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On the Clock: Evidence for the Rapid and Strategic Modulation of Mind Wandering

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Abstract

We examined the hypothesis that people can modulate their mind wandering on the basis of their expectations of upcoming challenges in a task. To this end, we developed a novel paradigm in which participants were presented with an analog clock, via a computer monitor, and asked to push a button every time the clock's hand was pointed at 12:00. Importantly, the time at which the clock's hand was pointed at 12:00 was completely predictable and occurred at 20-s intervals. During some of the 20-s intervals, we presented thought probes to index participants' rates of mind wandering. Results indicated that participants decreased their levels of mind wandering as they approached the predictable upcoming target. Critically, these results suggest that people can and do modulate their mind wandering in anticipation of changes in task demands.

Keywords

mind wandering, task-unrelated thought, modulation, cognitive control, task difficulty, open data, open materials, preregistered

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There has recently been a surge of research examining people's propensity to mind wander and the consequences of mind wandering. Over a short time frame, the popularity of mind wandering has spread to numerous psychological domains, including those examining attention (e.g., McVay & Kane, 2009), memory (e.g., Thomson, Smilek, & Besner, 2014), learning (e.g., Jing, Szpunar, & Schacter, 2016), creativity (e.g., Baird et al., 2012; but see Smeekens & Kane, 2016), clinical populations (e.g., Seli, Smallwood, Cheyne, & Smilek, 2015), workplace functioning (Knowles & Tay, 2002), and academic performance (e.g., Szpunar, Jing, & Schacter, 2014). Across various studies, it has become clear that mind-wandering rates vary across situations. Given the pervasive nature of situation-related modulations of mind wandering, understanding the nature of these variations presents a critical goal in understanding the mechanisms underlying mind wandering. To this end, we examined whether people can modulate their mind wandering from moment to moment in anticipation of upcoming changes in task demands.

The clearest evidence for variation in mind-wandering rates across tasks comes from work demonstrating that people mind wander more during easy than difficult tasks (e.g., Smallwood, Ruby, & Singer, 2013). A widely accepted explanation of this finding is that easy tasks require the employment of few executive resources for good performance, which allows people to mind wander without incurring many performance costs (thus, mind-wandering rates are high during easy tasks). Conversely, good performance on difficult tasks requires the employment of many executive resources, leaving few resources for mind wandering (thus, mind-wandering rates are low during difficult tasks). To explain how people distribute attention between external tasks and mind wandering across easy and difficult tasks, Thomson, Besner, and Smilek (2015) suggested that a control mechanism distributes resources between external tasks and internal concerns and changes the allocation of resources on the basis of task demands to maintain a high level of performance while allowing unused resources to be applied to mind wandering.

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To our knowledge, all the demonstrated changes in mind-wandering rates resulting from variations in task demands have involved changes in difficulty across different tasks or blocks within a task (e.g., Casner & Schooler, 2014; Thomson, Besner, & Smilek, 2013). Such modulation of mind wandering presumably reflects cases wherein people attempt to optimally distribute their resources on the basis of some experience with each task and then maintain that distribution of resources for the duration of each task. However, it is conceivable that mind wandering could be modulated from moment to moment, which would indicate that people can more flexibly control their mind wandering than has previously been thought. Indeed, this prediction is derived from a large body of research demonstrating rapid moment-by-moment modulations in control over behavior (e.g., Blais, Robidoux, Risko, & Besner, 2007; Jacoby, Lindsay, & Hessels, 2003).

To determine whether people can modulate their mind wandering on a moment-to-moment basis, we developed a task in which participants were shown an analog clock face whose hand ticked 20 times (once per second) before making a full revolution around the clock's face. During some of the 20-s intervals, we presented thought probes to index participants' rates of mind wandering. Participants were tasked with pressing a button each time the clock's hand pointed at 12:00. Notably, the time at which the hand pointed at 12:00 was completely predictable and occurred once every 20 s. Importantly, this predictability created fluctuations in momentary demands within the task: During the first 19 s of each revolution, task demands were constant and low (participants simply had to view the clock), whereas during the 20th second of each revolution, task demands increased, as participants had to press a button within a specified time frame. Although task demands were constant across the first 19 s of each revolution, we predicted that participants would modulate their mind wandering over this period in anticipation of changes in task demands (i.e., in anticipation of the critical event, where the clock's hand pointed at 12:00). Specifically, we predicted that if people can modulate their mind wandering from moment to moment, we should observe increased mind wandering following each critical event because the next critical event would not occur for 20 s; consequently, people should be able to mind wander without incurring performance costs. Moreover, we predicted that as the next critical event became more imminent, people should decrease their rates of mind-wandering in preparation for this (relatively difficult) event.

