Journal of Experimental Psychology:
Learning, Memory, and Cognition
2018, Vol. 44, No. 1, 85–98

0278-7393/18/$12.00 http://dx.doi.org/10.1037/xlm0000444

Cognitive and Contextual Correlates of Spontaneous and Deliberate Mind-Wandering

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Individuals with greater cognitive abilities generally show reduced rates of mind-wandering when completing relatively demanding tasks (Randall, Oswald, & Beier, 2014). However, it is yet unclear whether elevated rates of mind-wandering among low-ability individuals are manifestations of deliberate, intentional episodes of mind-wandering because of task disengagement or lack of motivation, or to spontaneous, unintentional failures to maintain task-oriented attention. The present study examined this issue by measuring working memory capacity (WMC), mind-wandering during 3 relatively demanding attention control tasks, and contextual variables (e.g., motivation, alertness, perceptions of task unpleasantness). Results indicated that the relationship between WMC and mind-wandering was primarily driven by spontaneous episodes. Lack of alertness also uniquely predicted more frequent spontaneous mind-wandering independently of WMC. Deliberate mind-wandering was primarily driven by a lack of motivation. Thus, cognitive and contextual factors can have distinct relationships with spontaneous and deliberate mind-wandering.

Keywords: mind-wandering, working memory capacity, attention control

At any given moment in our lives, we have an abundance of information competing for our attention. Most of the time, we direct our attention in a goal-driven manner. For example, a student sitting in class will devote her attention to the lecturer in order to learn and retain the information. But occasionally, attention diverts away from the primary task to irrelevant internal or external sources of information. Another student's persistent cough may be a source of distraction. An upcoming exam may lead the student to think about when she is going to find time to study later. This latter form of task-irrelevant thought can be considered an instance of mind-wandering, a topic of investigation that has become important in the last decade in cognitive psychology (Callard, Smallwood, Golchert, & Margulies, 2013; Smallwood & Schooler, 2006, 2015).

Mind-wandering can be defined as task-unrelated thought that is relatively independent of any immediate external stimulus. This type of thought can take on a number of dimensions including temporal focus, emotional valence, and self-relevance, among others (Andrews-Hanna et al., 2013; Klinger, 1999). One dimension of mind-wandering that may be particularly relevant is the degree to which the thoughts are under the individual's volitional control. In the above example, our student may be trying in earnest to pay close attention to the lecture, but her thoughts unintentionally stray to other topics. This would be an example of spontaneous (i.e., unintentional) mind-wandering. In another instance, she might find the lecture exceptionally uninteresting, and decide to plan her weekend instead. This would be an example of deliberate (i.e., intentional) mind-wandering. The distinction has led researchers to distinguish between intentional and unintentional mind-wandering when examining the frequency of task-unrelated thoughts during ongoing task completion (Grodsky & Giambra, 1990–1991; Seli, Cheyne, Xu, Purdon, & Smilek, 2015; Seli, Risko, & Smilek, 2016a).

One of the major goals of the empirical investigation of mind-wandering is to determine for whom mind-wandering is most likely to occur (Kane et al., 2007). To accomplish this goal, the field has embraced individual differences investigations of mind-wandering using a number of techniques including daily life experience sampling (e.g., Kane et al., 2007; Killingsworth & Gilbert, 2010), diaries and journals (e.g., Unsworth, Brewer, & Spillers, 2012; Unsworth, McMillan, Brewer, & Spillers, 2012), questionnaires (e.g., Broadbent, Cooper, Fitzgerald, & Parkes, 1982; Giambra, 1977), retrospective reports following laboratory tasks (e.g., Antrobus, Singer, & Greenberg, 1966), and thought probes embedded in laboratory tasks (e.g., Giambra, 1989). These investigations have yielded a number of important discoveries. Of most relevance to the current study is that the frequency with which individuals report mind-wandering both in the lab and in their day-to-day lives correlates with their cognitive abilities (Kane et al., 2007, 2016; McVay & Kane, 2012a, 2012b; Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013; Mrazek et al., 2012; Robison, Gath, & Unsworth, 2017; Robison & Unsworth, 2015, 2017; Unsworth, Brewer, et al., 2012; Unsworth & McMillan, 2013, 2014; Unsworth, McMillan, et al., 2012; Unsworth & Robison, 2016).

In general, individual differences investigations have demonstrated a negative relationship between the frequency of

This article was published Online First July 31, 2017.

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This research was supported by National Science Foundation Grant 1632327 and Office of Naval Research Grant N00014-15-1–2790 during data analysis and writing of the article.

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mind-wandering and cognitive ability (see Randall, Oswald, & Beier, 2014, for review). Several theories have been proposed for why this might be the case. Within the Control Failure × Concern theory (Kane & McVay, 2012; McVay & Kane, 2010), the degree to which individuals mind-wander is jointly determined by (a) their ability to maintain current goals active in mind and resist task-irrelevant thoughts and (b) the salience of personal concerns. Mind-wandering often occurs as the result of a failure to maintain task focus (i.e., control failure), allowing task-irrelevant, personally salient concerns to become the focus of current conscious thought. Therefore, within this conceptualization mind-wandering is considered unintentional and involuntary (Kane & McVay, 2012). People with superior executive control are better able to keep mind-wandering at bay, which allows them to maintain better task focus and achieve better behavioral performance. Mind-wandering as a control failure is thus theoretically spontaneous, not deliberate. Therefore, individual differences in cognitive ability should specifically predict spontaneous mind-wandering. Another possibility is that the relationship between mind-wandering and cognitive ability is driven by deliberate task disengagement. Low-ability participants may feel overwhelmed by the task, or simply find it too difficult to be worth the effort, and thereby deliberately mind-wander instead. If this is the case, individuals with low cognitive ability should show a greater frequency of deliberate, but not spontaneous, mind-wandering. Finally, another explanation may be a lack of motivation within low-ability participants. Although motivation does not typically fully explain differences in mind-wandering (e.g., Unsworth & McMillan, 2013), it could be the case that "low-ability" participants are unmotivated on the tasks that measure these abilities and thus choose to mind-wander more often. Seli, Cheyne, Xu, Purdon, and Smilek (2015) replicated the finding that lower levels of motivation predicted worse task performance. But they demonstrated that motivation was specifically related to intentional (i.e., deliberate) mind-wandering. Therefore, the distinction between spontaneous and deliberate mind-wandering may help explain the frequently observed relationship between cognitive abilities and mind-wandering tendencies.

Other theories argue that individuals with greater cognitive ability are more apt at controlling the occurrence of mind-wandering in a context-specific manner (Rummel & Boywitt, 2014; Smallwood & Andrews-Hanna, 2013). When the situation calls for it, executive control works to constrain attention to only task-relevant information. But when the external task environment is particularly undemanding, individuals with greater cognitive ability may be able to flexibly attend to both task-relevant and task-irrelevant information in an adaptive manner (Rummel & Boywitt, 2014; Smallwood & Andrews-Hanna, 2013). A better functioning cognitive system may offer a specific resistance to spontaneous mind-wandering, which is a similar prediction to that made by the Control Failure × Concern theory. In other instances, better cognitive ability may allow for more frequent deliberate mind-wandering depending on the context. These theories thus predict a negative correlation between spontaneous mind-wandering and cognitive ability during the completion of demanding external tasks. Further, there may be a positive correlation between deliberate mind-wandering and cognitive ability as people with greater abilities can successfully complete tasks while also entertaining task-irrelevant internal thoughts. Differentiating between these various possibilities was a major goal of the present study.

