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Michael S. Franklin¹, Michael D. Mrazek¹, Craig L. Anderson², Charlotte Johnston³, Jonathan Smallwood⁴, Alan Kingstone³, and Jonathan W. Schooler¹

Abstract

Objective: Although earlier work has shown a link between mind-wandering and ADHD symptoms, this relationship has not been further investigated by taking into account recent advances in mind-wandering research. **Method:** The present study provides a comprehensive assessment of the relationship between mind-wandering and ADHD symptomatology in an adult community sample ($N = 105$, 71 females, M age = 23.1) using laboratory measures and experience sampling during daily life. **Results:** Mind-wandering and detrimental mind-wandering were positively associated with ADHD symptoms. Meta-awareness of mind-wandering mediated the relationship between ADHD symptomatology and detrimental mind-wandering, suggesting that some of the negative consequences can be ameliorated by strategies that facilitate meta-awareness. Interestingly, participants with low ADHD scores showed a positive relationship between detrimental mind-wandering and useful mind-wandering; however, participants with high ADHD scores failed to engage in this type of “strategic” mind-wandering. **Conclusion:** These results provide new insights into the relationship between ADHD symptomatology and mind-wandering that could have important clinical implications. (*J. of Att. Dis.* XXXX; XX(X) XX-XX)

Keywords

ADHD, mind-wandering, control processes

ADHD is widely recognized as a serious mental health concern (Kupfer, 2000) that is characterized by inattention, hyperactivity, and impulsivity. In general, reviews of prevalence studies, Scahill and Schwab-Stone (2000) and Polanczyk and Rohde (2007) reported that 5% to 10% of children are diagnosed with ADHD. Although ADHD in adults is less well-recognized, a growing body of research has demonstrated that ADHD impairments continue into adulthood (Barkley, Fischer, Edelbrock, & Smallish, 1990; Mannuzza et al., 2011), both with respect to neuropsychological deficits (Barkley & Murphy, 2011; Herve, Epstein, & Curry, 2004) and impairments on executive tasks (Nigg, Butler, Huang-Pollock, & Henderson, 2002) for many individuals diagnosed with ADHD (4.4% of the adult general population; Kessler et al., 2006). These deficits lead to difficulties in academic and occupational functioning, as well as in family and marital relationships (Barkley & Fischer, 2011; Johnston, 2012; Johnston, Mash, Miller, & Ninowski, 2002). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association [APA], 2013) has explicitly recognized the persistence of ADHD and its associated impairments into adulthood.

Although ADHD is typically diagnosed as either present or absent, it has been suggested that ADHD may be better characterized as a continuum (Overbey, Snell, & Callis, 2011; Whalen, Jamner, Henker, Gehricke, & King, 2003). This would suggest that individuals with high levels of symptoms, even if they do not meet the criteria for ADHD may nevertheless struggle with attention and have a corresponding reduction in quality of life. In fact, many of the negative consequences associated with ADHD are also found in subclinical ADHD populations (Overbey et al., 2011; Whalen et al., 2003). One methodology for examining the usefulness of construing ADHD as a continuum rather than a category is by measuring ADHD symptomatology in

¹University of California, Santa Barbara, USA

²University of California, Berkeley, USA

³University of British Columbia, Vancouver, Canada

⁴University of York, UK

Corresponding Author:

Michael S. Franklin, Department of Psychological and Brain Sciences, University of California, Santa Barbara, Bldg 551, Room 1304, Santa Barbara, CA 93106-9660, USA.
Email: franklin@psych.ucsb.edu

a large sample of non-clinical participants and relating it to other measures of cognitive performance and well-being. In particular, the growing field of mind-wandering research presents a number of opportunities to explore how subclinical expressions of ADHD are related to distraction, performance, and the content of thought.

Mind-wandering is a situation in which individuals cease to focus on their primary task or current environment (a process known as perceptual decoupling) and their attention instead becomes directed toward task-unrelated concerns (Schooler et al., 2011; Smallwood, 2013; Smallwood & Schooler, 2006, in press). The extensive research into the occurrence and consequences of mind-wandering has been complemented by investigation into individuals' ability to notice their off-task thoughts. Such "meta-awareness" (Schooler, 2002; Schooler, Mrazek, Baird, & Winkielman, in press) has been examined in lab studies where participants discriminate between tuning out (aware of mind-wandering) and zoning out (unaware of mind-wandering; Smallwood, McSpadden, & Schooler, 2007) and is well-illustrated by the common experience of suddenly recognizing that we are mind-wandering while reading and have been skimming the words without any understanding of their meaning (Schooler, Reichle, & Halpern, 2004).

In a preliminary study of mind-wandering and ADHD, Shaw and Giambra (1993) compared the frequency of off-task thoughts of 14 college students with a history of diagnosed ADHD relative to two other groups: college students with no prior diagnosis of ADHD but who scored high (90th percentile) on self-report measures of ADHD symptoms and students with no diagnosis of ADHD who scored low on such measures (10th percentile). While engaging in a simple vigilance task, participants were periodically probed and asked to indicate whether they were having thoughts unrelated to the task, and if so to indicate whether those thoughts were deliberate or unintended. Shaw and Giambra (1993) found that college students with a history of ADHD had more unrelated thoughts than students in either of the control conditions, and also that those control participants who scored high on self-report measures of ADHD (the subclinical population) had more unrelated thoughts than those who scored low. Interestingly, these differences were entirely driven by the unintended task-unrelated thoughts.

