the Paired Sample t-test Analyses*

Measure	Pre-	Post	t-value	<i>p</i>	<i>d</i>
	Intervention	Intervention			
	<i>M (SD)</i>	<i>M (SD)</i>			
MWQ	18.42 (5.12)	16.75 (3.55)	1.45	0.18	0.42
MW-S	3.65 (1.36)	3.69 (0.87)	-0.087	0.93	- 0.025
MW-D	3.44 (1.23)	3.67 (1.09)	-1.028	0.33	- 0.30

*Note.* MWQ = Mind Wandering Questionnaire; MW-S = Mind Wandering – Spontaneous Scale; MW-D = Mind Wandering – Deliberate Scale

Table 4

*Correlations Between Variables Included in the Hierarchical Regression Analyses*

	1	2	3	4	5	6	7
1. T1 BAARS total ADHD score	1	.82**	.64*	.42	-.61*	-.665*	-.247
2. T1 MWQ score		1	.617*	.059	-.724**	-.605*	-.204
3. T1 MW-S score			1	.349	-.287	-.850***	-.349
4. T1 MW-D score				1	-.209	-.613*	-.480
5. MWQ difference score					1	.453	.261
6. MW-S difference score						1	.463
7. MW-D difference score							1

*Note.* T1 = Pre-intervention score; MWQ = Mind Wandering Questionnaire; MW-S = Mind Wandering – Spontaneous Scale; MW-D = Mind Wandering – Deliberate Scale; BAARS-IV Total = Barkley Adult ADHD Rating Scale – Total Score

\* p < .05, \*\* p < .01, \*\*\* p < 0.001

Table 5

*Summary of the Hierarchical Regression Analysis Predicting the MWQ Difference Score (N=11)*

	<i>B</i>	<i>SE B</i>	$\beta$	<i>p</i>	<i>R</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$
Step 1					.41	.17	.17
Constant	3.06	4.24					
T1 MWQ score	-0.29	0.21	-.41	.21			
Step 2					.50	.25	.08
Constant	4.05	4.41					
T1 MWQ score	-0.01	0.37	-.01	.99			
T1 BAARS total ADHD score	-0.20	0.21	-.49	.38			

*Note.* T1 = Pre-intervention score; MWQ = Mind Wandering Questionnaire; BAARS-IV Total = Barkley Adult ADHD Rating Scale – Total Score  
 $R^2_{adj}$  for step 1 = 0.08,  $R^2_{adj}$  for step 2 = 0.06.

Table 6

*Summary of the Hierarchical Regression Analysis Predicting the MW-S Difference Score (N=12)*

	<i>B</i>	<i>SE B</i>	$\beta$	<i>p</i>	<i>R</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$
Step 1					.85	.72	.72
Constant	3.81	0.79					
T1 MW-S score	-1.04	0.20	-.85	<0.001			
Step 2					.87	.75	.03
Constant	4.80	1.29					
T1 MW-S score	-0.87	0.26	-.72	.009			
T1 BAARS total ADHD score	-0.05	0.05	-.21	.358			

*Note.* T1 = Pre-intervention score; MW-S = Mind Wandering – Spontaneous Scale; BAARS-IV Total = Barkley Adult ADHD Rating Scale – Total Score  
 $R^2_{adj}$  for step 1 = .69,  $R^2_{adj}$  for step 2 = 0.69.

## CHAPTER 5

### General Discussion

The last few decades have seen resurgence in interest in the universally experienced phenomenon of mind wandering (Callard et al., 2013). Building on this research momentum, the aim of the present dissertation was to add to the growing literature on mind wandering, with a particular focus on fostering better understanding of the conceptualization and assessment of mind wandering, the association between mind wandering and symptoms of attention disorders, and the potential impact of mindfulness training in reducing the frequency of mind wandering.

