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The lights are on but no one's home: Meta-awareness and the decoupling of attention when the mind wanders

Jonathan Smallwood
University of Aberdeen, Aberdeen, Scotland

and

Merrill McSpadden and Jonathan W. Schooler
University of British Columbia, Vancouver, British Columbia, Canada

In a recent review, we suggested that an important aspect of mind-wandering is whether participants are aware that they are off task (Smallwood & Schooler, 2006). We tested this hypothesis by examining the information-processing correlates of mind wandering with and without awareness in a task requiring participants to encode words and detect targets with either a high or a low probability. Target detection was measured via response inhibition. Mind wandering in the absence of awareness was associated with a failure to supervise task performance, as indicated by short RTs, and was predictive of failures in response inhibition. Under conditions of low target probability, mind wandering was associated with a relative absence of the influence of recollection at retrieval. The results are consistent with the notion that mind wandering involves a state of decoupled attention and emphasizes the importance of meta-awareness of off-task episodes in determining the consequences of these mental states.

It is common in many everyday situations to suddenly notice that, for some time, we have been focusing on thoughts and feelings that are unrelated to what we are doing. These often unintentional mental states are examples of daydreaming (Singer, 1966), attentional lapses (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997), or *mind wandering*. In a recent review (Smallwood & Schooler, 2006), we suggested three facts about mind wandering. First, during mind wandering, performance of the primary task ceases to be supervised by attention and, instead, proceeds automatically. Second, attention switches from the primary task, and our private thoughts become the focus of awareness. Because mind wandering involves a focus on internal information, these episodes involve a state of *decoupled* processing, as indicated by its relation to encoding (Smallwood, Baraciaia, Lowe, & Obonsawin, 2003). Finally, the experience of *catching* mind wandering indicates that we often lack awareness that one is off task. The failure to recognize that one is off task suggests that mind wandering involves a temporary failure in meta-awareness. Meta-awareness refers to the ability to reflect upon the content of one's own mental state (Schooler, 2002). In this article, we combine verbal reports with performance measures to reveal for the first time the contribution that meta-awareness plays in mind wandering.

Verbal Reports

At present, we cannot independently identify whether an individual is off task, and so our strategy is to use verbal reports to indicate mind wandering. Participants can reliably report only those experiences that they have access to (Nisbett & Wilson, 1977). One paradox in the study of mind wandering is that if participants are unaware that they are off task, they cannot report that they are mind wandering (Schooler & Schreiber, 2004). One recognized method for improving the effectiveness of verbal reports is to limit participants to describing the immediate content of their awareness (Ericsson & Simon, 1980). In this experiment, we intermittently probed individuals as they performed a task and asked them to describe whether, *at the moment that the probe occurred*, the participants were, first, mind wandering and, second, aware of this fact. Because these reports required the individual merely to report the content of their awareness, this technique ensured that we could reliably access experiences that might otherwise not be reported.

Information Processing

In science, it is possible to infer the existence of otherwise unobservable phenomena by virtue of the changes that these "invisible" entities cause in a second set of observations. For example, it is possible to demonstrate the

J. Smallwood, j.smallwood@abdn.ac.uk

existence of a distant planet that is too dim to be seen by virtue of the slight wobble that this body makes to the orbit of the larger body of its local star (Sato et al., 2005). In this study, we mapped mind wandering onto performance measures to examine whether changes in the awareness of mind wandering would be consistent with the temporal variations we observed in a secondary set of observations—in this case, performance measures.

In the absence of awareness that one is mind wandering, we cannot instantiate the control processes necessary to remedy the consequences of off-task episodes on performance. However, if we are aware that we are mind wandering, behavior becomes more flexible, because we can strategically account for some of the negative consequences of off-task experiences. In the following sections, we will consider the specific relations between mind wandering, meta-awareness, and three different performance measures: response time (RT), response inhibition, and memory.

Response time. In this task, we employed a go/no-go task in which participants respond frequently and need to inhibit their responses when faced with a target. This task requires that the participants continually supervise their performance to override the tendency to engage in mindless *stimulus-press* behavior that manifests as a short RT (Manly, Robertson, Galloway, & Hawkins, 1999; Robertson et al., 1997). Thoughtful performance of this task requires that the participants respond with a long, controlled RT. Mind wandering in the absence of meta-awareness precludes the ability to supervise task performance and, so, should manifest as a short RT. On the other hand, when the participants are on task or aware that they are mind wandering, they may maintain the ability to supervise the primary task and, so, show longer RTs.