Shaw and Giambra's (1993) study is suggestive of a potentially major source of difficulty for adults suffering from ADHD symptomatology: difficulties in preventing inappropriate task-unrelated thinking. Also relevant are the growing number of studies that have found that the frequency with which individuals experience task-unrelated thoughts is associated with detriments on a host of tasks including reading (Schooler et al., 2004), memory (Smallwood, Obonsawin, & Heim, 2003), vigilance (McVay & Kane, 2009; Smallwood et al., 2004), and working memory (Mrazek et al., 2012). Viewed in light of the growing

evidence for deficits in task performance following mind-wandering, the apparent susceptibility of adults with ADHD symptomatology to mind-wandering could be an important yet under-recognized source of difficulty in their everyday lives.

Although a failure of inhibition may be one important reason why individuals with ADHD symptomatology experience excessive task-unrelated thoughts (Nigg et al., 2002), an additional possibility exists. As mind-wandering often continues for some time before being recognized by the individual, it is possible that off-task episodes could occur not only because of failures in inhibition but also because of a relative absence of meta-awareness (Schooler, 2002). Therefore, it is possible that the participants with ADHD symptoms in Shaw and Giambra's (1993) study showed elevations in spontaneous mind-wandering because of a consistent failure to notice that their minds had wandered.

Clearly, one important feature of mind-wandering is that it often occurs for some time before individuals recognize it (Schooler, 2002; Schooler et al., 2004; Smallwood, 2013; Smallwood & Schooler, 2006). This relative lack of awareness is likely to be of critical importance for those with ADHD who have a propensity to drift away from the task at hand. For such individuals, it may be possible to acquire strategies or use external prompts/reminders in a manner that would allow them to "check in" to make sure that their minds are still on task. Such compensatory strategies could, in principle, help to ameliorate the negative effects of inhibitory deficits that might otherwise be observed (for a discussion, see Schooler et al., 2011). The existence of such strategies may also help to explain reductions in adult maladaptive ADHD symptomatology that result from cognitive behavioral therapy (Murphy, 2005; Safren et al., 2005), which guides patients through strategies aimed at developing more adaptive cognitive processes or habits and/or using external supports (e.g., timers, reminders) that serve to promote effective internal cognitive strategies (e.g., staying on task).

Current Study

In the present study, we examined the relationship between mind-wandering, meta-awareness, and ADHD symptomatology in college students both in the laboratory and in everyday life. In addition to tasks and questionnaires that measure mind-wandering and ADHD, we included measures of executive function and creativity. Measures aimed at assessing executive function were included to explore how working memory capacity and inhibition relate to the main variables of interest. Creativity measures were included to investigate the positive association between mind-wandering and creativity (Baird et al., 2012), and how this may relate to ADHD symptomatology (White & Shah, 2006). In the laboratory phase, we investigated the

relationship between mind-wandering and ADHD with a variety of tasks and scales to comprehensively assess (1) *mind-wandering*: (a) Sustained Attention to Response Task (SART), (b) Reading and Mind-Wandering Task, (c) Imaginal Processes Inventory (IPI), (d) Attention-Related Cognitive Errors Scale (ARCES), (e) Mindful Attention Awareness Scale–Lapses Only (MAAS-LO), (f) Memory Failures Scale (MFS), (g) Self-Consciousness Scale; (2) *ADHD*: (a) Conners' Adult ADHD Rating Scale–Self Report Screening Version (CAARS-S:SV), (b) Adult ADHD Self-Report Scale (ASRS-V1.1); (3) *Executive Functioning*: (a) Automated Reading Span (RSPAN), (b) Stop-Signal Task; (4) *Creativity*: (a) Unusual Uses Test (UUT), (b) Remote Associates Test (RAT); and (5) *Mood*: (a) Positive and Negative Affective Schedule (PANAS).

One important limitation of laboratory studies is that they may not generalize to everyday life. Fortunately, in recent years, important advances have been made in quantifying everyday life experiences. The experience sampling method requires individuals to carry a personal digital assistant (PDA) that periodically prompts them with questions about their current experience. This procedure has effectively revealed the frequency of everyday experiences ranging from basic classifications of thoughts (Csikszentmihalyi & Larson, 1987; Killingsworth & Gilbert, 2010; McVay, Kane, & Kwapil, 2009) and emotions (Barrett & Fossum, 2001) to very specific analyses of the frequency of particular types of cravings (Stone & Shiffman, 2002). The PDA-based experience sampling method thus offers a methodology by which the experience sampling method used in the laboratory to study mind-wandering can be applied to everyday contexts.