Correspondingly, the first study was designed with the intention to help examine the utility of three existing mind wandering measures in capturing mind wandering frequency using ecological momentary assessment methodology. Inspired by the suggestion that mind wandering reflects a key aspect of Attention-Deficit/Hyperactivity Disorder (ADHD) symptomology (Seli, Smallwood, Cheyne et al., 2015), the focus of the second study was to add to our understanding of the association between mind wandering and symptoms of two attention disorders (i.e., ADHD and the proposed disorder of Sluggish Cognitive Tempo). Finally, incorporating the findings from study one supporting the conclusion that mind wandering and mindfulness reflect opposing constructs (Mrazek, Smallwood, & Schooler, 2012; Mrazek et al., 2013; Luo, Zhu, & You, 2016), as well as from study two which offered additional evidence for a relationship between ADHD symptoms and mind wandering, the goal of the final study was to evaluate whether an instructor-led 8-week mindfulness intervention resulted in reductions in self-reported mind wandering among parents and teachers of children with ADHD.

### Thematic Results

**Conceptualization of mind wandering.** Increasing interest and research into mind wandering has been plagued by mixed terminology (Callard et al., 2013). Differentiating mind

wandering from related constructs, such as daydreaming and “mind pops,” is important as it helps limit confounds within the literature. This includes differentiating self-generated thought that occurs during an activity versus that which occurs in the absence of an ongoing task. It also includes distinguishing between thoughts that pertain to the task (i.e. task-related interferences) or reflect stimulus-dependent distraction (e.g., distractions that rely on sensory input) versus self-generated thoughts that are unrelated to the task and do not reflect a form of distraction. Consequently, across the dissertation mind wandering was conceptualized as self-generated thought that occurs during a task or activity but is unrelated to it. Notably, this definition is not without flaws, and it is important to appreciate that our understanding of the construct of mind wandering will continue to evolve. As recently suggested it may be the case that mind wandering may be best understood as a multidimensional construct (Seli et al., 2018).

More recently, the importance of taking into account intention when conceptualizing mind wandering has been emphasized (Carriere et al., 2013, Seli, Carriere, & Smilek, 2015; Seli, Risko, & Smilek, 2016a). Aligning with research highlighting the need for differentiation between mind wandering that occurs with intention versus that which occurs without intention, the dissociation between spontaneous and deliberate mind wandering was repeatedly shown across the studies. For example, university students who reported more mind wandering in response to probes received during their daily experiences, indicated more frequent mind wandering on the Mind Wandering – Spontaneous measure (MW-S; Carriere et al., 2013), but no parallel finding was obtained for the measure of deliberate mind wandering. Similarly, support for the importance of appreciating the intentionality of mind wandering was revealed by the result showing that only spontaneous mind wandering was significantly negatively associated with mindfulness. This pattern of findings demonstrates the importance of using measures that take into consideration this distinction.

Extending these findings, future work utilizing probe-caught measures of mind wandering would benefit from collecting information about intentionality of each mind wandering episode captured in real time.

**Assessment of mind wandering.** Understanding the challenges inherent in accurately capturing and measuring mind wandering helps explain why this commonly experienced phenomenon has evaded many researchers until relatively recently. Reflecting difficulties in investigating this multifaceted construct empirically, recent efforts have been directed at developing self-report questionnaires that uniquely capture mind wandering. In light of this progress in measurement development, one of the key aims of this dissertation was to examine the recently developed self-report measures for their utility in capturing one's proneness to mind wander. The findings, demonstrating convergent validity with probe-caught mind wandering during daily experience, provided valuable support for the utility of self-report in the measurement of mind wandering. This is consistent with the conclusion drawn by Randall and colleagues (2014), who argued that the estimates provided by thought probes designed to capture the presence of mind wandering were not more effective than use of self-report scales that relied on retrospective recall. Importantly these inferences need to be interpreted in light of a few notable caveats: a) self-report data may be limited by recall-bias, social desirability in reporting, and meta-awareness; b) asking about mind wandering often terminates an ongoing mind wandering episode; and c) although not applied in the present studies, ecological momentary assessment (EMA) data may provide insight into fluctuations in mind wandering that is not possible with the use of brief self-report scales designed to provide trait-level estimates of mind wandering. Thus, appreciating the limitations of self-report while recognizing that self-report measures represent a convenient and valuable way to evaluate mind wandering, the findings from

the initial study were used to bolster confidence in the applicability of including the mind wandering questionnaires in the subsequent studies.