If participants were not motivated to perform well on the clock task, they might not modulate their mind wandering in accordance with the varying task demands. Indeed, if participants had little concern for their performance, they might maintain a consistent level of task disengagement, irrespective of the position of the clock's hand. Thus, to increase participants' motivation to perform well on the task, we offered bonus money for good performance.

Method

In accordance with the recommendations of Simmons, Nelson, and Simonsohn (2012), we report how we determined our sample sizes, all data exclusions, and all measures in the study.[1]

Participants

Participants were recruited via Amazon Mechanical Turk and were paid $2 for completing the study, which lasted approximately 25 min. We collected data from two independent samples to allow for a direct replication of our findings. Each of the two samples consisted of 60 participants (Sample 1: 19 women, 41 men; mean age = 28.83 years; Sample 2: 29 women, 31 men; mean age = 28.92 years) who were between the ages of 18 and 35 years.[2] For our first sample, we decided to collect data from 60 participants (which seemed reasonable for our within-subjects design) and agreed that we would attempt to replicate our effect (if observed) in an independent sample of the same size. Having observed the anticipated effect in Sample 1, we preregistered our hypotheses, primary analyses, and sample size for our direct replication (Sample 2). It was determined in advance that we would exclude (without replacement) from our analyses all data from participants whose error rates on the clock task were three or more interquartile ranges away from the mean (this exclusion criterion was preregistered for Sample 2). Consequently, data from 3 participants in Sample 1 and 5 participants in Sample 2 were excluded from our analyses—postexclusion sex distribution and mean age: Sample 1: 19 women, 38 men; mean age = 28.86 years; Sample 2: 27 women, 28 men; mean age = 29.02 years. All participants provided informed consent and were treated in accordance with guidelines approved by the ethics committee at the University of Waterloo.

The clock task

Participants viewed a simplified clock face consisting of a white circle against a black background and a straight-line "hand" that rotated within the circle in the style of a traditional analog clock (see Fig. 1). The diameter of the outer clock circle was 192 pixels. The angle of the hand changed by 18° on every tick, therefore completing one complete revolution of the clock's face

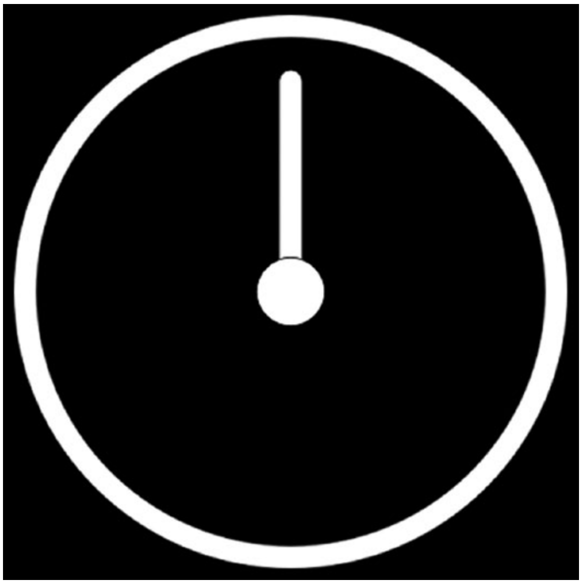

Fig. 1. Simplified clock face used in the clock task, with hand pointed at the 12:00 position. The diameter of the clock face was 192 pixels. The clock's hand made a complete revolution every 20 s.

every 20 ticks. At the start of the task, when the clock face first appeared, the hand was already in the 12:00 position, and it moved to the first tick position after a 3-s delay, continuing to tick once every second thereafter. As a result, the hand took 20 s to complete one full revolution; in total, 60 full revolutions were completed. Participants were instructed to press the space bar on their keyboard after each full revolution, when the hand reached the 12:00 (upright) position, and to do so within a maximum of 500 ms for their responses to be counted as correct. Any responses occurring within 50 ms prior to the hand reaching the 12:00 position were also counted as correct; this was done to account for both potential momentary errors in timing accuracy of the program (as timing accuracy cannot be strictly controlled in a web browser) and potential anticipatory responses on the part of participants due to the rhythmic nature of the task. A bonus payment of $0.02 was added to the participant's compensation for every correct response.