This aspect of the study will enable us to explore the generalizability of the laboratory measures and to assess the ability of these real-world measures to predict and account for how mind-wandering, and, specifically its content (e.g., how interesting, novel, or detrimental particular mind-wandering episodes are rated) relate to ADHD symptomatology in adults' everyday lives. For example, there are certain times when one may follow an internal train of thought at the expense of current task performance because that internal train of thought is particularly useful or is less likely to interfere with other aspects of their lives. Recent work has shown that participants who demonstrate strategic mind-wandering in the sense that they limit their task-unrelated thinking to situations in which it is less likely to interfere with ongoing performance exhibit a pattern of economic decision making that is associated with less impulsive long-term decisions (Bernhardt et al., in press; Smallwood, Ruby, & Singer, 2013). Whether intentional or not, we refer to this as a type of "strategic" mind-wandering, because it suggests a process that uses certain guidelines (i.e., usefulness or appropriateness to a given context) to optimize the contents of attention. This is known as the *context regulation*

hypothesis (Smallwood & Andrews-Hanna, 2013; Smallwood & Schooler, in press). It seems plausible that there may be a detriment in this type of "strategic" mind-wandering for those with ADHD.

Collectively, the above measures will enable us to assess (a) how ADHD symptomatology relates to cognitive tasks and questionnaires assessing mind-wandering, meta-awareness, executive function, and creativity; (b) the role of awareness of mind-wandering in overcoming negative consequences of ADHD; (c) how "strategic" mind-wandering may relate to ADHD symptomatology; and (d) the relationship between ADHD symptomatology and mind-wandering in daily life.

Method

Participants

There were 105 participants in the study (71 females, M age = 23.1, SD = 7.4). Participants were recruited by posted flyers on the University of British Columbia campus and were paid Can\$20 after the first session and Can\$50 after the second session (including Can\$30 for using the PDA). If participants responded to 75% or more of the probes on the PDA, they were entered in a raffle to win an extra Can\$50. The sample size (N) as seen in Table 1 used for the summary statistics and correlations reflects the number of participants for whom data were available for a particular measure(s)—out of 105. Missing data occurred for participants failing to attend a session, failing to respond to a scale, and/or software malfunction.

Tasks and Scales

Mind-wandering

SART. For the SART, a central fixation cross (500 ms) was followed by either an "O" or a "Q" appearing centrally on a computer screen for 2,000 ms. Participants were required to press the left mouse button for the "O's" and withhold a response to the "Q's." There were 172 trials in total, 20 of which were "Q's" (12%). Of particular interest was the number of commission errors, or false alarms, where participants responded to the "Q's" as this has been associated with mind-wandering (McVay & Kane, 2009; Smallwood, Nind, & O'Connor, 2009).

Reading and Mind-Wandering Task. The text used in this experiment was selected from Bill Bryson's *A Short History of Nearly Everything* (2004), which is a general science book written in non-technical language. Four excerpts were selected for this experiment, each detailing a different aspect of science taught at school: evolution, biology, physics, and chemistry. Each excerpt was edited to approximately 2,500 words. The particular excerpts have been used elsewhere to study the relationship between mind-wandering and reading

Table 1. The Correlation Between Variables of Interest (MW, Performance, Creativity, and PDA) and the Composite ADHD Score Along With Descriptive Statistics.

Category	Variable	Summary statistics			Correlation with composite ADHD	
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	Pearson correlation coefficient
MW (composite/z score)	MW lab/PDA	103	0.00	0.78	96	.24*
	MW scales	103	0.00	0.84	97	.68***
	MW awareness	97	0.00	0.82	90	-.30**
Performance	SART errors	104	0.17	0.13	97	.27**
	Reading comprehension	101	0.64	0.13	94	-.01
	RSPAN score	100	44.83	16.67	93	.05
	STOP (SSD)	102	333.92	181.14	95	-.02
Creativity	RAT score	104	9.99	5.03	97	.11
	UUT uniqueness	101	5.75	4.39	94	-.01
	UUT fluency	101	30.79	10.47	94	-.03
PDA	Detriment	100	2.60	0.81	93	.31**
	Interest	100	2.88	0.72	93	.16
	Useful	100	2.51	0.77	93	.08
	Novel	100	2.22	0.58	93	.02
	Positive	100	3.27	0.64	93	.06
	Negative	100	2.09	0.73	93	.16
Mood	Proportion missed	104	0.31	0.20	97	.32**
	PANAS positive	98	2.56	0.70	92	.11
	PANAS negative	98	1.34	0.33	92	.26*

Note. MW = mind-wandering; PDA = personal digital assistant; SART = Sustained Attention to Response Task; RSPAN = Automated Reading Span; SSD = Stop-Signal Delay; RAT = Remote Associates Test; UUT = Unusual Uses Test; PANAS = Positive and Negative Affective Schedule.
* $p < .05$. ** $p < .01$. *** $p < .001$.

(see Smallwood et al., 2009). Participants completed this task twice, once in each of the two sessions. For a given session, two passages were chosen, with the particular passages counterbalanced across participants/sessions.