As alluded to above, the use of EMA was also applied in study one with the aim of collecting ecologically valid estimates of mind wandering. Building on previous work, including the seminal research by Killingsworth and Gilbert (2010), the study employed probe-caught methodology using software appropriate for mobile technology. In addition to reflecting the ease with which this methodology could be applied to the study of mind wandering, the findings also identified an important consideration for future work. Specifically, the strength of the associations examined varied depending on what response latency threshold was applied. As such, with the growing number of studies likely to apply this type of methodology in this area of study, explicit identification of the response latency used will be necessary to help ensure appropriate comparisons are made across studies.

Whereas both use of self-report questionnaires and EMA data have provided important clues into our understanding of mind wandering, our ability to detect the onset of a mind wandering episode and to differentiate it from an ongoing period of mind wandering (e.g., maintenance phase; Randall et al., 2014), has not been aided by use of these methodologies. Consequently, towards this aim application of physiological techniques (e.g., pupil dilation and eye movement, fMRI and EEG recordings) may be helpful to include in future research.

### **Examination of the relation between mind wandering and attention difficulties**

There exist individual differences in the proclivity to experience mind wandering episodes (Callard et al., 2013; Diaz et al., 2014; McVay et al., 2009). Correspondingly, while recognizing that context (e.g., being bored by a task) may influence the frequency of mind wandering, the

tendency with which one experiences mind wandering likely reflects a stable character trait. It then follows that mind wandering may be associated with other individual difference factors, such as endorsement of Attention-Deficit/Hyperactivity Disorder (ADHD) symptoms. While the connection between ADHD and mind wandering may seem intuitive given that both constructs are characterized by attention problems, there is a relative dearth of research on this topic. Thus building on the findings from the studies done to date, an aim of the present research was to tease apart the extent to which particular symptom dimensions of ADHD (i.e., inattention, hyperactivity, and impulsivity), along with Sluggish Cognitive Tempo symptoms, would significantly predicted trait levels of mind wandering. Consistent with previous suggestions that spontaneous mind wandering is associated with stable individual differences (Giambra, 1995), symptoms of ADHD were only associated with spontaneous mind wandering and not deliberate mind wandering. Similarly, the results obtained align well with previous studies that have reported an association between mind wandering and ADHD symptoms (Shaw & Giambra, 1993; Franklin et al., 2014; Seli, Smallwood, et al., 2015). Finally, research showing that individual differences in mind wandering are linked to certain cognitive abilities (e.g., working memory; Kane et al., 2007) fits with the obtained findings revealing a link between mind wandering and symptoms of ADHD and sluggish cognitive tempo, as both clinical profiles have been associated with working memory difficulties (Camprodon-Rosanas et al., 2017; Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005). That said, due to the inconsistency in the variables included in the final hierarchical models, as well as limited previous research (in particular pertaining to symptoms of Sluggish Cognitive Tempo) conclusive explanations for the found relationships are not warranted. Future research is needed to help elucidate these links.

The present set of studies were not designed to evaluate the existing theories of mind wandering, and as such the findings cannot be used to support one theory over another. That said, the association found between ADHD symptoms and mind wandering does highlight the potential role of executive control in understanding both phenomena. This is because differences in the control of attention/cognitive resources have been suggested to explain both ADHD symptoms and mind wandering. Unfortunately, how or the extent to which the difficulties in executive control explain mind wandering over other factors (e.g., meta-awareness, presence of current personal concerns etc.) cannot be addressed with these studies. Moreover, the impact of different cognitive processes likely varies based on the type of mind wandering experience (e.g., deliberate versus spontaneous mind wandering).