Thought probes

Throughout the clock task, mind wandering was sampled using intermittent thought probes. Twenty probes were pseudorandomly presented throughout the task, with five occurring in each of the four quadrants of the clock face. Probes were forced to appear once in each quadrant before any quadrant could be repeated. They were also not allowed to occur during the 1-s period at the start of each quadrant or on the tick immediately prior to the start of a quadrant; this ensured equality of probe conditions across quadrants, without interfering too greatly with either the rhythm of the task or participants' subsequent ability to correctly respond to the hand reaching the 12:00 position (i.e., the start of the first quadrant). When a probe was presented, the clock stopped ticking, and the participant was shown the following instruction: "Just now, were your thoughts on or off task? *Remember, being off task is thinking about anything unrelated to the task.* Whether you were mind-wandering will not affect your bonus payment. Please respond honestly." The possible response options were (a) "on task," (b) "intentionally mind-wandering," and (c) "unintentionally mind-wandering" (Seli, Cheyne, Xu, Purdon, & Smilek, 2015).[3] Participants were instructed to click on the option best characterizing their mental state just prior to the probe. Importantly, we presented the probe above the clock face so that participants could still see the position of the hand while responding to the probe. The probe disappeared, and the clock resumed ticking after a 500-ms delay once an option was clicked.

Motivation and multitasking

Motivation to respond correctly during the clock task was assessed immediately following the practice session and again after the experiment was completed. The postpractice probe was worded as follows: "Before you begin, how motivated would you say you are to press the spacebar as soon as the hand reaches the 12 o'clock position? Please be as HONEST and ACCURATE as possible." The postexperiment probe was worded similarly: "How motivated were you to press the spacebar as soon as the hand reached the 12 o'clock position? Please be as HONEST and ACCURATE as possible." Participants rated their motivation in each case using a 100-point analog slider scale (0 = *not at all motivated*, 100 = *extremely motivated*; the numeric values recorded were not displayed to participants). The width of the sliding scale was 400 pixels; thus, motivation increased by 1 point for every 4 pixels of movement on the slider. These motivation questions were included purely for exploratory purposes and will not be discussed further.

After completing the clock task, as in some previous studies collecting data via an online platform (e.g., Ralph & Smilek, 2017), participants were asked to self-report the extent to which they engaged in media multitasking during the experiment using two simple questions: (a) "While you completed the clock task do you feel you were regularly multitasking? (e.g., listening to music, watching videos, browsing websites, etc.)" and (b) "About how much of the time were you multitasking?" These questions were also included purely for exploratory purposes and will not be discussed further.

Procedure

Participants were given instructions to familiarize them with the requirements of the clock task. They were also given detailed instructions regarding the thought-probe responses. In particular, they were told that their minds may do one of three things: (a) remain on task, (b) intentionally wander, and (c) unintentionally wander. They were instructed that being on task meant they were thinking only about things related to the task (e.g., thoughts about watching the clock and thoughts about the speed of their responses), whereas mind wandering meant they were thinking about something completely unrelated to the task (e.g., thoughts about what to eat for dinner, thoughts about plans they have with friends, or thoughts about an upcoming deadline). They were given further instructions that any thoughts not related to the task counted as mind wandering, and if they experienced any mind wandering, they should indicate whether it was engaged intentionally or unintentionally (for exact instructions, see Seli, Risko, & Smilek, 2016).

Participants then completed a short practice phase consisting of two full revolutions of the hand around the clock's face, followed with feedback on the accuracy of their responses during the practice (e.g., "you responded 1 out of 2 times and were able to respond within the maximum of 500 milliseconds 1 time"). After being provided with feedback, participants received the first motivation probe. Following the practice phase, participants completed the additional 60 revolutions of the experimental phase with intermittent thought probes. The task ended with the postcompletion motivation probe, presented immediately after the final thought probe. Altogether, the experiment took approximately 25 min to complete, assuming participants did not take any breaks during the thought or motivation probes.