To highlight the importance of differentiating between spontaneous and deliberate mind-wandering, some recent work has demonstrated that these two types of off-task thought show distinct relationships with other important individual differences. Carriere, Seli, and Smilek (2013) developed two scales to measure self-reported tendencies to spontaneously and deliberately mind-wander in day-to-day life: the Mind-Wandering: Spontanous (MW-S) scale and the Mind-Wandering: Deliberate (MW-D) scale. Using this questionnaire, Seli, Smallwood, Cheyne, and Smilek (2015) demonstrated that self-reported attention-deficit/hyperactivity disorder (ADHD) symptoms were specifically related to spontaneous rather than deliberate mind-wandering. Further, a sample of individuals with clinically diagnosed ADHD reported significantly more spontaneous, but not deliberate, mind-wandering compared with a sample with no such diagnosis (Seli, Carriere, & Smilek, 2015). Similarly, Seli, Risko, Purdon, and Smilek (2017) showed that self-reported obsessive–compulsive symptoms were related to spontaneous mind-wandering much moreso than to deliberate mind-wandering. Finally, deliberate and spontaneous mind-wandering are differentially related to the non-reactivity facet of mindfulness (Seli, Carriere, et al., 2015), with spontaneous mind-wandering being negatively related to nonreactivity and deliberate mind-wandering being positively related. Together these studies highlight the importance of the spontaneous-deliberate distinction when investigating how mind-wandering tendencies relate to aspects of psychological functioning.

One element of the above-mentioned studies is that they correlate two self-report measures, so shared method variance may be driving the observed relationships. To address this issue, Seli et al. (2016a) had participants complete the MW-D and MW-S scales as well as a the Metronome Response Task (MRT; Seli, Cheyne, & Smilek, 2013) into which thought probes were embedded. Participants responded to each thought probe with one of three options: (1) on task, (2) intentionally thinking about task-unrelated thoughts, and (3) unintentionally thinking about task-unrelated thoughts. MW-S scores significantly predicted unintentional (i.e., spontaneous) mind-wandering reports and MW-D scores significantly predicted intentional (i.e., deliberate) mind-wandering reports. Therefore, there is some evidence that the MW-S and MW-D scales map onto thought probe reports of the same theoretical construct.

Extending these findings to neuroimaging, a recent study measured cortical thickness and resting-state functional connectivity and administered the MW-S and MW-D scales among a sample (N = 123) of healthy young adults (Golchert et al., 2017). Self-reported tendencies toward spontaneous mind-wandering correlated with cortical thinning in a cluster extending from the left intraparietal sulcus to posterior regions of the temporal lobe, greater functional connectivity between ventral regions of the left inferior frontal gyrus and the temporal pole, and cortical thinning in the left angular gyrus within the Default Mode Network (Yeo et al., 2011), a distributed brain network thought to underlie self-generated thoughts. Self-reported tendencies toward deliberate mind-wandering correlated with cortical thickness in a cluster in the prefrontal cortex extending from dorsal regions of the medial prefrontal cortex to the inferior frontal sulcus. Deliberate mind-wandering also correlated with greater functional connectivity between areas in the right rostral prefrontal cortex, the anterior temporal lobe, the anterior insula, and a cluster extending from the left posterior superior temporal gyrus to the angular gyrus. Further, the left ventral inferior frontal gyrus related to both spontaneous and deliberate mind-wandering. Golchert et al. argue that these results reflect heightened integration between the Default Mode Network and regions of the Fronto-Parietal Network for individuals who endorse higher rates of deliberate mind-wandering. A less integrated connection between these networks predicted more spontaneous mind-wandering, which may relate to the inability to control thoughts in a goal-directed manner. Therefore, there is at least preliminary evidence that spontaneous and deliberate mind-wandering relate to distinct structural and functional differences in the brain.

So far we have mostly addressed the nature of the relationship between cognitive ability and mind-wandering rates. But the present study also investigated how various contextual factors can influence how often individuals mind-wander. Factors like alertness/fatigue, task interest, motivation, and prior experience have all been shown to predict mind-wandering rates. For example, Unsworth and McMillan (2013) asked participants to rate their motivation, interest, and topic experience following a reading comprehension task. The reading material was a passage from a political science textbook, so the participants (college students) presumably had varying degrees of interest and experience with the material. Results revealed that greater motivation, interest, and experience all predicted lower rates of mind-wandering and better reading comprehension. Importantly, these variables were entirely independent of and uncorrelated with working memory capacity (WMC; see also Robison & Unsworth, 2015). An effect of motivation on mind-wandering has also been observed when examining intentional and unintentional mind-wandering during college lectures (Seli, Wammes, Risko, & Smilek, 2016). Students who reported higher motivation reported significantly fewer instances of mind-wandering during lectures, which mediated the relationship between motivation and retention of lecture material (Seli, Wammes, et al., 2016). Seli, Cheyne, et al. (2015) have also demonstrated negative correlations among motivation, mind-wandering rate, and task performance on the MRT. MRT performance and motivation both negatively correlated with spontaneous and deliberate mind-wandering, but not differentially so. However, motivation specifically correlated with deliberate mind-wandering. Individuals who expressed low motivation levels tended to report more intentional task-unrelated thoughts, as opposed to unintentional (i.e., spontaneous) thoughts. So clearly the degree to which an individual is motivated to perform well on a task can influence how often they mind-wander, and this can account for motivation-related differences in task performance.

Fatigue is another potent factor that can lead to greater rates of mind-wandering. Poh, Chong, and Chee (2016) examined the effect of sleep-deprivation on mind-wandering using an experimental design. One group of participants was not allowed to sleep over the course of one night, which was ensured by participants staying in the lab overnight and remaining under constant supervision of the researchers. The other group was permitted to sleep for up to nine hours in the lab. In the morning, all participants completed high-load and low-load versions of a visual search task (Forster & Lavie, 2009). Poh et al. (2016) found that sleep-deprived participants reported significantly more mind-wandering as well as significantly reduced awareness of their own mind-wandering in the high-load condition. Using an individual differences approach, Stawarczyk and D'Argembeau (2016) probed participants throughout a task to measure subjective sleepiness and mind-wandering. At both a between-subjects and a within-subjects level, greater sleepiness predicted more mind-wandering and worse task performance. Furthermore, mind-wandering and sleepiness made independent contributions to task performance. Finally, a sample of drivers reported that they find themselves mind-wandering more when they are tired compared with when they feel more alert (Burdett, Charlton, & Starkey, 2016). Together these studies suggest that in addition to contextual variables like motivation, interest, and experience, fatigue and alertness have an impact on mind-wandering as well.