### **Overall Limitations**

The results from the three studies need to be interpreted in light of a few important limitations. First, use of restricted participant samples may limit the generalizability of the results. This may be particularly evident when examining the demographic characteristics of the participants in the first two studies. All participants were university undergraduate students, the majority self-identified as female, and most were between the ages of 18-22 (85.9 % of the sample in study one and 90.6% of the sample in study two). Relatedly, whereas the sample in study three was composed of mostly parents of children with ADHD who were recruited from the community, the sample size underpowered our analyses, thus limiting the conclusions that could be made. Furthermore, due to the use of these samples it was not possible to examine with any confidence the potential age-related changes in the examined relationships (e.g., between mind

wandering and ADHD symptom presentation). Use of clinical samples in future work may help answer questions that present use of convenience samples did not permit.

Second, all three studies heavily relied on self-report data. Although support for the applicability of existing mind wandering questionnaires was in part addressed by study one, it is not possible to completely rule-out inaccuracies stemming from the nature of the retrospective self-report data collected, as many of the questionnaire items included relied on adequate meta-awareness. This potential recall bias may be especially exacerbated for individuals with attention difficulties. Consequently, gathering information about the confidence of the participants' self-report and/or corroborating the self-report information with informant data, are important considerations for future work in this area.

Finally, research on several of the constructs examined in the current dissertation is in its relative infancy (i.e., Sluggish Cognitive Tempo). This is reflected in the recent development of many self-report questionnaires designed to uniquely capture these constructs. Despite effort to include recently validated measures, a few novel measures were published following data completion in the present studies (e.g., the Mind Excessively Wandering Scale; Mowlem et al., 2016). As such, these measures were not included in the present work, and thus represent a potential focus for future studies. Notably, however, some of these new measures were specifically designed for use with select populations (e.g., the Mind Excessively Wandering Scale was developed for use with adults with ADHD), and thus their inclusion in the discussed three studies may be inappropriate.

### **Conclusions and Implications**

Cumulatively, the results provide support for the utility of existing self-report measures in capturing trait levels of mind wandering, and highlight their potential usefulness in helping track

self-perceived changes in mind wandering. The results also add to the growing literature stressing the importance of taking into account whether the mind wandering occurred with intention or without. Finally, in light of the demonstrated association between mind wandering and symptoms of ADHD and Sluggish Cognitive Tempo, the conclusions drawn have potential clinical implications. That is, in line with what has been previously suggested (Seli, Smallwood, et al., 2015), mind wandering may reflect a particular difficulty for those with an attention disorder. In turn, this area of difficulty could be specifically targeted when developing and implementing appropriate interventions. Use of self-report questionnaires of mind wandering, could in turn be helpful to evaluate self-reported change following an intervention, particularly if curbing mind wandering is an identified intervention goal. Consistent with the intervention aims of study three, this may be especially pertinent for interventions focused on fostering mindfulness, given the established negative association between mind wandering and mindfulness.

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**Appendix A**  
**DEMOGRAPHIC INFORMATION**

**Age (years):** \_\_\_\_\_

**Gender:** [1] FEMALE [2] MALE [3] OPEN [4] OTHER [5] PREFER NOT TO ANSWER  
[6] \_\_\_\_\_

**Race/ethnic background:**

- [1] ABORIGINAL
- [2] ASIAN OR ASIAN DESCENT (NON-ARAB)
- [3] HISPANIC/LATINO
- [4] NON-HISPANIC BLACK OR AFRICAN DESCENT
- [5] NON-HISPANIC WHITE, CAUCASIAN, OR EUROPEAN DESCENT
- [6] ARAB OR MIDDLE-EASTERN DESCENT
- [7] OTHER/MIXED (please describe) \_\_\_\_\_
- [8] PREFER NOT TO ANSWER