Response inhibition. In simple go/no-go tasks, failures to correctly withhold a response are termed failures in response inhibition, and under conditions of low target probability, these errors have been attributed to drifts in attention away from the task (Manly et al., 1999; Robertson et al., 1997). Mind wandering in the absence of awareness should be associated with poor response inhibition, because participants lack the ability to supervise their performance. Awareness of mind wandering allows us to supervise our task performance, and so, this mental state should not be associated with failures in response inhibition.

Retrieval. According to dual-process accounts of memory, remembering is influenced by two processes: one described as recollection, the other as familiarity (Jacoby, 1998). Recollection relates to our ability to form detailed episodic memories, and familiarity involves simpler exposure effects on memory. Recollection plays a decreasing role the less attention the participant pays to the task—for example, under dual-task conditions (Jennings & Jacoby, 1993).

Irrespective of awareness, mind wandering involves a change in the content of the information upon which working memory is focused. We suggested that mind wandering involves a state of *decoupled* attention (Smallwood & Schooler, 2006), because participants are dividing their attention between the task, which is processed superficially, and task-irrelevant information, which, when off task, provides the focus of attention. Only when the participants' attention is fully focused on the task will they devote enough resources to encode the stimulus in sufficient detail to *recollect* the event.

Previous studies suggest that mind wandering is associated with more false alarms (Smallwood et al., 2003) and a relative absence of recollection (Smallwood et al., 2003; Smallwood, Heim, Riby, & Davies, 2006). Since mind wandering, with or without awareness, involves a reduction in the quantity of resources directed toward the primary task and these changes in resources are known to reduce recollection (Jennings & Jacoby, 1993), mind wandering may be associated with an absence of recollection, irrespective of meta-awareness.

Target probability. In go/no-go tasks, a high target frequency reduces attentional lapses, because the frequency of targets ensures that the participants intermittently return their attention to the task (Manly et al., 1999; Robertson et al., 1997). By reducing the frequency of intervals between task-critical events, the need for cognitive control on behalf of the individual is reduced, and this exogenous support to attention should mitigate the consequences of mental states on performance. In this study, we examined whether a high target probability would reduce the negative consequences of mind wandering on task performance. As a manipulation, therefore, we varied the frequency of the targets that the participants needed to detect. The participants completed the task with either a low-probability (LP) target (20%) or a high-probability (HP) target (40%).

AIMS

We measured mind wandering in a 20-min task that provided a continuous measure of RT. In addition, participants were asked to withhold a response to a target, providing a measure of response inhibition. Finally, participants completed a retrieval phase, thereby providing a measure of memory for the stimulus presented.

We can make the following predictions on how performance measures will relate to mind wandering with and without awareness.

1. Mind wandering without awareness precludes the ability to supervise the task and so will manifest as careless performance of the task: a short RT and poor response inhibition.

2. Mind wandering with awareness affords some degree of supervision of the task and so should involve more thoughtful performance of the task: a slower RT and preserved response inhibition.

3. Mind wandering, in general, involves the processing of task-irrelevant information, in addition to the information from the current task. The reduction in the quantity of resources devoted to the primary task during mind wandering will lead to a reduction in recollection.

4. A high target probability provides a source of external support to task performance, mitigating the need for cognitive control to perform the task successfully.

Under conditions of high target probability, we anticipate a weaker relation between mental states and performance measures.

METHOD

Participants

Fifty-five undergraduate students participated for either course credits or a payment of $20. Participants were allocated either to the LP condition ($n = 25$) or to the HP ($n = 30$) condition.

Materials

The stimuli for this experiment were words from Jacoby (1998). The target stimulus (XXXXX) was randomly embedded in the stimuli list. Following a fixation period (1,000 msec), these stimuli were presented for 2,000 msec. Block duration varied in a quasirandom fashion between 60 and 90 sec and was terminated by the appearance of the thought probe. To ensure a continuous measure of RT, no targets occurred in the last four stimuli before a thought probe.