Another contextual variable of interest in the present study was perceived task difficulty. A number of studies have manipulated the difficulty of a task to examine the associated change in mind-wandering. The results are rather mixed. For example, Antrobus et al. (1966) manipulated a target-detection task to make target presentation rate faster and showed an associated decrease in mind-wandering. Grodsky and Giambra (1990–1991) manipulated difficulty in a vigilance task and a reading task and measured intentional and unintentional mind-wandering. In the vigilance task, high-difficulty conditions led to less unintentional mind-wandering than low-difficulty conditions. In the reading task, unintentional and intentional mind-wandering were about equal in the high- and low-difficulty conditions. Feng, D'Mello, and Graesser (2013) observed more of an impact of mind-wandering on comprehension when the text was more difficult to read. Similarly, Al-Balushi and Al-Harthy (2015) observed greater mind-wandering for submicroscopic chemistry texts, which are more difficult for students, compared with macroscopic chemistry texts. In a visual search task, Forster and Lavie (2009) manipulated perceptual load and found less mind-wandering in a high-load condition compared with a low-load condition. Finally, Xu and Metcalfe (2016) found that mind-wandering rates were lowest when learners studied information in their region of proximal learning. Therefore, it is apparent that there are manipulations that can make tasks easier or more difficult, and these manipulations can affect mind-wandering rates. Overall, it seems like there is a U-shaped function in that extremely easy and extremely difficult tasks will produce the highest rates of mind-wandering, and there may be a "sweet-spot" of difficulty where the lowest rate of mind-wandering occurs (Van Steenbergen, Band, & Hommel, 2015; Xu & Metcalfe, 2016). Finally, some results suggest manipulations to task difficulty can differentially affect spontaneous and deliberate mind-wandering (Seli, Risko, & Smilek, 2016b). In the present study, we did not manipulate task difficulty. Rather, we asked participants how difficult and unpleasant they found the tasks to see how these perceptions predicted task performance, spontaneous mind-wandering, and deliberate mind-wandering.

Theoretically, the above-mentioned contextual variables may have different relationships with spontaneous and deliberate mind-wandering. On one hand, if participants find a task difficult and unpleasant, they may choose to deliberately mind-wander as a means of escaping the cognitive rigor of the task. Similarly, if participants find a task exceptionally boring or monotonous, they may intentionally "check out" and start to mind-wander. On the other hand, participants who are not alert may have trouble maintaining their attention, which would lead to more spontaneous mind-wandering. In general, our goal in measuring these various contextual factors was to identify the noncognitive predictors of conscious states that stray from task focus. Specifically, we wanted to see how these factors predicted spontaneous and deliberate mind-wandering differentially.

Present Study

The research reviewed above supports the idea that mind-wandering is a multifaceted construct that has a number of predictors at the level of individual differences. First, one's cognitive abilities (e.g., WMC) can predict how often one mind-wanders. Second, contextual variables like motivation, alertness, task interest, and perceived task difficulty can predict how often one mind-wanders. Third, the intentionality dimension of mind-wandering may be particularly important for the investigation of individual differences, as spontaneous and deliberate mind-wandering may differentially relate to such predictors. So to investigate such a complex phenomenon, we took a multifaceted approach that incorporates both cognitive and contextual predictors with a specific focus on the intentionality dimension of mind-wandering.

The present study had several aims. The first was to examine the relationship between WMC and its relationship with spontaneous and deliberate mind-wandering. To date, a number of investigations have shown negative correlations between mind-wandering and cognitive abilities like WMC, attention control, and fluid intelligence (Kane et al., 2007; McVay & Kane, 2009, 2012a, 2012b; McVay, Unsworth, McMillan, & Kane, 2013; Robison, Gath, & Unsworth, 2017; Robison & Unsworth, 2015; Unsworth, Brewer, & Spillers, 2012; Unsworth, McMillan, et al., 2012; Unsworth & McMillan, 2013, 2014; Unsworth & Robison, 2016), particularly when mind-wandering is measured during difficult or demanding tasks like reading comprehension, antisaccade, Stroop, psychomotor vigilance, and the Sustained Attention to Response Task. But no individual differences investigation has directly tested the assumption that cognitive ability should specifically predict unintentional and involuntary episodes of mind-wandering (Kane & McVay, 2012). Therefore, the primary goal of the present study was to examine how working memory capacity (WMC) relates to spontaneous and deliberate mind-wandering. Our prediction, based on the control failures perspective, is that WMC will specifically predict spontaneous mind-wandering rather than deliberate mind-wandering. However, one alternative explanation is that low-WMC participants generally show more frequent mind-wandering because they find the tasks too difficult and thus decide to intentionally disengage. Another explanation is that these participants are unmotivated, and their elevated rates of mind-wandering can be explained by this lack of task interest/motivation. In each of these alternative explanations, WMC would be negatively predictive of deliberate mind-wandering rather than spontaneous mind-wandering. Further, the context-regulation (Smallwood & Andrews-Hanna, 2013) and cognitive flexibility hypotheses (Rummel & Boywitt, 2014) make the prediction that in some contexts, cognitive ability will actually predict more deliberate mind-wandering. Therefore, a second goal of the present study was to examine if the present set of tasks are contexts in which this might occur. If we observe a positive relationship between WMC and deliberate mind-wandering, this would provide evidence for this view, as it would suggest that high-ability individuals can simultaneously complete external tasks and entertain irrelevant, internal streams of thought. Additionally, as prior research has shown a relationship between motivation and mind-wandering (Seli, Cheyne, et al., 2015; Unsworth & McMillan, 2013), we asked participants to report their motivation and interest levels following tasks during which we measured mind-wandering. Further, we asked participants to report their alertness and perceptions of task difficulty. In general, we wanted to examine how these various contextual factors would differentially (or perhaps similarly) predict spontaneous and deliberate mind-wandering. Finally, we wanted to see how the cognitive (i.e., WMC) and contextual predictors predicted common and unique variance in mind-wandering. To this end, we used confirmatory factor analysis and structural equation modeling to examine these variables at the latent level.

Method

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

Participants and Procedure

A total of 210 participants were recruited from the University of Oregon human subjects pool. Participants completed all measures in a single 2-hr session and were given partial course credit for participating. We had a target minimum sample size of 200, and we used the end of an academic term as our stopping rule for data collection. Because of computer errors and failures to follow task instructions, data was unavailable for some tasks for some participants. In Table 1 we report the sample sizes for each individual measure. The procedure was approved by the Institutional Review Board of the University of Oregon. All participants were treated according to the ethical standards of the American Psychological Association and were debriefed following the session.

Tasks

Working memory capacity.

Operation span. In this task, participants solved a series of math operations while trying to remember a set of unrelated letters (Unsworth, Heitz, Schrock, & Engle, 2005). Participants were required to solve a math operation, and after solving the operation, they were presented with a letter for 1 s. Immediately after the letter was presented the next operation was presented. At recall participants were asked to recall letters from the current set in the correct order by clicking on the appropriate letters. For all of the span measures, items were scored correct if the item was recalled correctly from the current list in the correct serial position. Participants were given practice on the operations and letter recall tasks only, as well as two practice lists of the complex, combined task. List length varied randomly from three to seven items, and there were two lists of each length for a total possible score of 50. The score was total number of correctly recalled items in the correct serial position.