**Marital Status:**

- [1] SINGLE
- [2] IN A ROMANTIC RELATIONSHIP (NON-COHABITING)
- [3] MARRIED/CIVIL UNION/COHABITING
- [4] WIDOWED

**Please describe your current level of employment, outside of being a student:**

- [1] Full-time (including volunteer work)
- [2] Part-time (including volunteer work)
- [3] Not currently employed or volunteering

**Do you smoke cigarettes?** [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how many cigarettes you smoke per day (on average): \_\_\_\_\_

**Do you consume caffeine (e.g., caffeinated coffee, caffeinated tea, energy drinks, energy shots)?**

- [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how much coffee/tea/energy drinks you drink per day (on average):  
\_\_\_\_\_ (indicate size)

**Do you drink alcohol?** [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how frequently you drink alcohol:

[1] daily

[2] 3 or more times a week / a couple times a month

[3] less than 3 times a week

[4] less than 1 time per month

If YES, please indicate how many alcoholic drinks you consume per week (on average): \_\_\_\_\_

**Do you use cannabis (marijuana, hashish, liquid THC, etc)?**

[1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how frequently you use cannabis (marijuana, hashish, liquid THC, etc.)

[1] daily

[2] 3 or more times a week

[3] less than 3 times a week / a couple times a month

[4] less than 1 time per month

**SLEEP INFORMATION**

On the average, how many hours did you sleep each night during the past 4 weeks? \_\_\_\_\_

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
Do you feel drowsy or sleepy during the day?	1	2	3	4	5	6
Do you have trouble staying awake during the day?	1	2	3	4	5	6
Do you take naps (5 minutes or longer) during the day?	1	2	3	4	5	6
Do you get the amount of sleep you need?	1	2	3	4	5	6

**MEDICAL HISTORY**

Have you ever been diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD)?

[1] YES [2] NO

[3] PREFER NOT TO ANSWER

**Have you ever been diagnosed with or had experience with any of the following:**

*Head injury with loss of consciousness?* [1] YES [2] NO [3] PREFER NOT TO ANSWER

*Seizure Disorder?* [1] YES [2] NO [3] PREFER NOT TO ANSWER

*Learning Disability?* [1] YES [2] NO [3] PREFER NOT TO ANSWER

*Mental Health Disorder (e.g., depression, anxiety)?* [1] YES [2] NO [3] PREFER NOT TO ANSWER

*Are you currently taking any form of medication (e.g., for ADHD, seizure disorder, depression, etc), ?*

DO NOT SAY YES IF IT IS FOR: BIRTH CONTROL, ASTHMA/RESPIRATORY PROBLEMS (e.g., ALLERGIES), VITAMINS.

[1] YES [2] NO [3] PREFER NOT TO ANSWER

**DEVELOPMENTAL HISTORY**

Has anyone ever told you that you:

Started talking late? [1] NO [2] YES

Crawled or walked late? [1] NO [2] YES

Were difficult to manage as a young child? [1] NO [2] YES

Were late in being toilet trained? [1] NO [2] YES

Had problems getting along with other children? [1] NO [2] YES

Were aggressive toward others? [1] NO [2] YES

**ACADEMIC HISTORY**

What is the highest level of education you have completed so far?

[1] High School Diploma or equivalent

[2] College Degree

[3] Bachelor's Degree

[4] Master's or Professional Degree

[5] Doctorate Degree

Please indicate your year at UWindsor:

[1] 1<sup>st</sup> year [2] 2<sup>nd</sup> year [3] 3<sup>rd</sup> year [4] 4<sup>th</sup> year [5] 5<sup>th</sup> year or beyond

**To which academic faculty do you belong?**

- [1] Faculty of Arts, Humanities and Social Sciences
- [2] Faculty of Science
- [3] Faculty of Business Administration
- [4] Faculty of Education
- [5] Faculty of Engineering
- [6] Faculty of Human Kinetics
- [7] Faculty of Nursing
- [8] Inter-Faculty Program, Please Specify:

---

**Overall GPA:** [1] below 60 [2] 60-70 [3] 70-80 [4] 80 or above

**Major GPA:** [1] below 60 [2] 60-70 [3] 70-80 [4] 80 or above

**Are you currently having any difficulty in university?**

[1] YES [2] NO [3] PREFER NOT TO ANSWER

IF YES, please describe:

---

---

**Do you receive any special accommodations at university?**

[1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please describe:

---

---

**Appendix B**

**MIND WANDERING QUESTIONNAIRE**

**Instructions**

Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

	<b>Almost Never</b>	<b>Very Infrequently</b>	<b>Somewhat Infrequently</b>	<b>Somewhat Frequently</b>	<b>Very Frequently</b>	<b>Almost Always</b>
I have difficulty maintaining focus on simple or repetitive work	1	2	3	4	5	6
While reading, I find I haven't been thinking about the text and must therefore read it again	1	2	3	4	5	6
I do things without paying full attention	1	2	3	4	5	6
I find myself listening with one ear, thinking about something else at the same time	1	2	3	4	5	6
I mind-wander during lectures or presentations	1	2	3	4	5	6

**Appendix C**

**MIND WANDERING – DELIBERATE SCALE**

**Instructions**

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

I allow my thoughts to wander on purpose	1 Rarely	2	3	4	5	6	7 A lot
I enjoy mind wandering	1 Rarely	2	3	4	5	6	7 A lot
I find mind wandering is a good way to cope with boredom	1 Not at all true	2	3	4	5	6	7 Very true
I allow myself to get absorbed in pleasant fantasy	1 Rarely	2	3	4	5	6	7 A lot

**MIND WANDERING – SPONTANEOUS SCALE**

**Instructions**

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

I find my thoughts wandering spontaneously	1 Rarely	2	3	4	5	6	7 A lot
When I mind-wander my thoughts tend to be pulled from topic to topic	1 Rarely	2	3	4	5	6	7 A lot
It feels like I don't have control over when my mind wanders	1 Almost never	2	3	4	5	6	7 Almost always
I mind wander even when I'm supposed to be doing something else	1 Rarely	2	3	4	5	6	7 A lot

**Appendix D**  
**DAY-TO-DAY EXPERIENCES**

**Instructions:** Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

	1 Almost Always	2 Very Frequently	3 Somewhat Frequently	4 Somewhat Infrequently	5 Very Infrequently	6 Almost Never
I could be experiencing some emotion and not be conscious of it until some time later.	1	2	3	4	5	6
I break or spill things because of carelessness, not paying attention, or thinking of something else.	1	2	3	4	5	6
I find it difficult to stay focused on what's happening in the present.	1	2	3	4	5	6
I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.	1	2	3	4	5	6
I tend not to notice feelings of physical tension or discomfort until they really grab my attention.	1	2	3	4	5	6
I forget a person's name almost as soon as I've been told it for the first time.	1	2	3	4	5	6
It seems I am "running on automatic," without	1	2	3	4	5	6

much awareness of what I'm doing.						
I rush through activities without being really attentive to them.	1	2	3	4	5	6
I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.	1	2	3	4	5	6
I do jobs or tasks automatically, without being aware of what I'm doing.	1	2	3	4	5	6
I find myself listening to someone with one ear, doing something else at the same time.	1	2	3	4	5	6
I drive places on "automatic pilot" and then wonder why I went there.	1	2	3	4	5	6
I find myself preoccupied with the future or the past.	1	2	3	4	5	6
I find myself doing things without paying attention.	1	2	3	4	5	6
I snack without being aware that I'm eating.	1	2	3	4	5	6