Participants read the text in each passage one paragraph at a time using the left mouse button to move to the next page. For each passage, 10 multiple-choice questions were created, each with four options as answers. During reading, thought probes were triggered if reading time exceeded a randomly selected elapsed time interval (range 13-30 s). On average, this yielded 8.7 probes per individual. Participants were asked, "In the moments prior to the probe, was your attention focused: (a) Completely on the task, (b) mostly on the task, (c) on both the task and unrelated concerns, (d) mostly on unrelated concerns, and (e) completely on unrelated concerns?" and "Please select the statement that best describes your thinking prior to the probe: I was aware of the focus of my thoughts (Press A), I was unaware of the focus of my thoughts (Press U), or I was neither aware or unaware (Press N)."

In addition, participants were instructed to press the spacebar whenever they noticed they were mind-wandering. We calculated participants' comprehension accuracy, mean thought probe score, proportion aware/unaware, and the total number of self-catches.

IPI. Participants responded to Part I of the IPI, a 24-item questionnaire used to assess the frequency of daydreams (as an index of mind-wandering) and night dreaming (Singer & Antrobus, 1963). Each question has five alternatives, with responses ranging from infrequent to frequent. A mean was calculated for daydreaming across items. A higher mean score indicates that the participant experiences a greater number of daydreams.

ARCES. ARCES (Carriere, Cheyne, & Smilek, 2008) measures the frequency of everyday cognitive failures that are most likely caused by a lapse of attention. Participants use a scale of five possible responses, ranging from 1 (*never*) to 5 (*very often*). The mean across items was calculated, and a higher mean score indicates more attention-related cognitive errors.

MAAS-LO. We used a revised 12-item version of the MAAS (Brown & Ryan, 2003) as a measure of attention lapses called the MAAS-LO (Carriere et al., 2008). This scale requires participants to answer questions about mindlessness in everyday situations using a 6-point scale ranging from 1 (*almost never*) to 6 (*almost always*). The mean was calculated across items; a higher number indicates greater frequency of attention lapses and is associated with less mindfulness.

MFS. Participants completed the 12-item MFS (Cheyne, Carriere, & Smilek, 2006) to assess everyday memory failures that are minimally explained by attentional errors. The scale includes items such as “I forget what I went to the supermarket to buy,” where participants respond on a 5-point scale ranging from 1 (*never*) to 5 (*very often*). The mean score was calculated with a high score indicating that a participant is more prone to everyday memory failures.

Self-Consciousness Scale. A 23-item Self-Consciousness Scale (Fenigstein, Scheier, & Buss, 1975) was administered to assess three different aspects of self-consciousness: public, private, and social anxiety as engagement of self-reflective processes has been shown to increase certain categories of task-unrelated thoughts, such as spontaneous thoughts about the future (Smallwood et al., 2011). Each item is rated on a 5-point scale from 0 (*extremely uncharacteristic*) to 4 (*extremely characteristic*). A mean was calculated for each of the three dimensions with a higher mean score indicating that participants are more self-conscious on that particular dimension.

ADHD

CAARS-S:SV. The CAARS-S:SV is a 30-item scale used to screen for symptoms of inattention, hyperactivity, and impulsivity in adults (Conners, Erhardt, & Sparrow, 1999). Participants were asked to rate the frequency with which each of the 30 symptoms has recently been a problem using a 4-point rating scale ranging from 0 (*not at all/never*) to 3 (*very much/very frequently*). The 18 items that make up the ADHD Symptoms scale were used in this study as they directly assess the *DSM* (4th ed.; *DSM-IV*; APA, 1994) criteria for ADHD. A mean score was calculated across these 18 items, with a higher score indicating that a participant displayed more symptoms consistent with ADHD.

ASRS-V1.1. The ASRS-V1.1 is an 18-item scale that contains the 18 items corresponding to the adult presentation of ADHD symptoms in the *DSM-IV* (Adler et al., 2006; Kessler et al., 2005). Participants were asked to rate the frequency with which each of the 18 symptoms has recently been a problem using a 6-point rating scale where responses range from 0 (*never*) to 5 (*very often*). In addition to creating a mean score across all items as an indicator of ADHD symptomatology, Part A, which consists of 6 items, can also be used as a diagnostic screening criterion for ADHD (Krause, Krause, Dresel, la Fougere, & Ackenheil, 2006). Here, four or more responses of 2 or greater indicate symptoms of adult ADHD.

Executive functioning

RSPAN. The reading span task used was an automated E-Prime script acquired from the Engle Lab at Georgia Tech (Unsworth, Heitz, Schrock, & Engle, 2005). For this task, participants were required to read sentences and

verify whether they made sense, after which, a letter was presented. Participants were required to keep in mind the letter presented after each sentence, and after a certain number of sentences, they were prompted to recall all the letters presented since the previous prompt in the correct order by clicking a box next to the appropriate letter. The trials consist of three sets of each of the five different set sizes (ranging from 3 to 7). Therefore, there were a total of 75 letters and 75 sentence problems. The reading span score used was based on the traditional “absolute RSPAN” scoring method, which is a sum of all of the perfectly recalled sets.

Stop-Signal Task. The Stop-Signal Task used was downloaded from Gordon Logan’s website¹; all the specific details of the task can be found in Verbruggen, Logan, and Stevens (2008). The basic task required participants to discriminate between squares and circles. On the stop-trials (25%), an auditory stop signal followed the primary-task stimulus and participants were instructed to withhold their responses. A practice phase of 32 trials was followed by an experimental phase consisting of three blocks of 64 trials.