Symmetry span. Participants recalled sequences of red squares within a matrix while performing a symmetry-judgment task (Unsworth, Redick, Heitz, Broadway, & Engle, 2009). In the symmetry-judgment task, participants were shown an 8 × 8 matrix with some

Table 1
Descriptive Statistics for All Measures

Measure	*N*	*M*	*SD*	Skew	Kurtosis	Reliability
1. Operation span	210	37.49	8.61	−.79	.37	.70
2. Symmetry span	210	19.12	4.92	−.44	−.34	.54
3. Reading span	210	37.02	8.57	−.57	−.35	.72
4. Antisaccade	205	.51	.15	.38	−.38	.74
5. Stroop	203	841	179	1.38	3.47	.83
6. PVT	207	500	130	2.12	5.77	.99
7. Anti MW-S	205	.84	1.63	2.70	9.38	
8. Stroop MW-S	203	1.88	3.61	2.97	9.94	
9. PVT MW-S	209	2.58	2.47	.98	.44	
10. Anti MW-D	205	.26	.88	5.02	29.31	
11. Stroop MW-D	203	.41	1.62	5.57	32.79	
12. PVT MW-D	209	.59	1.23	2.62	7.23	
13. Anti Mot	168	3.72	1.53	−.28	−.82	
14. Stroop Mot	162	4.03	1.26	−.37	−.33	
15. PVT Mot	168	4.16	1.38	−.45	−.45	
16. Anti alert	168	3.29	1.36	.06	−.74	
17. Stroop alert	162	3.13	1.27	.13	−.53	
18. PVT alert	168	3.16	1.32	.11	−.76	
19. Anti Unpls	205	4.25	1.42	−.50	−.53	
20. Stroop Unpls	203	3.17	1.11	.28	.31	
21. PVT Unpls	209	3.59	1.30	.06	−.36	

Note. Thought probe reports are sums averaged across participants. Reliabilities were computed using Cronbach's alpha on each set size for operation span, symmetry span, and reading span and on each reaction time for psychomotor vigilance. Split-half coefficients were calculated for Stroop reaction times and antisaccade accuracy. Anti = antisaccade; PVT = psychomotor vigilance task; MW-S = spontaneous mind-wandering; MW-D = deliberate mind-wandering; Mot = motivation; Alert = alertness; Unpls = unpleasantness.

squares filled in black. Participants decided whether the design was symmetrical about its vertical axis. The pattern was symmetrical half of the time. Immediately after determining whether the pattern was symmetrical, participants were presented with a 4 × 4 matrix with one of the cells filled in red for 650 ms. At recall, participants recalled the sequence of red-square locations by clicking on the cells of an empty matrix. Participants were given practice on the symmetry-judgment and square recall task as well as two practice lists of the combined task. List length varied randomly from two to five items, and there were two lists of each length for a total possible score of 28. We used the same scoring procedure as we used in the operation span task.

Reading span. While trying to remember an unrelated set of letters, participants were required to read a sentence and indicated whether or not it made sense (Unsworth et al., 2009). Half of the sentences made sense, whereas the other half did not. Nonsense sentences were created by changing one word in an otherwise normal sentence. After participants gave their response, they were presented with a letter for 1 s. At recall, participants were asked to recall letters from the current set in the correct order by clicking on the appropriate letters. Participants were given practice on the sentence judgment task and the letter recall task, as well as two practice lists of the combined task. List length varied randomly from three to seven items, and there were two lists of each length for a total possible score of 50. We used the same scoring procedure as we used in the operation span and symmetry span tasks.

Attention control.

Psychomotor vigilance. The psychomotor vigilance task (Dinges & Powell, 1985) was used as the primary measure of sustained attention. Participants were presented with a row of zeros on screen. After a variable amount of time the zeros began to count up in 17-ms intervals from 0 ms (as determined by the 60 Hz monitor refresh rate). The participants' task was to press the spacebar as quickly as possible once the numbers started counting up. After pressing the space bar the response time was left on screen for 1 s to provide feedback to the participants. Interstimulus intervals were randomly distributed and ranged from 2 s to 10 s. The entire task lasted for 10 min for each individual (roughly 75 total trials). The dependent variable was the average reaction time (RT) for the slowest 20% of trials (Dinges & Powell, 1985). Thought probes were randomly presented after 20% of trials.

Antisaccade. In this task (Kane, Bleckley, Kane, & Engle, 2001) participants were instructed to stare at a fixation point which was onscreen for a variable amount of time (200 ms to 2,200 ms). A flashing white "=" was then flashed either to the left or right of fixation (11.33° of visual angle) for 100 ms. The target stimulus (a B, P, or R) then appeared onscreen for 100 ms, followed by masking stimuli (an H for 50 ms followed by an 8 which remained onscreen until a response was given). The participants' task was to identify the target letter by pressing a key for B, P, or R (the keys 4, 5, 6 on the numberpad) as quickly and accurately as possible. In the prosaccade condition the flashing cue (=) and the target appeared in the same location. In the antisaccade condition the target appeared in the opposite location as the flashing cue. Participants received, in order, 10 practice trials to learn the response mapping, 15 trials of the prosaccade condition, and 50 trials of the antisaccade condition. The dependent variable was proportion correct on the antisaccade trials. Thought probes appeared after 22% of antisaccade trials (11 total probes).

Stroop. Participants were presented with a color word (red, green, or blue) presented in one of three different font colors (red, green, or blue). The participants' task was to indicate the font color via key press (*red* = 1, *green* = 2, *blue* = 3). Participants were told to press the corresponding key as quickly and accurately as possible. Participants received 15 trials of response mapping practice and six trials of practice with the real task. Participants then received 135 experimental trials. Of these trials, 67% were congruent such that the word and the font color matched (i.e., red printed in red) and the other 33% were incongruent (i.e., red printed in green). The dependent variable was the mean RT for accurate incongruent trials. Thought probes appeared after 23% of incongruent trials (21 total probes).

Thought probes. Thought probes were included in the psychomotor vigilance, antisaccade, and Stroop tasks. The response options for the thought probes were based on prior investigations of mind-wandering and other thought content (i.e., external distraction, task-related interference; mind-blanking; Robison et al., 2017; Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011; Unsworth & Robison, 2016; Ward & Wegner, 2013). After a certain percentage of trials (listed for each task above), probes appeared asking participants to report the current contents of their consciousness. Specifically, they saw a screen that said, "Please characterize your current conscious experience." Possible responses were (a) I am totally focused on the current task, (b) I am thinking about my performance on the task, (c) I am distracted by sights/sounds/physical sensations, (d) I am intentionally thinking about things unrelated to the task, (e) I am unintentionally thinking about things unrelated to the task, and (f) I am not very alert/my mind is blank. Participants responded by pressing the appropriate number on the keyboard. We scored response 1 as *on-task*, response 2 as *task-related interference*, response 3 as *external distraction*, response 4 as *deliberate mind-wandering*, response 5 as *spontaneous mind-wandering*, and response 6 as *mind-blanking*.