**Appendix E****DEMOGRAPHIC INFORMATION**

Date of Birth (MM/YY): \_\_\_/\_\_\_

Age (years): \_\_\_\_

**Gender:** [1] FEMALE [2] MALE [3] OTHER [4] PREFER NOT TO ANSWER

**Race/ethnic background:**

- [1] ABORIGINAL
- [2] ASIAN OR ASIAN DESCENT (NON-ARAB)
- [3] HISPANIC/LATINO
- [4] NON-HISPANIC BLACK OR AFRICAN DESCENT
- [5] NON-HISPANIC WHITE, CAUCASIAN, OR EUROPEAN DESCENT
- [6] ARAB OR MIDDLE-EASTERN DESCENT
- [7] OTHER/MIXED (please describe) \_\_\_\_\_
- [8] PREFER NOT TO ANSWER

**Marital Status:**

- [1] SINGLE
- [2] IN A ROMANTIC RELATIONSHIP (NON-COHABITING)
- [3] MARRIED/CIVIL UNION/COHABITING
- [4] WIDOWED

**Body Weight:** \_\_\_\_\_ [POUNDS (lbs)/ KILOGRAMS (kg)] (please circle one)

**Height:** \_\_\_\_\_ [FEET AND INCHES (ft.) /CENTIMETERS (cm)] (please circle one)

**Please describe your current level of employment, outside of being a student:**

- [1] Full-time (including volunteer work)
- [2] Part-time (including volunteer work)
- [3] Not currently employed or volunteering

Do you smoke cigarettes? [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how many cigarettes you smoke per day (on average): \_\_\_\_\_

Do you drink alcohol? [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how frequently you drink alcohol:

[1] daily

[2] 3 or more times a week / a couple times a month

[3] less than 3 times a week

[4] less than 1 time per month

If YES, please indicate how many alcoholic drinks you consume per week (on average): \_\_\_\_\_

Do you use cannabis (marijuana, hashish, liquid THC, etc)?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how frequently you use cannabis (marijuana, hashish, liquid THC, etc.)

[1] daily

[2] 3 or more times a week

[3] less than 3 times a week / a couple times a month

[4] less than 1 time per month

Do you use stimulants (e.g., amphetamine, "speed", crystal meth, dexadrine, non-prescribed Ritalin, Preludin, ephedrine)? [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how frequently you do you use stimulants (e.g., amphetamine, "speed", crystal meth, dexadrine, non-prescribed Ritalin, Preludin, ephedrine)?

[1] daily

[2] 3 or more times a week

[3] less than 3 times a week / a couple times a month

[4] less than 1 time per month

Do you use cocaine (intranasal, IV, crack, freebase, etc.)?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please indicate how frequently you do you use cocaine?

[1] daily

[2] 3 or more times a week

[3] less than 3 times a week / a couple times a month

[4] less than 1 time per month

**MEDICAL HISTORY**

Have you ever been diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD)?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, were you ever prescribed a stimulant medication, such as Ritalin?

[1] YES [2] NO [3] N/A [4] PREFER NOT TO ANSWER

**Have you ever been diagnosed with or had experience with any of the following:**

Traumatic Brain Injury? [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please specify what kind: \_\_\_\_\_

If YES, do you receive treatment or accommodations for this currently?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

Seizure Disorder? [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please specify what kind: \_\_\_\_\_

If YES, do you receive treatment or accommodations for this currently?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

Learning Disability? [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please specify what kind: \_\_\_\_\_

If YES, do you receive treatment or accommodations for this currently?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

Mental Health Disorder? [1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please specify what kind: \_\_\_\_\_

If YES, do you receive treatment or accommodations for this currently?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

Are you currently taking any form of medication?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please specify what kind: \_\_\_\_\_

**DEVELOPMENTAL HISTORY**

Has anyone ever told you that you:

Started talking late? [1] NO [2] YES

Crawled or walked late? [1] NO [2] YES

Were difficult to manage as a young child? [1] NO [2] YES

- Were late in being toilet trained? [1] NO [2] YES
- Had problems getting along with other children? [1] NO [2] YES
- Were aggressive toward others? [1] NO [2] YES

### ACADEMIC HISTORY

What is the highest level of education you have completed so far?