The stop-signal delay (SSD) was used as an indicator of inhibitory ability; a high value indicates better inhibitory ability in that participants are able to withhold a response after a larger delay between the primary stimulus and the stop signal.

Creativity

UUT. The UUT requires participants to generate as many unusual uses as possible for a common object, such as a brick, in a set amount of time, and the originality of the responses is taken as an index of creative thinking (e.g., Milgram & Milgram, 1976; Torrance, 2008; Wallach & Kogan, 1965). Here, each participant was given 2 min to list as many uses as possible for four common objects: a hanger, screwdriver, toothpicks, and a sheet of paper.

We were interested in fluency, as measured by the total number of uses given for an object, as well as the uniqueness of responses. Uniqueness was computed based on the method outlined in Wallach and Kogan (1965). In this method, responses to each UUT stimulus are pooled across the sample and points are assigned for statistically unique responses. Unique responses (responses given by only one person) are assigned a 1 whereas other responses receive a 0, and the points are summed to yield a measure of creativity.

RAT. For the RAT, participants were presented with three words and were required to find a fourth word that relates to all three. Participants were given 15 min to complete 30 sets of words and were able to skip particular problems and come back if they were stuck. The particular stimuli were compiled from Mednick and Mednick (1967) and Bowers, Regehr, Balthazard, and Parker (1990). The total number of problems solved correctly was used to measure performance on this task.

Mood

PANAS. The 20-item PANAS was administered at the beginning and end of each session. The PANAS is composed of two mood scales, one measuring positive affect (PA) and the other measuring negative affect (NA; Watson, Clark, & Tellegen, 1988). Each item is rated on a 5-point scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*) to indicate the extent to which the respondent has felt this way in the indicated time frame. A mean score across the items and across sessions for the particular subscale was calculated and used as an indicator of PA and NA.

PDA Questionnaire

Participants were provided with a PDA model Palm z22 and responded to the probes using the stylus. The Experience Sampling Program (ESP²) was used to present the probes and collect data. Each time a participant was probed by the PDA, he or she was first asked "Were you off-task?" if they responded "Yes," they were prompted to answer the following questions: (a) Were you aware or unaware that you were off-task? (b) Was your off-task thinking regarding the past, the future, neither? (c) Rate how detrimental your mind-wandering was to the task you were doing from 1 (*not at all*) to 5 (*extremely*). Use the same 5-point scale to rate your thoughts regarding (d) how interesting they were, (e) how useful they were, (f) how novel they were (i.e., have you had identical thoughts previously). Then regardless of mind-wandering, all participants were asked to use the same 5-point scale to answer (g) how positive is your mood at the moment, and (h) how negative is your mood at the moment.

Procedure

In Session 1, participants first responded to the various questionnaires (order counterbalanced; PANAS, CAARS-S:SV, ASRS-V1.1, IPI, The Adult Autism Spectrum Quotient [AQ], ARCES, MAAS-LO, MFS, and Self-Consciousness Scale). This was followed by the five experimental tasks: Reading Mind-Wandering task, SART, one of the creativity tasks (either RAT or UUT counterbalanced across participant and session), followed by either the RSPAN or STOP task counterbalanced across participants. After completing the experimental tasks, participants then completed the PANAS for a second time.

For approximately 1 week after Session 1, participants were given a PDA to carry with them that randomly probed participants and required them to respond to the questions described above approximately 8 times per day during a 12-hr interval pre-specified by the participants in which they would be available to respond to the probes. These timing parameters for the PDA probes were based on earlier

experience sampling studies (Christensen, Barrett, Bliss-Moreau, Lebo, & Kaschub, 2003; Reis & Gable, 2000).

During Session 2, participants first completed the PANAS, then completed three experimental tasks: Reading Mind-Wandering Task, SART, and one of the creativity tasks not completed in Session 1 (either the RAT or UUT) and either the RSPAN or the STOP task. Participants finished the session by completing the PANAS.

Results and Discussion

How Do the Tasks and Scales Relate to ADHD Symptomatology?

Because many of the tasks/scales were designed to measure similar constructs, some were combined to create composite scores.³ An ADHD composite score was calculated for each participant by first converting their CAARS-SV score and ASRS score to *z* scores, and then taking the mean of these two scores. It should be noted that scores on the ADHD symptoms scale of the CAARS-SV ($M = 19.57$, $SD = 7.45$) were consistent with other work looking at non-clinical populations (Ashare & Hawk, 2012). A composite Lab/PDA mind-wandering score was calculated for each participant by converting the mean thought probe score across both reading sessions and the mean proportion off-task as reported via the PDA into *z* scores, then taking the mean of these two scores. A composite scale mind-wandering score was calculated by converting the scores from the ARCES, MFS, and IPI–Daydreaming Scales into *z* scores, and then taking the average of these three scores. A composite awareness of mind-wandering score was created by converting the proportion of unaware mind-wandering reports during the reading task and the proportion of unaware mind-wandering reports as recorded via the PDA into *z* scores.⁴ The composite awareness score was created by taking the mean of the two *z* scores and multiplying by -1 so that a high score indicates greater awareness.