Task questions. At the end of each of the three attention control tasks, participants were asked several questions to measure motivation, interest, perceptions of task difficulty, alertness, perceptions of task unpleasantness, and perceptions of performance. Specifically, participants were asked, "How motivated were you to perform well on the task?", "How interested were you in the task?", "How easy/difficulty did you find the task?", "How alert do you feel right now?"," How unpleasant did you find the task?", and "How would you best describe your performance on the task?" Participants responded to the first five questions on a 1 to 6 scale. For the final question, the response options were 1 (*I think I did well, and I put forth a lot of effort*), 2 (*I think I did well, but I did not put forth a lot of effort*), 3 (*I put forth a lot of effort, but I do not think I did well*), and 4 (*I did not put forth a lot of effort, and I do not think I did well*). Participants pressed the key corresponding to their response.

Questionnaires. After completing all tasks, participants completed a packet of questionnaires that included the MW-S and MW-D scales (Carriere et al., 2013), as well as several other scales that were not part of the present investigation.

Results

Descriptive statistics for all relevant measures are shown in Table 1. As can be seen, the measures showed considerable variability. Some measures, particularly the reports of spontaneous and deliberate mind-wandering, had relatively high skew and kurtosis values. Because the majority of participants reported zero instances of spontaneous and deliberate mind-wandering, the distributions for these variables are positively skewed and leptokurtic. However, these somewhat non-normal distributions did not significantly affect our ability to fit models to the data.[1] A computer error led to the motivation and alertness questions not being recorded for some participants, and the specific sample sizes for each individual measure are shown in Table 1.

Our primary dependent variables of interest were spontaneous and deliberate mind-wandering, so we focus our analyses on these two reports.[2] Proportions for all thought probe reports for each task are shown in Table 2. External distraction was quite rare, which was to be expected because participants completed the tasks in individual run rooms. Reports of deliberate mind-wandering were also quite rare, occurring only 2% to 4% of the time. Deliberate mind-wandering was significantly more common during the psychomotor vigilance task than in the antisaccade (Bonferroni-corrected $p = .02$) and Stroop tasks ($p = .001$), which did not differ ($p = .99$; omnibus analysis of variance: $F(2, 400) = 6.52$, $p = .002$, partial $\eta^2 = .03$). Spontaneous mind-wandering accounted for 8% to 18% of thought probes across tasks. The psychomotor vigilance task produced the most spontaneous mind-wandering, $F(2, 400) = 38.93$, $p < .001$, partial $\eta^2 = .16$, significantly more than the antisaccade (Bonferroni-corrected $p < .001$) and Stroop tasks ($p < .001$), which did not differ ($p = .99$).

We next performed confirmatory factor analysis to investigate our primary relationships of interest at the latent level. To fit models, we used the sample correlation matrix using all available data (pairwise correlations). In an initial model, operation span, symmetry span, and reading span scores loaded onto a working memory capacity (WMC) latent variable. The antisaccade, Stroop, and psychomotor vigilance tasks loaded onto an attention control (AC) latent variable. Reports of spontaneous mind-wandering from the three attention control tasks loaded onto a spontaneous mind-wandering (MW-Spont) latent variable, and reports of deliberate mind-wandering from the loaded onto a deliberate mind-wandering (MW-Delib) latent variable. Because of significant overlap between the memoranda in operation span and reading span, we allowed the error variances from these two tasks to correlate in this model and all subsequent models. The motivation, interest, alertness, difficulty, and unpleasantness questions from the attention control tasks were allowed to load onto latent variables representing each of these contextual factors. In this model, motivation and interest were nearly perfectly correlated, as were difficulty and unpleasantness. To avoid issues of multicollinearity among the contextual variables, we did not include

[1] As a check, we transformed the spontaneous and deliberate mind-wandering variables from each of the three tasks by taking the square root of each value to reduce skew. This procedure reduced the skew statistics for the Anti MW-S, Stroop MW-S, PVT MW-S, Anti MW-D, Stroop MW-D, and PVT MW-D to 1.31, 2.90, 1.27, 3.44, −.13, and 1.47, respectively. We reran the confirmatory factor analysis on a correlation matrix from these transformed values, and the pattern of fit statistics and correlations among latent variables was very similar. Therefore, we kept the raw, untransformed values for our analyses.

[2] As can be seen in Table 2, task-related interference accounted for a substantial number of thought probe reports. However, these reports did not covary with WMC or any of the contextual variables, and we did not analyze them further. The latent correlations between the primary variables of interest and all other measures are shown in Table A1 of the Appendix.

Table 2
Thought Probe Response Proportions

	On task		TRI		ED		MW-D		MW-S		Blank	
Task	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Anti	.40	.35	.35	.33	.03	.06	.02	.08	.08	.15	.12	.24
Stroop	.58	.36	.22	.28	.02	.04	.02	.08	.09	.17	.08	.19
PVT	.35	.29	.30	.22	.04	.08	.04	.09	.18	.18	.08	.15

Note. Anti = antisaccade; PVT = psychomotor vigilance task; TRI = task-related interference; ED = external distraction; MW-D = deliberate mind-wandering; MW-S = spontaneous mind-wandering; Blank = mind-blanking.

interest and difficulty in our final analyses. Therefore, for the model that we report, we only included motivation, alertness, and unpleasantness as the contextual latent variables. The fit of the resulting model was acceptable, $\chi^2(167) = 310.17$, CFI = .92, NNFI = .90, RMSEA = .07, SRMR = .06.[3] A correlation matrix for all variables used in this model is shown in Table 3. Latent variable loadings and correlations among latent variables are reported in Tables 4 and 5.

To summarize the model, WMC and attention control significantly and positively correlated, and each negatively correlated with spontaneous mind-wandering. The relationship between deliberate mind-wandering and attention control was also negative, but not significantly so. Interestingly, the relationship between WMC and deliberate mind-wandering was positive, albeit not significant ($p = .08$). Spontaneous and deliberate mind-wandering were significantly positively related. Motivation and alertness both significantly and negatively correlated with spontaneous and deliberate mind-wandering. In other words, individuals who were more alert reported fewer instances of spontaneous and deliberate mind-wandering, as did individuals who reported higher levels of motivation. Further, perceptions of task unpleasantness were significantly and positively predictive of spontaneous and deliberate mind-wandering. That is, individuals who found the attention control tasks more unpleasant tended to report more instances of both spontaneous and deliberate mind-wandering. Additionally, the contextual factors all significantly correlated with one another. Individuals who reported more task motivation tended to report higher levels of alertness and lower perceptions of task unpleasantness. Individuals who reported lower levels of alertness also tended to report higher levels of task unpleasantness. The contextual variables are significantly correlated with performance on the attention control tasks, but not with WMC.

Our next step was to examine how the cognitive and contextual variables accounted for shared and unique variance in spontaneous and deliberate mind-wandering. To do so, we specified a structural equation model (Figure 1) in which we allowed WMC and the contextual variables (motivation, alertness, unpleasantness) to predict spontaneous (MW-Spont) and deliberate mind-wandering (MW-Delib). We did not include attention control in this model because of the inherent dependencies between performance on the attention control tasks, mind-wandering, and the contextual variables. WMC was included as the sole cognitive variable because it provided a relatively independent assessment of cognitive ability. The fit of this model was acceptable, $\chi^2(120) = 209.38$, CFI = .93, NNFI = .90, RMSEA = .06, SRMR = .06. Together, the predictors accounted for 34% of the variance in spontaneous mind-wandering and 33% of the variance in deliberate mind-wandering. Only alertness and WMC accounted for a significant amount of unique variance in spontaneous mind-wandering. Therefore, the relationships between spontaneous mind-wandering, motivation, and unpleasantness seem to be driven by their shared variance with alertness. Motivation was the only predictor that accounted for a significant amount of unique variance in deliberate mind-wandering. Together, this model suggests there are both cognitive and contextual predictors of spontaneous and deliberate mind-wandering. Whereas spontaneous mind-wandering was primarily driven by alertness and WMC, deliberate mind-wandering was primarily driven by motivation.