Primary measures

Primary performance measures included error rates (i.e., errors of omission) for the clock task as well as rates of mind wandering (intentional and unintentional). Errors of omission occurred when participants failed to respond within 500 ms of the hand reaching the 12:00 position (and, as noted above, any responses occurring within 50 ms prior to the hand reaching the 12:00 position were also counted as correct). For each quadrant of the clock face, rates of mind wandering were calculated as the proportion of times participants reported intentional and unintentional mind wandering in response to the thought probes.

Results

In Table 1, we present descriptive statistics for all primary measures, both for Sample 1 and for Sample 2. As can be seen, skewness and kurtosis levels exceeded

Table 1. Descriptive Statistics for All Primary Measures for Sample 1 (n = 57) and Sample 2 (n = 55)

Sample and measure	*M*	95% CI	Skewness	Kurtosis
Sample 1				
Errors of omission (maximum = 60)	6.158	[4.461, 7.855]	1.362	1.559
Intentional mind wandering: Quadrant 1	.235	[.152, .319]	1.274	0.704
Intentional mind wandering: Quadrant 2	.274	[.174, .374]	1.031	–0.535
Intentional mind wandering: Quadrant 3	.253	[.166, .339]	1.092	–0.034
Intentional mind wandering: Quadrant 4	.196	[.115, .278]	1.614	1.529
Unintentional mind wandering: Quadrant 1	.105	[.060, .150]	1.649	2.025
Unintentional mind wandering: Quadrant 2	.158	[.105, .211]	1.005	–0.165
Unintentional mind wandering: Quadrant 3	.130	[.079, .181]	2.176[a]	6.781[a]
Unintentional mind wandering: Quadrant 4	.116	[.063, .169]	1.612	1.761
Sample 2				
Errors of omission (maximum = 60)	5.291	[3.922, 6.660]	1.706	3.463
Intentional mind wandering: Quadrant 1	.156	[.095, .218]	1.557	1.778
Intentional mind wandering: Quadrant 2	.244	[.162, .325]	1.016	–0.117
Intentional mind wandering: Quadrant 3	.225	[.151, .300]	0.960	–0.032
Intentional mind wandering: Quadrant 4	.182	[.113, .251]	1.219	0.159
Unintentional mind wandering: Quadrant 1	.189	[.125, .253]	1.169	0.568
Unintentional mind wandering: Quadrant 2	.196	[.139, .254]	1.382	2.589
Unintentional mind wandering: Quadrant 3	.200	[.144, .256]	1.347	2.818
Unintentional mind wandering: Quadrant 4	.167	[.112, .222]	1.004	–0.126

Note: Means for each type of mind wandering represent the proportion of times participants reported it in a given quadrant. For skewness and kurtosis, standard errors were, respectively, 0.316 and 0.623 for Sample 1 and 0.322 and 0.634 for Sample 2. CI = confidence interval.

[a]For this measure, posttransformation skewness was 0.873 and kurtosis was –0.357.

acceptable ranges (skewness > 2, kurtosis > 4; Kline, 1998) for reports of unintentional mind wandering in the third quadrant (in Sample 1). To normalize these values, we used a rank-based inverse normal transformation, which minimizes the effects of outliers while also maintaining the standard Type I error rate and increasing power (Templeton, 2011). This transformation effectively normalized the data (skewness < 2, kurtosis < 4; Kline, 1998). However, results of analyses including the transformed data did not statistically differ from those including the nonnormal data, and thus to retain the natural means and standard deviations, we included the nontransformed data in all analyses reported below.

Of primary interest in the present study was determining whether participants modulated their mind wandering as a function of variations in within-task demands (i.e., as a function of the successive quadrants of the clock's face). To explore this possibility, we conducted a 2 (mind-wandering type: intentional, unintentional) × 4 (quadrant: 1, 2, 3, and 4) repeated measures analysis of variance (ANOVA) with proportion of mind wandering as the dependent variable, separately for Sample 1 and Sample 2 (see Fig. 2).

Sample 1

In Sample 1, Mauchly's test of sphericity was statistically significant for quadrant, so Greenhouse-Geisser values are presented where appropriate. The ANOVA yielded a significant main effect of mind-wandering type, $F(1, 56) = 6.802$, $MSE = 0.211$, $p = .012$, $\eta_p^2 = .108$, indicating that, when collapsing across quadrant, participants more frequently engaged in intentional than unintentional mind wandering (see Fig. 2, left panel). Moreover, there was a significant main effect of quadrant, $F(2.62, 146.732) = 4.529$, $MSE = 0.088$, $p = .004$, $\eta_p^2 = .075$, and a nonsignificant Mind-Wandering Type × Quadrant interaction, $F(3, 168) = 0.395$, $MSE = 0.034$, $p = .757$, $\eta_p^2 = .007$.