- [1] High School Diploma or equivalent
- [2] College Degree
- [3] Bachelor's Degree
- [4] Master's or Professional Degree
- [5] Doctorate Degree

Please indicate your year at UWindsor: [1] 1<sup>st</sup> year

- [2] 2<sup>nd</sup> year
- [3] 3<sup>rd</sup> year
- [4] 4<sup>th</sup> year
- [5] 5<sup>th</sup> year or beyond

To which academic faculty do you belong?

- [1] Faculty of Arts, Humanities and Social Sciences
- [2] Faculty of Science
- [3] Faculty of Business Administration
- [4] Faculty of Education
- [5] Faculty of Engineering
- [6] Faculty of Human Kinetics
- [7] Faculty of Nursing
- [8] Inter-Faculty Program, Please Specify:

Overall GPA: [1] below 60 [2] 60-70 [3] 70-80 [4] 80 or above

Major GPA: [1] below 60 [2] 60-70 [3] 70-80 [4] 80 or above

Are you currently having any difficulty in university?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

IF YES, please describe: \_\_\_\_\_

Do you receive any special accommodations at university?

[1] YES [2] NO [3] PREFER NOT TO ANSWER

If YES, please describe: \_\_\_\_\_

## Appendix F

### STUDY TITLE: HOW FOCUSED IS YOUR THINKING? : A TEXTING STUDY

Study conducted by: Dragana Ostojic ([ostojicd@uwindsor.ca](mailto:ostojicd@uwindsor.ca)) under the supervision of Dr. Carlin Miller

#### PHASE 2 – DATA COLLECTION CONDUCTED VIA TEXT MESSAGE

In order to participate in this part of the study you must:

- Have a working cell phone
- Have an unlimited texting plan that allows for sending and receiving of text messages

You will be asked to respond to **6** text messages sent randomly between **9 a.m. and 9 p.m. for 7 days**. Each message you receive will be the same, but numbered differently. You will be asked to respond to each text message as quickly as possible, **BUT DO NOT ANSWER A TEXT MESSAGE IF IT IS UNSAFE TO DO SO** (e.g., if you are driving). Here is an example of the message you will receive and a possible response

Notice the number of the question

**Message you will receive.**

**1.** Are you thinking about something other than what you're currently doing?

(a) completely on-task  
(b) mostly on-task  
(c) both on the task and unrelated concerns  
(d) mostly on unrelated concerns  
(e) completely on unrelated concerns.

Make sure to include the number of the question

**Possible Response:**

**1 D**

NOTE: the message will be identical but the number of the question will be different. Make sure to include the number of the question when you send your response.

IF YOU RECEIVE MULTIPLE TEXT MESSAGES BEFORE YOU ARE ABLE TO SAFELY RESPOND, PLEASE JUST RESPOND TO THE LAST MESSAGE.

**ONLY RESPOND TO TEXT MESSAGES WHEN IT IS SAFE TO DO SO! AS SUCH PLEASE DO NOT RESPOND TO A TEXT MESSAGE WHEN YOU ARE DRIVING, CROSSING A STREET, OR DOING ANY ACTIVITY IN WHICH RESPONDING TO THE TEXT MESSAGE MAY PUT YOU IN DANGER.**

#### **BONUS POINT ALLOCATION:**

Those who respond to up to 33% of the text message across the 7 days of data collection (0 to 14 text messages) will receive 0.5 bonus points. Those who respond to 33% to 66% of text messages across the 7 days (15 to 28 text message) will be awarded 1.0 bonus point. Those who respond to over 66% of the text messages will be awarded 1.5 bonus points. As such, those who complete both phases will be eligible to receive up to 2 bonus points.

**Vita Auctoris**

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PLACE OF BIRTH: Sarajevo, Bosnia and Herzegovina

YEAR OF BIRTH: 1987

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2001 – 2005

University of Toronto, Toronto  
2005 – 2010

University of Windsor, Windsor  
2011 - 2018