Thought probes. The individuals were interrupted during performance and were asked whether they were mind wandering. During the thought probe, text was presented in yellow against a blue background. Participants were informed that we wished them to distinguish whether they were mind wandering and whether they were aware of this. We defined mind wandering with awareness as a *tune out* and mind wandering without awareness as a *zone out*. These definitions were provided in a booklet that was available throughout the procedure (see the Appendix). Participants responded to the thought probe using the keyboard.

Procedure

Upon arrival, participants were greeted by a research assistant, who outlined the procedure and gained informed consent. Ethical approval had been obtained from the University Ethics Committee.

Participants were instructed to respond with the space bar when words appeared on the screen. In addition, we asked participants to withhold their response when presented with the target. Finally, we asked participants to remember the words for a subsequent retrieval task and to put equal emphasis on performing the task both quickly and accurately. Before beginning, participants completed a practice block including thought probes.

Retrieval was measured using process dissociation. Task instructions were adapted from the inclusion/exclusion procedure described by Jacoby (1998). A total of 110 word stems were presented sequentially on the screen in a random order; 80 were old words, and the remaining 30 were new. Stimulus duration was 9 sec, with an interstimulus interval of 2 sec. Participants completed a word stem by pushing the space bar and inputting the complete word. During inclusion, participants were instructed to complete the word stem, first, with a word that they remembered seeing and, failing that, to use anything that came to mind, irrespective of whether they remembered seeing it or not. During exclusion, participants were instructed to complete the word stem only with information that was novel. The order of blocks was counterbalanced.

RESULTS

Analytic Strategy

In this experiment, we first compared the distribution of mind wandering as the task proceeded. Next, we compared the relation between mind wandering and measures of information processing, using an ANOVA. Finally, because RT varies with psychological processes, we could use this measure as an ordinal indication of the information processing associated with any given mental state. Using multiple regression, we explored whether the RT associated with a particular mental state was predictive of the other two performance measures gained in this study: response inhibition and retrieval.

Distribution of Mind Wandering

Thought probes. Figure 1A presents the distribution of mind wandering. These data were analyzed using an ANOVA with repeated measures on mental state (zone outs or tune outs) and time on task (first half or second half) and a between-participants factor of target probability (HP or LP). This yielded an interaction between time on task and target probability [$F(1,53) = 6.3$, $MS_e = 0.075$, $p < .01$, partial $\eta^2 = .11$], implying that under conditions of HP, the overall frequency of mind wandering increased with time [$t(29) = -3.9$, $p < .001$], but not under LP conditions [$t(24) = 0.31$, $p = .75$].

Response Time

Absolute RT. Figure 1B presents the RT associated with each mental state. A mixed ANOVA was employed to examine these data and indicated an effect of mental state [$F(2,66) = 3.85$, $MS_e = 21{,}965$, $p < .05$, partial $\eta^2 = .10$]. Separate paired *t* tests indicated that zone outs were shorter than both tune outs [$t(39) = -2.5$, $p < .05$] and on-task experiences [$t(53) = -2.3$, $p < .05$]. The difference between tune outs and on task experiences was unreliable [$t(39) = 2.8$, $p = .15$]. Contrast analysis indicated an interaction between target probability and mental state [$F(1,33) = 3.5$, $p = .07$], implying that zone outs were shorter in the LP condition [$F(2,30) = 4.2$, $MS_e = 20{,}995$, $p < .025$, partial $\eta^2 = .220$] than in the HP condition [$F(2,36) = 1.5$, $MS_e = 9{,}589$, $p = .23$, partial $\eta^2 = .080$].

Response Inhibition

Failures to withhold.[1] Consistent with expectations, response inhibition was preserved in the HP condition (mean failures $= .06$, $SE = .07$), relative to the LP condition [mean failures $= .12$, $SE = .09$; $t = 2.3$, $p < .05$]. Analysis of the RT prior to errors suggested that absolute RT [$t(37) = 0.88$, $p = .42$] did not vary with condition.

RT as a predictor of response inhibition. We examined the relationship between RT during mind wandering and two measures of target detection: (1) the likelihood of a failure in response inhibition and (2) the RT prior to an error (see Table 1). This analysis provided a model that reliably predicted failure to correctly withhold a response [$F(4,28) = 4.8$, $p < .01$] and the RT prior to a failure [$F(4,23) = 10.8$, $p < .001$]. In both cases, failures in response inhibition were associated with mind wandering only in the absence of awareness.