Most critically, however, the ANOVA revealed a significant quadratic function for quadrant, $F(1, 56) = 7.297$, $MSE = 0.025$, $p = .009$, $\eta_p^2 = .115$. To follow up on this quadratic effect, we next conducted two paired-samples *t* tests to more directly determine whether the overall proportion of mind wandering (i.e., the sum of the proportions of intentional and unintentional types) varied as a function of quadrant. In particular, we tested for differences in rates of overall mind wandering from (a) Quadrant 1 to Quadrant 2 and (b) Quadrant 2 to Quadrant 4. Results indicated that from Quadrant 1 to Quadrant 2, rates of overall mind wandering significantly increased by 9%, $t(56) = 2.501$, $SE = 0.037$, $p = .015$, $d = 0.331$, and that from Quadrant 2 to Quadrant 4, they significantly decreased by 12%, $t(56) = 3.188$, $SE = 0.037$, $p = .002$, $d = 0.422$ (see Fig. 2, left panel). These results suggest that participants did indeed modulate their mind wandering by gradually increasing it after encountering the critical event and then decreasing it as the next critical event became more imminent.

Sample 2

To determine whether the foregoing findings were replicable, we next turned our attention to the data from Sample 2, on which we conducted the same analysis reported above (see Fig. 2, right panel). Here, we failed to observe a significant main effect of mind-wandering type, $F(1, 54) = 0.126$, $MSE = 0.162$, $p = .724$ (one-tailed $p = .362$), $\eta_p^2 = .002$, which suggests that the finding of more intentional than unintentional mind wandering observed in Sample 1 was perhaps spurious or, at best, unreliable. As in Sample 1, there was, however, a significant main effect of quadrant, $F(3, 162) = 3.008$, $MSE = 0.023$, $p = .032$ (one-tailed $p = .016$), $\eta_p^2 = .053$, and a nonsignificant Mind-Wandering Type × Quadrant interaction, $F(3, 162) = 1.074$, $MSE = 0.029$, $p = .362$, $\eta_p^2 = .020$.

Most critically, however, we again observed a significant quadratic function for quadrant, $F(1, 54) = 6.556$, $MSE = 0.031$, $p = .013$ (one-tailed, $p = .007$), $\eta_p^2 = .108$. To follow up on this quadratic effect, we again tested for differences in rates of overall mind wandering from (a) Quadrant 1 to Quadrant 2 and (b) Quadrant 2 to Quadrant 4. Results indicated that from Quadrant 1 to Quadrant 2, overall mind wandering significantly increased by 10%, $t(54) = 2.482$, $SE = 0.038$, $p = .016$ (one-tailed $p = .008$), $d = 0.334$, and that from Quadrant 2 to Quadrant 4, overall mind wandering significantly decreased by 9%, $t(54) = 2.127$, $SE = 0.043$, $p = .038$ (one-tailed $p = .019$), $d = 0.287$ (see Fig. 2, right panel). Taken together with the results from Sample 1, these findings provide strong evidence that people modulate their mind wandering on a moment-to-moment basis in anticipation of upcoming critical events.

Exploratory analyses

For exploratory purposes, we sought to determine whether rates of intentional and unintentional mind wandering, averaged across the quadrants, were associated with people's propensity to produce errors of omission during the clock task. Given that these analyses were purely exploratory, we used the full body of data collected across Samples 1 and 2 ($N = 112$) to maximize power (descriptive statistics are presented in Table 2). Results of the correlation analyses indicated that rates of neither intentional ($r = -.087$, $p = .359$) nor unintentional ($r = .061$, $p = .525$) mind wandering were significantly