In our final analysis, we examined how WMC, motivation, alertness, unpleasantness, and spontaneous mind-wandering accounted for unique and shared variance in attention control. To do so, we fit a model a structural model (see Figure 2). We did not include deliberate mind-wandering as a predictor in the model because it did not significantly correlate with attention control in the confirmatory factor analysis (see Table 5).[4] The fit of the model was acceptable, $\chi^2(119) = 229.36$, CFI = .93, NNFI = .90, RMSEA = .06, SRMR = .06. WMC accounted for a significant amount of variance independent of its shared variance with the contextual variables. Although all the contextual variables correlated with attention control in the confirmatory factory analysis (see Table 5), only motivation had a significant direct effect on attention control over and above the shared variance accounted for by all the predictors in the model. Collectively, WMC, motivation, alertness, unpleasantness, and spontaneous mind-wandering accounted for 82% of the variance in attention control. So in general, the model shows that both cognitive and contextual factors have independent and joint effects on performance during laboratory tasks.

Discussion

The goals of the present study were threefold: (1) to determine whether the relationship between WMC and mind-wandering is driven by spontaneous or deliberate mind-wandering (or both), (2) to see how various contextual factors predict spontaneous and deliberate mind-wandering, and (3) to see how cognitive and contextual predictors account for shared and unique variance in spontaneous and deliberate mind-wandering. To meet these goals, we measured participants' WMC, then measured mind-wandering during three relatively demanding attention control tasks (antisaccade, Stroop, and psychomotor vigilance). After each of the attention control tasks, we asked participants to report their level of alertness, motivation, interest, perceptions of task difficulty, and perceptions of task unpleasantness. To analyze the relationships among the various dependent variables, we used confirmatory factor analysis and structural equation modeling. In general, we found that the major predictors of spontaneous mind-wandering were WMC and alertness. Individuals with greater WMC and

[3] CFI = comparative fit index; NNFI = non-normed fit index; RMSEA = root mean squared error of approximation; SRMR = standardized root mean residual.

[4] Including deliberate mind-wandering in the model led to some suppression effects. Compared with the confirmatory factor analysis, the relationship between deliberate mind-wandering and attention control changed sign and magnitude.

Table 3
Correlations Among all Measures

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Operation span	—																			
2. Symmetry span	.40	—																		
3. Reading span	.52	.28	—																	
4. Antisaccade	.18	.24	.16	—																
5. Stroop	−.08	−.15	−.17	−.35	—															
6. PVT	−.11	−.13	−.07	−.27	.33	—														
7. Anti MW-S	−.20	−.07	−.17	−.11	.14	.12	—													
8. Stroop MW-S	−.05	−.10	−.05	−.12	.14	.33	.36	—												
9. PVT MW-S	−.07	−.05	−.09	.05	.10	.26	.39	.40	—											
10. Anti MW-D	−.12	−.02	−.17	−.26	.08	.09	.11	.21	−.03	—										
11. Stroop MW-D	.07	.03	.01	−.04	−.01	.02	−.04	.10	−.02	.18	—									
12. PVT MW-D	.11	.13	−.01	−.03	.09	−.01	.20	.03	.06	.24	.43	—								
13. Anti Mot	.02	.00	.14	.36	−.29	−.39	−.18	−.17	−.06	−.32	−.14	−.31	—							
14. Stroop Mot	.01	−.09	.04	.15	−.30	−.35	−.15	−.18	−.07	−.15	−.14	−.25	.48	—						
15. PVT Mot	.01	−.01	.02	.19	−.17	−.42	−.28	−.26	−.16	−.16	−.19	−.35	.43	.53	—					
16. Anti alert	−.02	−.01	.04	.25	−.24	−.22	−.16	−.10	−.10	−.17	−.04	−.11	.34	.30	.30	—				
17. Stroop alert	.02	−.07	.02	.17	−.33	−.31	−.09	−.26	−.20	−.06	−.12	−.15	.26	.53	.31	.53	—			
18. PVT alert	.00	.01	.09	.23	−.21	−.39	−.25	−.31	−.34	−.09	−.04	−.23	.31	.29	.50	.45	.45	—		
19. Anti Unpls	.03	.06	−.02	−.24	.08	−.01	.04	.08	−.03	.16	.03	.04	−.18	−.04	−.11	−.12	−.04	−.05	—	
20. Stroop Unpls	−.01	−.02	−.07	−.15	.27	.19	.06	.09	.09	.02	.08	.10	−.18	−.21	−.10	−.23	−.18	−.17	.15	—
21. PVT Unpls	.01	−.04	−.04	−.10	.13	.24	.21	.25	.18	.09	.07	.20	−.30	−.27	−.36	−.17	−.22	−.33	.26	.23

Note. Correlations with absolute values >.14 are significant at $p < .05$. PVT = psychomotor vigilance task; Anti = antisaccade; MW-S = spontaneous mind-wandering; MW-D = deliberate mind-wandering; Mot = motivation; Alert = alertness; Unpls = unpleasantness.

Table 4
Latent Variable Loadings

Measure	WMC	AC	MW-S	MW-D	Motivation	Alertness	Unpleasantness
Operation span	.54						
Symmetry span	.75						
Reading span	.37						
Antisaccade		.48					
Stroop		−.51					
PVT		−.67					
Anti MW-S			.58				
Stroop MW-S			.66				
PVT MW-S			.62				
Anti MW-D				.30			
Stroop MW-D				.50			
PVT MW-D				.83			
Anti Mot					.67		
Stroop Mot					.69		
PVT Mot					.72		
Anti alert						.65	
Stroop alert						.71	
PVT alert						.71	
Anti Unpls							.32
Stroop Unpls							.35
PVT Unpls							.73

Note. $N = 203$ was assumed to compute standard errors around estimates of factor loadings. All factor loadings were significant at $p < .05$. PVT = psychomotor vigilance task; Anti = antisaccade; WMC = working memory capacity; AC = attention control; MW-S = spontaneous mind-wandering; MW-D = deliberate mind-wandering; Mot = motivation; Alert = alertness; Unpls = unpleasantness.

higher self-reported alertness reported significantly fewer instances of spontaneous mind-wandering. The major predictor of deliberate mind-wandering was motivation. Individuals with lower self-reported levels of motivation reported significantly more deliberate instances of mind-wandering.