Table 1 displays the means and standard deviations for the variables of interest as well as the correlations of these variables with the composite ADHD score. The variables that showed a significant positive correlation with the composite ADHD score are mind-wandering in the lab/daily life composite score, the mind-wandering scale composite score, SART errors, detrimental mind-wandering during daily life, the proportion of missed PDA probes (i.e., those not responded to), and the PANAS Negative. The awareness of mind-wandering composite score was negatively correlated with the composite ADHD score.

These findings reinforce the notion that ADHD symptomatology is related to mind-wandering during lab tasks (as measured directly via thought probes and indirectly through SART errors) and in daily life. Interestingly, even though the composite ADHD score was related to

mind-wandering, it was not associated with performance decrements (e.g., reading comprehension and reading span). Although it has previously been reported that ADHD leads to poor inhibitory performance as measured with the STOP task, there is precedence for failing to find this effect in college students (Maclaren, Taukulis, & Best, 2007).

Even though the participants were not asked whether they had ever received a diagnosis of ADHD, 14 participants had symptoms consistent with ADHD via the ASRS screening, meeting the criteria for additional clinical investigation. Interestingly, these participants did not differ significantly in terms of frequency of mind-wandering in the lab and daily life compared with those participants not meeting this screening criterion, but they did report more unaware mind-wandering during reading, $t(100) = 2.03, p = .04$, and in daily life, $t(99) = 1.99, p = .05$, compared with the rest of the sample.

Role of Awareness of Mind-Wandering in Overcoming Negative Consequences of ADHD Symptomatology

The overall analyses above showed that participants who score higher on the ADHD scales report more detrimental effects of mind-wandering in daily life (i.e., as measured via the PDA; $r = .31, p < .01$). Using a mediational analysis (Preacher & Hayes, 2004), we subsequently determined that meta-awareness partially mediates the relationship between ADHD symptomatology and detrimental mind-wandering (Figure 1); in other words, by taking into account awareness, the relationship between ADHD symptoms and detrimental mind-wandering is weakened.

Relationship Between ADHD Symptomatology and “Strategic Mind-Wandering”

We used the PDA data to investigate the role of ADHD in this type of strategic mind-wandering by asking the following question: Does the relationship between the usefulness and detriment ratings of a mind-wandering episode vary based on the ADHD composite score? This analysis was done using a mixed effects model with a random intercept for participant to examine the interaction of the ADHD composite score and usefulness ratings on detriment ratings at the individual probe level. There was a significant interaction, $F(1,783) = 7.40, p = .007$. Figure 2 uses a median split of the composite ADHD score to help visualize this relationship. Participants with low ADHD scores tended to have detrimental mind-wandering episodes that are also useful (i.e., they were willing to incur a cost to the current task if they felt that the mind-wandering episode was useful). Participants with high ADHD scores showed no relationship between how detrimental a

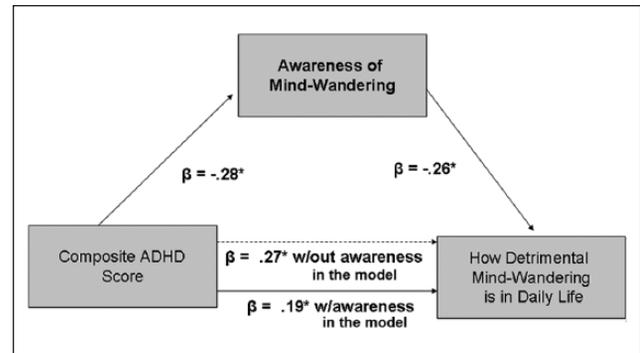


Figure 1. Bootstrapping was used to calculate a 95% confidence interval around the indirect effect using 5,000 resamples [0.01, 0.20].

Note. Zero falls outside this interval indicating partial mediation. * $p < .05$.

mind-wandering episode is and its usefulness (i.e., they had disruptive mind-wandering episodes even when these were in no way useful). This finding is consistent with the high level of distractibility associated with ADHD and supports the notion of general executive functioning deficits in which top-down control is unable to suppress (or, in this case, facilitate useful) mind-wandering episodes.

ADHD Symptomatology and Mind-Wandering in Daily Life

In addition to using the PDA data to examine the relationship between a participant's ADHD score and his or her ability to engage in “strategic” mind-wandering, we were also interested in how interest ratings of the mind-wandering episodes might relate to ADHD symptoms. Although the mean PDA interest rating was not significantly correlated with the ADHD composite score (see Table 1), we performed an exploratory analysis to further examine the subpopulation of participants who reported at least one “very interesting” mind-wandering episode. This was done to examine some of the characteristics of participants who perceive that they have particularly interesting mind-wandering episodes. Notably, these participants had a higher composite ADHD score ($n = 34, M = 0.25, SD = 0.77$) than the participants who did not report a very interesting mind-wandering episode ($n = 63, M = -0.16, SD = 0.93, t(95) = 2.20, p = .03$). This suggests that those participants with ADHD symptoms may be more likely to report experiencing very interesting mind-wandering episodes. Although one explanation might be that these participants just mind-wander more, and therefore have an increased chance to report a very interesting mind-wandering episode, the number of off-task episodes is not significantly correlated with the interest rating of these off-task episodes ($r = .05, p = .60$).