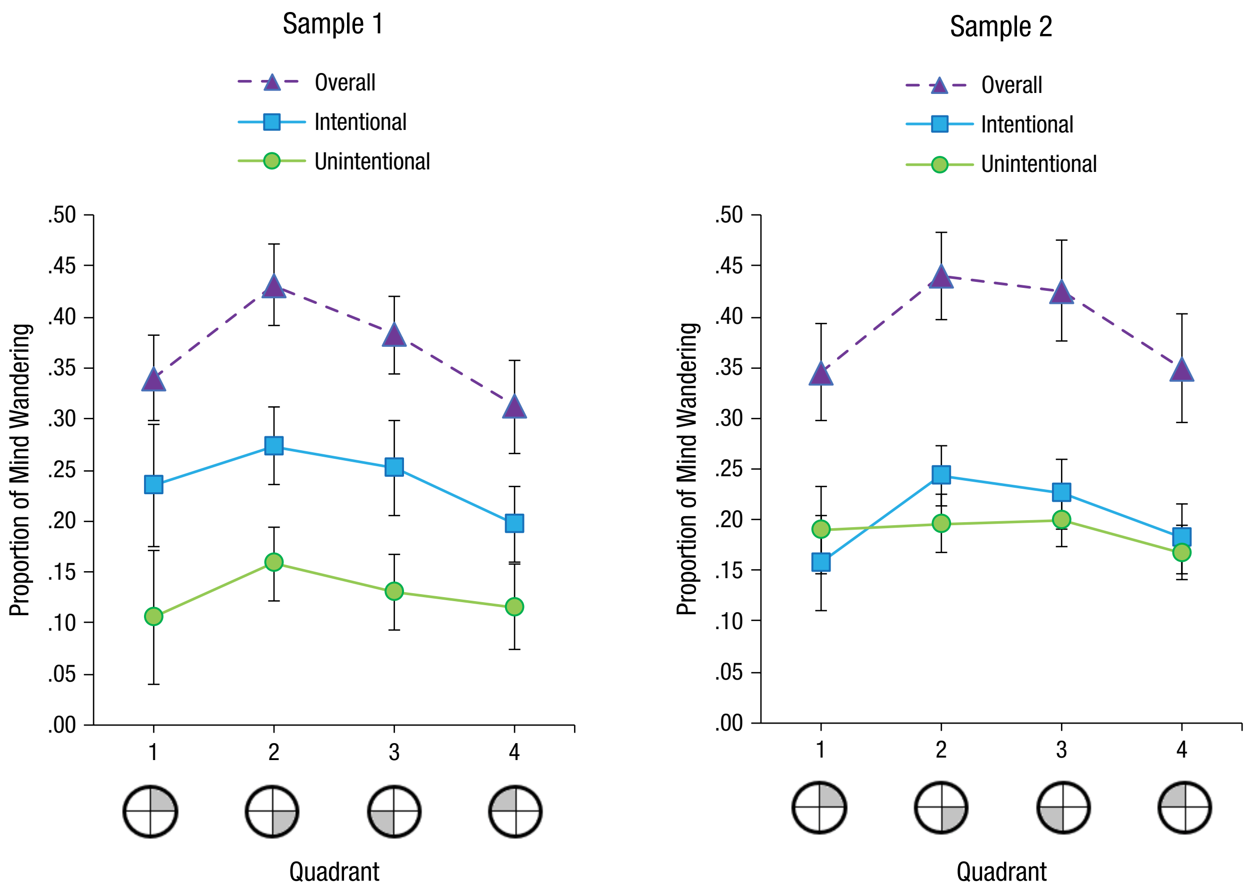

Fig. 2. Mean proportion of mind wandering as a function of quadrant, separately for intentional mind wandering, unintentional mind wandering, and overall mind wandering (i.e., the sum of the proportions of intentional and unintentional mind wandering). Results are shown separately for Sample 1 and Sample 2. Error bars show 95% confidence intervals, computed for within-subjects data.

correlated with errors of omission. What this suggests, then, is that people's tendency to mind wander was not, as is typically the case, associated with performance decrements in the clock task. It should be noted, however, that participants performed extremely well on the clock task, with a mean error rate of only 9.5% (see Table 2). Thus, given that there was potentially a restriction of range in the rates of omission errors, we encourage the reader to interpret these results with some caution.