The first major implication of these results is that the relationship between WMC and mind-wandering is driven by WMC's ability to predict the resistance of involuntary, unintentional task-unrelated thoughts. This has been an assumption of the control failure view of mind-wandering, especially within tasks that are relatively attention demanding (Kane et al., 2007; Kane & McVay, 2012; McVay & Kane, 2010). Consequently, we can rule out several alternative explanations for why greater WMC frequently predicts decreased rates of mind-wandering. It was not the case that low-WMC participants were deliberately mind-wandering more often. This rules out the explanation that low-WMC participants find attention control tasks exceedingly difficult or unpleasant and in turn choose to mind-wander. Indeed, although individuals who found the tasks more unpleasant showed more spontaneous and deliberate mind-wandering, unpleasantness and WMC were unrelated. We also did not observe any evidence that low-WMC participants were simply unmotivated. Although a lack of motivation was a strong predictor of deliberate mind-wandering, motivation was unrelated to WMC, which replicates prior work

Table 5
Latent Variable Correlations

Latent	1	2	3	4	5	6
1. WMC	—					
2. AC	**.38**	—				
3. MW-S	−.20[†]	**−.47**	—			
4. MW-D	.18[*]	−.08	.17[*]	—		
5. Motivation	−.03	**.78**	**−.40**	**−.52**	—	
6. Alertness	−.03	**.69**	**−.49**	**−.28**	**.74**	—
7. Unpleasantness	−.04	**−.47**	**.43**	**.30**	**−.61**	**−.50**

Note. $N = 203$ assumed for estimating standard errors around latent correlations. Bolded correlations are significant at $p < .05$. WMC = working memory capacity; AC = attention control; MW-S = spontaneous mind-wandering; MW-D = deliberate mind-wandering.
[†] $p = .06$. [*] $p = .08$.

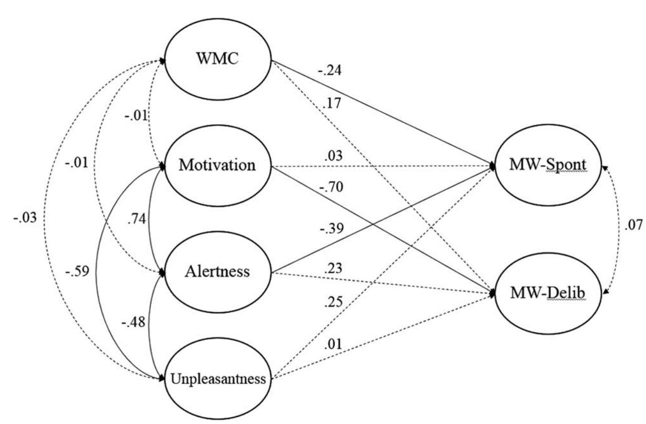

Figure 1. Structural equation model in which working memory capacity (WMC), motivation, alertness, and unpleasantness were entered as predictors of spontaneous (MW-Spont) and deliberate (MW-Delib) mind-wandering. The error variances from WMC, motivation, alertness, and unpleasantness were allowed to correlate. Solid lines represent significant paths at $p < .05$. Dotted lines represent nonsignificant paths.

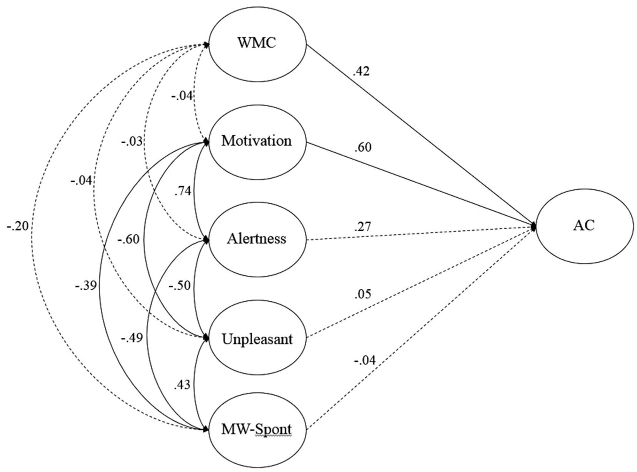

Figure 2. Structural model in which working memory capacity (WMC), motivation, alertness, unpleasantness (Unpleasant), and spontaneous mind-wandering (MW-Spont) were entered as predictors of attention control task performance (AC). The error variances from the predictors were allowed to correlate. Solid lines represent significant paths at $p < .05$. Dotted lines represent nonsignificant paths.

(Robison & Unsworth, 2015; Unsworth & McMillan, 2013). Collectively, the evidence suggests that the reason for the frequently observed negative relationship between WMC and mind-wandering is that low-WMC participants have a much harder time controlling the occurrence of spontaneous, involuntary shifts of attention away from task goals, which is consistent with the characterization of many episodes of mind-wandering as "control failures" (Kane & McVay, 2012; McVay & Kane, 2009, 2010). In fact, the latent correlation between WMC and spontaneous mind-wandering was quite similar to other latent variable investigations of these two constructs (Kane et al., 2016; McVay & Kane, 2012a, 2012b; Robison et al., 2017; Robison & Unsworth, 2015, 2017; Unsworth & McMillan, 2013, 2014).

The second major finding from the present investigation was the specific pattern of relationships among the various contextual variables and the two types of mind-wandering. Higher levels of motivation and alertness both predicted fewer instances of spontaneous and deliberate mind-wandering, and perceptions of greater task unpleasantness predicted more instances of deliberate and spontaneous mind-wandering. These findings highlight the necessity of taking a multifaceted approach to mind-wandering, examining both cognitive and contextual predictors of the tendency toward off-task thought. Specifically, the structural equation model revealed that motivation was the primary predictor of deliberate mind-wandering. This provides converging evidence with other studies that have demonstrated such a relationship (e.g., Seli, Cheyne, et al., 2015). When individuals feel particularly unmotivated, they may actually choose to mind-wander. Alternatively, lower alertness was a strong predictor of spontaneous episodes of mind-wandering. Therefore, some individuals may be trying to maintain task focus, but their attentional state fluctuates between periods of focus and mind-wandering. Although we interpret the pattern of findings to indicate that low levels of alertness and motivation lead to more frequent mind-wandering, it is worth noting that these questions immediately followed the three tasks during which mind-wandering was measured. Thus it is possible that poor task performance and self-reported off-task states led participants to report a lack of alertness, motivation, and so forth to justify their poor performance and lack of task focus.[5] However, we would argue this is unlikely given the nature of the tasks. Specifically, participants probably do not have an idea of what "good" performance is. They might notice, for example, that they had a particularly long response time on the PVT, or that they made an error on the Stroop task. However, Stroop accuracy did not correlate with motivation reported after the Stroop task ($r = .02$, $p = .78$). For both the Stroop and PVT tasks, differences between high- and low-ability individuals are on the order of milliseconds, and there is no explicit feedback in the antisaccade task. So it is unlikely participants were sensitive to how well they were performing. Therefore, we feel confident that participants were not responding to the contextual questions based on their performance.

Altogether, the pattern of results supports the idea that mind-wandering is a heterogeneous, multifaceted construct, and various contextual factors can account for how often people mind-wander, over and above differences in cognitive abilities. Furthermore, these contextual factors can lead to specific types of off-task thought, such as spontaneous and deliberate mind-wandering. In the current study, we focused on one specific dimension of mind-wandering (i.e., intentionality). In the future, it will be worthy to examine how other dimensions (e.g., temporal focus, emotional valence) differentially relate to these various contextual factors.