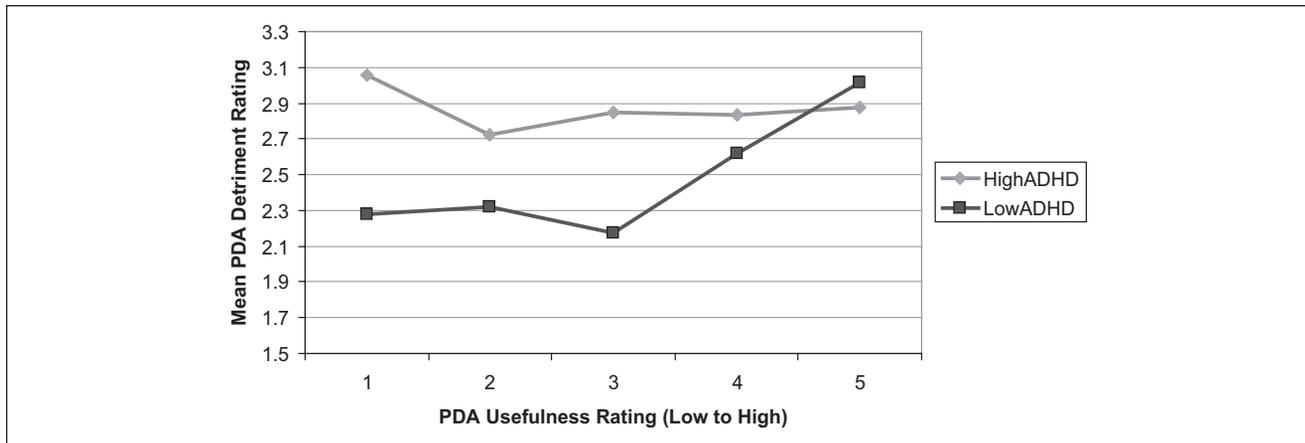


Figure 2. The relationship between how detrimental and how useful a mind-wandering episode is based on ADHD group (calculated using a median split).

Note. Used for display purposes only, statistical analyses were done as described in the text using continuous, not categorical, variables. MW = mind-wandering; PDA = personal digital assistant.

General Discussion

The results of this study reveal new details about the relationship between ADHD symptomatology and mind-wandering in laboratory tasks and in daily life. In particular, we found that a composite ADHD score was positively correlated with both the frequency of mind-wandering (measured in and out of the lab) and a lack of awareness of mind-wandering. Although prior work has suggested a link between ADHD symptomatology and mind-wandering (Shaw & Giambra, 1993), this had not been demonstrated before in a naturalistic setting, where participants are probed as they go about typical daily activities. In addition, these findings build upon earlier work by providing a more stable, trait-based mind-wandering measure based on multiple laboratory sessions (and throughout the week via PDA). A more detailed analysis of the PDA data revealed that those participants with high ADHD scores are more likely to have mind-wandering episodes that are detrimental and interfere with their daily life. This study therefore reveals, for the first time, particular mind-wandering deficits related to ADHD symptomatology in a community sample. These data are consistent with the notion that ADHD may lead to impairments, even at a subclinical level (Overbey et al., 2011; Whalen et al., 2003), and support the view that understanding mind-wandering induced failures in performance depends on taking into account the context in which the episode occurs, and hence their potential consequences (Smallwood & Andrews-Hanna, 2013). It is important to note that ADHD is associated with anxiety, substance use, and depression (Biederman et al., 1995). Because the current study is unable to account for the influences of these comorbid conditions, future work would be needed to disentangle these additional factors. Despite this caveat and

the fact that these data were not collected from a screened or diagnosed ADHD population, the findings reported may be relevant to clinical ADHD populations as well.

Furthermore, we present new evidence regarding the relationship between meta-awareness of mind-wandering and ADHD symptomatology; that participants high on the ADHD scales are more likely to be unaware that they are mind-wandering. Additional analyses showed that the relationship between the composite ADHD score and detrimental mind-wandering was partially mediated by awareness of mind-wandering. In other words, ADHD symptomatology becomes less associated with detrimental mind-wandering when you take into account awareness of mind-wandering. This suggests the intriguing possibility that it is not simply the frequency of distraction that best explains the detrimental impacts of ADHD but also a lack of awareness of distraction. Low meta-awareness of mind-wandering may prevent self-regulatory attempts to prevent or repair negative outcomes (Schooler et al., 2011). Therefore, one important conclusion that may emerge from this finding is that it might outline potential compensatory strategies arising from meta-awareness that may help a subset of at-risk individuals mitigate the disruptive effects of mind-wandering in their daily lives. If so, then this research may subsequently lead to the development of techniques that enable adults with ADHD to more effectively recognize mind-wandering lapses and thereby reduce a hitherto under-recognized source of difficulty in their day-to-day lives. Accordingly, clinical interventions using external cues/reminders to make people become more meta-aware of their mind-wandering could alleviate some of the negative consequences of ADHD.