Discussion

Our findings support and extend the resource-control account of attention (Thomson et al., 2015). According to this account, mind wandering uses the same resource pool required for attention-demanding tasks; however, the allocation of resources is governed by a control mechanism that determines the amount of resources allocated to (a) a primary task and (b) other tasks or internal concerns (mind wandering). Critically, this account suggests that the allocation of resources is under strategic control, implying that mind wandering is not necessarily a control failure (as suggested by McVay & Kane, 2010) but that it can be permitted in certain contexts. This account allows for the counter-intuitive possibility that mind wandering can occur, even during challenging tasks, without producing performance costs, provided that people's resources are optimally allocated. In support of this, Thomson et al. (2013) demonstrated that mind wandering varied as a function of task difficulty (with less mind wandering during more difficult tasks), while participants showed no measurable performance costs during periods of mind wandering. Our findings extend the resource-control account by demonstrating that strategic modulation of the allocation of resources to primary tasks and mind wandering can occur on a moment-to-moment basis in anticipation of changing task demands. In line with Thomson et al.'s (2015) account, this locally controlled engagement in mind wandering seems to reflect strategic efforts to mind wander when doing so will not result in performance costs. Consistent with this view, we found here that people's propensity to mind wander had no measurable influence on performance.

Table 2. Descriptive Statistics for All Measures Included in Exploratory Analyses (N = 112)

Measure	M	95% CI	Skewness	Kurtosis
Errors of omission (maximum = 60)	5.732	[4.652, 6.813]	1.521	2.279
Intentional mind wandering	.221	[.171, .271]	1.211	0.581
Unintentional mind wandering	.157	[.129, .185]	1.372	3.302

Note: Means for each type of mind wandering represent the proportion of times participants reported it throughout the experiment. For skewness and kurtosis, standard errors were 0.228 and 0.453. CI = confidence interval.

Given that mind wandering has been associated with beneficial processes such as goal-directed thinking (Gorgolewski et al., 2014) and future planning (Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011), mind wandering when task demands are low might be functional because it could allow people to capitalize on the benefits of mind wandering without incurring performance costs. Indeed, in everyday life, such strategic mind wandering could allow people to multitask and thus fulfill more goals than they otherwise would had they consistently attended to a single task that did not require their full attention. For instance, engaging in goal-directed mind wandering during familiar parts of a lecture would presumably benefit students because it would allow them to plan or problem solve without impairing learning. Such findings would be important because most research has suggested that mind wandering is often detrimental (Mooneyham & Schooler, 2013). However, perhaps these findings should not surprise researchers because in most studies of mind wandering, participants are provided with tasks that do not permit them to mind wander without incurring performance costs because these tasks consistently demand participants' attention. Many of the tasks we complete in daily life, however, do not place such consistent demands on our attention but instead allow us to engage in task-unrelated thoughts without incurring performance costs. Thus, by employing more ecologically valid tasks in which demands vary (e.g., the clock task), future research may be better equipped to identify beneficial effects of mind wandering, which could lead to a more favorable appraisal of this experience.

Although we made no predictions regarding the intentionality of mind wandering, our results indicated that rates of intentional mind wandering were higher than (Sample 1) or the same as (Sample 2) rates of unintentional mind wandering. This is noteworthy because most previous research examining the intentionality of mind wandering in the laboratory has found higher rates of unintentional compared with intentional mind wandering (e.g., Seli, Maillet, Smilek, Oakman, & Schacter, 2017; Seli, Ralph, Konishi, Smilek, & Schacter, 2017). Our interpretation of this finding is that because the critical events in the clock task were predictable, participants realized they could (for most of the task) engage in mind wandering without incurring performance costs, and they therefore more frequently guided their thoughts to task-unrelated musings than they would have had they been performing a less predictable task. That said, we found no evidence for differential patterns of intentional and unintentional mind wandering as a function of variations in within-task demands. What this may suggest is that rather than modulate their mind wandering per se, participants modulated the extent to which they focused their attention on the clock task: In cases where they strategically relinquished on-task focus, they could have engaged in (a) intentional task-unrelated thoughts or (b) unintentional task-unrelated thoughts. Importantly, in these latter cases, the modulation effect would be attributable not to the unintentional engagement in mind wandering but rather to the intentional disengagement of on-task focus, which would then be succeeded by unintentional task-unrelated thoughts.