A third major finding in the present study was the fact that various factors affected how well individuals performed on the attention control tasks. As Smallwood and Schooler (2006) note, "every laboratory study is at least partially a study of mind-wandering" (p. 956). In the present study, we showed that in addition to one's cognitive abilities, a number of other factors correlate with performance on such tasks. In fact, all of the contextual variables significantly correlated with performance on the attention control tasks. So clearly, variance in aspects like motivation, interest, and alertness are meaningful, as these factors can lead to differences in performance. Importantly, these differences are independent of differences in cognitive ability. This was confirmed in a structural model predicting attention control task performance (see Figure 2). By combining contributions of WMC, spontaneous mind-wandering, and the contextual variables, we were able to account for 82% of the variance in attention control. Therefore, in many cases, researchers should be aware of the many factors that impact task performance, in addition to their controlled independent variables. In the current study, the questions about alertness, motivation, and so forth, immediately followed the attention control tasks, so that is why motivation was correlated with performance on these tasks. It is likely that motivation also affects performance on WMC and other tasks. Had we measured motivation following the complex span tasks, those reports likely would have correlated with performance on those tasks. But in the present study, our goal was to examine the how contextual variables affect mind-wandering and performance

[5] We thank Dr. Paul Seli and Dr. Michael Kane for raising this possibility during the review process.

within the attention control tasks, and how these variables in turn account for performance independently of WMC.

We should note a few elements of the present study that may have affected our observed pattern of relationships. One element was that deliberate mind-wandering was quite rare, and this may have been due to the demanding nature of the attention control tasks. Indeed, only 17% of participants reported at least one instance of deliberate mind-wandering on the Stroop task, 15% on the antisaccade task, and 29% on the psychomotor vigilance task. Therefore, most participants never intentionally directed their attention away from the task to internal task-unrelated thoughts. The antisaccade, Stroop, and psychomotor vigilance tasks all require consistent controlled attention to respond quickly and accurately. Therefore, many participants may have felt as if any deliberate mind-wandering would have harmed their performance. It is certainly possible that an easier set of tasks would encourage more deliberate mind-wandering. For example Seli et al. (2016b) demonstrated that intentional mind-wandering was more common among a group of participants who completed an easy version of the SART, whereas unintentional mind-wandering was more common among participants who completed the traditional, more difficult version, even though overall rates of mind-wandering were about equal across conditions. Another possibility is that participants are wary of reporting deliberate mind-wandering because to do so would be undesirable. Essentially, when participants report deliberate mind-wandering, they are admitting to intentionally disengaging from the researcher's task, which might seem nefarious. So even if participants are intentionally mind-wandering, they might be loath to report it. As part of one ongoing study in our lab, we are investigating whether the framing of mind-wandering (positive, negative, or neutral) affects the degree to which participants report unintentional and intentional mind-wandering during the SART.

As a corollary of the low rates of deliberate mind-wandering, we may have hindered our ability to definitively identify the relationship between WMC and deliberate mind-wandering. Some studies have demonstrated a positive relationship between WMC and mind-wandering during particularly easy tasks (e.g., Levinson, Smallwood, & Davidson, 2012; Rummel & Boywitt, 2014). Furthermore, high-WMC participants may tend to use their excess cognitive capacity to plan during relatively simple tasks (Baird, Smallwood, & Schooler, 2011; but see Robison & Unsworth, 2017). In the current study, WMC and deliberate mind-wandering were positively, but not quite significantly, related. So the magnitude of this relationship is still rather ambiguous. According to the context-regulation hypothesis (Smallwood & Andrews-Hanna, 2013), there are at least some contexts in which individuals with greater cognitive ability will mind-wander more often, and theoretically this relationship should be driven by deliberate mind-wandering. Additionally, the cognitive flexibility hypothesis states that individuals with greater cognitive ability have the means to flexibly adjust the occurrence of mind-wandering to meet the demands of the external task environment (Rummel & Boywitt, 2014). It is worth noting that we observed a significant positive correlation between WMC and deliberate mind-wandering on the MW-D scale. So individuals with greater WMC report deliberately mind-wandering more often in their day-to-day lives. Therefore, it is plausible to observe a positive relationship between WMC and deliberate mind-wandering in certain contexts. Future research will need to examine how the relationships among WMC, spontaneous, and deliberate mind-wandering change as a function of task complexity. Furthermore, there may be two types of deliberate mind-wandering (Seli, Risko, Smilek, & Schacter, 2016). Whereas one form of deliberate mind-wandering may represent a strategic decision to entertain task-irrelevant thoughts (e.g., mentally planning a trip to the grocery store while waiting at the DMV), another may be a manifestation of low motivation (e.g., feeling bored by a lecture and daydreaming about the weekend). We did not distinguish between these two types of deliberate mind-wandering in the current study. It may be worthy to do so in the future given the nature of the relationship between deliberate mind-wandering and WMC in the current study.[6]

Conclusions

Recent research into mind-wandering has demonstrated that task-unrelated thought is a rather diverse construct with a multifaceted set of predictors. Among these predictors are cognitive abilities, motivation, interest, and alertness, among others. When attention is demanded by an external task, individual differences in WMC typically predict reduced rates of mind-wandering. However, it has not been clear whether the elevated rates of mind-wandering among low-WMC individuals is a manifestation of spontaneous or deliberate mind-wandering. By distinguishing between these two types of mind-wandering, we found that the relationship was driven by spontaneous, not deliberate, mind-wandering. Lack of motivation, low alertness, and task unpleasantness all predicted more deliberate mind-wandering, and motivation was the strongest independent predictor of this conscious state. Together the results further delineate the relationship between WMC and mind-wandering, as well as identify both cognitive and contextual factors that influence the occurrence of spontaneous and deliberate mind-wandering.

[6] We thank Dr. Paul Seli for noting this possibility during the review process.

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(*Appendix follows*)

Appendix

Additional Latent Correlations

Table A1

Latent Correlations Among Variables Excluded From Primary Analyses

Measure	Alert	Mot	Unpls	MW-S	MW-D	WMC
MW-S Q	**−.44**	**−.23**	.15	**.24**	.03	.12
MW-D Q	−.01	.10	−.02	.13	.02	**.34**
TRI	−.01	−.04	−.07	**−.24**	.004	.05
Blank	**−.73**	**−.54**	**.44**	**.27**	.17	.07
ED	**−.30**	**−.29**	.11	−.02	−.10	−.20

Note. Correlations are among latent variables simultaneously entered into a confirmatory factor analysis. Bolded correlations are significant at $p < .05$. Alert = alertness; Mot = motivation; Unpls = unpleasantness; MW-S = spontaneous mind-wandering during attention control tasks; MW-D = deliberate mind-wandering during attention control tasks; WMC = working memory capacity; MW-S Q = Mind-Wandering: Spontaneous Questionnaire; MW-D Q = Mind-Wandering: Deliberate Questionnaire; TRI = task-related interference; Blank = reports of mind-blanking during attention control tasks; ED = external distraction.

Received January 23, 2017
Revision received May 15, 2017
Accepted May 21, 2017 ■