Of course, the extent to which those with ADHD symptomatology are able to utilize strategies to compensate for their tendency to mind-wander will need to be investigated,

perhaps especially those with the poorest outcomes. For example, on one hand, it has been documented that attention training can be beneficial for those diagnosed with ADHD (Heinrich, Gevensleben, Freisleder, Moll, & Rothenberger, 2004; Klingberg et al., 2005). On the other hand, we found that participants high on the ADHD scale fail to engage in strategic mind-wandering. Low ADHD participants showed a relationship between ratings of the usefulness and detriment for a mind-wander—they were willing to incur a cost to the task at hand to engage in useful mind-wandering. High ADHD participants showed no such relationship, which suggests that it might be inherently difficult for these participants to engage higher level control processes to control their mind-wandering episodes. However, these findings do suggest the intriguing possibility that reported decreases in ADHD symptomatology from childhood into adulthood (Biederman, Mick, & Faraone, 2000) may be related to adults' better developed meta-cognitive strategies that may be used to manage their symptoms, which is consistent with work done using cognitive behavioral therapy (Safren et al., 2005). This is also consistent with studies done with college students showing that individuals who are off-task are not necessarily more distractible (Barron, Riby, Greer, & Smallwood, 2011) and that better self-control is associated with less detrimental and more strategic mind-wandering (Baird, Smallwood, & Schooler, 2011; Smallwood et al., 2013). It is thus possible that ADHD symptomatology is associated with more detrimental mind-wandering episodes because individuals with high levels of symptoms lack the higher order control processes that may be helpful in coordinating the content of an internal train of thought and minimizing the disruptive aspects of the experience (Smallwood, 2013; Smallwood & Andrews-Hanna, 2013).

Although the present study failed to find a previously reported positive relationship between ADHD symptomatology and creativity (White & Shah, 2006), there was one positive outcome associated with high ADHD scores. Specifically, a subset of the participants who had extremely interesting mind-wandering episodes had significantly higher composite ADHD scores. This may relate to findings reported by Kass, Wallace, and Vodanovich (2003) showing that attention scores on the Adult Behavior Checklist (in particular, hyperactivity) are best predicted by the Boredom Proneness subscale that assesses, among other things, the need for a stimulating environment. Perhaps this is not limited to one's external environment, with ADHD symptomatology facilitating more interesting trains of thought to create a more stimulating internal environment.

The present study provides new insights into the relationship between mind-wandering and ADHD symptomatology in a subclinical adult sample. We found increased mind-wandering in the lab, as well as in daily life (and increased detrimental mind-wandering), was associated with ADHD

scale measures. In addition, the findings suggest that some of the negative consequences of mind-wandering can be offset by strategies that encourage meta-awareness. Last, the relationship between ADHD and "interesting" mind-wandering episodes reveals that there may be some beneficial aspects of the mind-wandering experience for those with ADHD symptomatology (Franklin et al., 2013). Together, these results provide promising directions for future research that could potentially help those with a tendency toward ADHD to manage their symptoms.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Notes

1. <http://www.psy.vanderbilt.edu/faculty/logan/#stopit>
2. <http://www.experience-sampling.org/>
3. Mean intercorrelation between constituent components = 0.47, $SD = 0.17$; all $ps < .05$.
4. In the reading task, participants had the option of responding "neither aware or unaware" so the proportion of aware and unaware mind-wandering did not together add to 100%. Because we felt that unaware mind-wandering would be more closely related to ADHD, we combined the proportion of unaware mind-wandering across both contexts (reading/personal digital assistant [PDA]).

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Author Biographies

Michael S. Franklin, PhD, is a project scientist at the University of California, Santa Barbara in the Department of Psychological and Brain Sciences. His current research interests include mind-wandering and the development of methods to detect mind-wandering in real-time.

Michael D. Mrazek, PhD, is a post-doctoral scholar at the University of California, Santa Barbara in the Department of Psychological and Brain Sciences. His research focuses on the opposing constructs of mind-wandering and mindfulness, with an emphasis on how cultivating a capacity for non-distraction can enhance performance and well-being. He also examines how dramatically and rapidly an individual's life can be improved under ideal conditions.

Craig L. Anderson is a PhD student at the University of California, Berkeley in the Department of Psychology. His research interests include how attention changes the experience of emotions and how positive emotions, particularly awe, impact well-being.

Charlotte Johnston, PhD, is a professor and director of clinical training in the Psychology Department at the University of British Columbia. Her research focuses on ADHD and family interactions.

Jonathan Smallwood, PhD, is reader in psychology/cognitive neuroscience in the Department of Psychology in the University of York, United Kingdom. His research interests include understanding the neural basis of self-generated thoughts (such as daydreaming or mind-wandering) and exploring the functional outcomes associated with different forms of these experiences.

Alan Kingstone, PhD, is a professor in the Department of Psychology at the University of British Columbia in Vancouver, Canada.

Jonathan W. Schooler, PhD, is a professor at the University of California, Santa Barbara in the Department of Psychological and Brain Sciences. His current research interests include mind-wandering, meta-awareness, creativity, and issues related to replication in the sciences.