One area of future research arising from the present work involves examinations of the role that working memory capacity (WMC) plays in people's ability to modulate their mind wandering. Research examining mind wandering and WMC has found that, relative to people with low WMC, those with higher WMC mind wander less frequently during more challenging tasks, which suggests that people with higher WMC are better at suppressing intrusive thoughts (e.g., McVay & Kane, 2012). Moreover, daily-life investigations of mind wandering have found that when attempting to concentrate on an activity, people with higher WMC mind wander less than people with low WMC, but when people are less inclined to concentrate on an activity than usual, people with higher WMC mind wander more than people with low WMC (Kane et al., 2007, 2017). In the context of the clock task, because participants' attempts to concentrate are presumably low at periods when the critical event is remote and relatively high when it is imminent, modulation of mind wandering might be moderated by WMC; that is, people high in WMC might be better able to modulate their mind wandering during the clock task than people low in WMC.

The present findings also suggest it would be useful to explore a possible link between people's ability to modulate their mind wandering in anticipation of upcoming task challenges and their ability to perform time-based prospective memory tasks (i.e., remembering to complete an action after a set amount of time has passed; e.g., attending a meeting in 10 min). Whereas such time-based tasks often include an *ongoing task* (e.g., making odd/even judgments) and a *prospective task* (e.g., remembering to press a key after a minute has passed; e.g., Vanneste, Baudouin, Bouazzaoui, & Taconnat, 2016), the clock task, at face value, consists only of an ongoing task, namely, monitoring the clock's hand and responding when it points to 12:00. However, mind wandering during the clock task might itself constitute an ongoing task, in which case, remembering to intermittently disengage from mind wandering in the service of attending to the clock task could be viewed as a type of time-based prospective memory task. One hypothesis, then, is that people who perform well on time-based prospective memory tasks might be better able to strategically modulate their mind wandering.

Concluding Remarks

We demonstrated that people can modulate their mind wandering on a moment-to-moment basis in anticipation of upcoming challenges within a task. This finding is important for two key reasons. First, it suggests that people have fine-grained control over their mind wandering and can modulate their mind wandering on the order of seconds. Interestingly, this locally controlled engagement of mind wandering might reflect strategic efforts to engage in off-task thoughts when doing so would not result in performance costs, which may permit people to capitalize on the benefits of mind wandering. Second, this finding is important because one dominant theory in the mind-wandering literature has conceptualized mind wandering as reflecting failures of executive control (McVay & Kane, 2010). However, the finding that people can, at times, modulate their mind wandering from moment to moment suggests that conceptualizations of mind wandering as exclusively reflecting failures of executive control appear to be unwarranted and that a broader conceptualization of mind wandering as a cognitive experience that can occur in a controlled manner is appropriate.

Action Editor

D. Stephen Lindsay served as action editor for this article.

Author Contributions

P. Seli developed the study concept. All authors contributed to the study design. Testing and data collection were performed by J. S. A. Carriere. P. Seli and J. D. Wammes analyzed the data. P. Seli drafted the manuscript, and all authors provided critical revisions. All the authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797618761039

Open Practices

All data and materials have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/kszj7/. Our hypotheses, primary analyses, and sample size for Sample 2 were preregistered at the Open Science Framework (https://osf.io/kszj7/). Sample 1 was not preregistered because we were undecided on the precise analyses we would conduct. The complete Open Practices Disclosure for this article can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797618761039. This article has received badges for Open Data, Open Materials, and Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

Notes

1. In an initial investigation of our hypothesis, we conducted two studies in which participants completed a modified version of the sustained-attention-to-response task (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997), in which the critical no-go trials were presented in a predictable manner. However, the findings across our preliminary studies were mixed. Having attributed these mixed findings to our design, we developed the clock task (described in the Method section) to circumvent three potential shortcomings of our initial design. In particular, we (a) made the predictable pattern of critical events visible (and hence explicit) to participants, (b) rewarded good performance to increase the likelihood that participants were motivated to reduce rates of mind wandering in anticipation of the critical events, and (c) permitted participants to have continued access to the predictable pattern (i.e., the clock's face) when thought probes were presented, which minimized the concern that the probes disrupted their understanding of where

in the pattern they were (for a summary, see the Supplemental Material available online).
2. Because of an error, an additional (61st) person participated in the second sample, but consistent with our preregistered plan, we did not analyze that person's data.
3. We did not have any a priori hypotheses regarding the intentionality of mind wandering but nevertheless indexed these two types of mind wandering because prior work has shown that this distinction is sometimes quite useful given that intentional and unintentional mind wandering sometimes show unique associations with variables of theoretical interest (Seli, Risko, & Smilek, 2016; Seli, Risko, Smilek, & Schacter, 2016).

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