Retrieval

The probability of completing a word stem under inclusion and exclusion conditions was calculated for each mental state, using the standard formulas [$p(\text{inclusion}) = R + (1-R)F$ and $p(\text{exclusion}) = (1-R)F$]. These were then transformed into estimates of recollection [$R = p(\text{inclusion}) - p(\text{exclusion})$] and familiarity [$F = p(\text{exclusion})/(1-R)$]. Preliminary analysis indicated that no overall differences were observed between retrieval during tune outs and zone outs (for all comparisons, $p > .17$), and so we

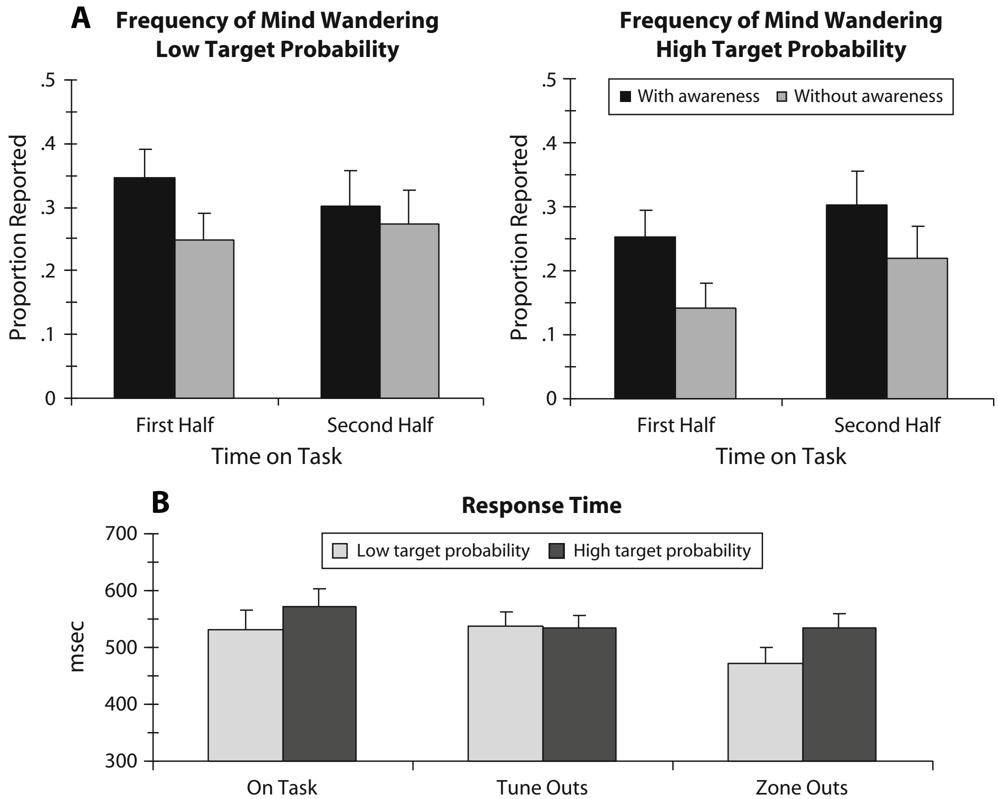

Figure 1. Relations between (A) time on task, target probability, and the frequency of mind wandering and (B) response time, target probability, and mind wandering.

collapsed these categories to examine the effects of mind wandering (see Figure 2). Initial mixed ANOVA yielded a retrieval × mental state × target probability interaction that approached significance [$F(1,39) = 2.9$, $p = .09$]. In the LP condition, a mental state × retrieval interaction approached significance [$F(1,17) = 4.01$, $MS_e = 0.062$, $p < .06$, partial $\eta^2 = .19$], implying that only when on task did participants show a recollection advantage [$t(18) = 3.17$, $p < .01$]. In the HP condition, the lack of recollection advantage is attributable to the clear increase in the influence of familiarity when on task [$F(2,42) = 6.6$, $p < .001$].

RT as a predictor of retrieval. Using multiple regression, we explored whether RT associated with mental states was predictive of retrieval. In this analysis, retrieval was the dependent measure and RT and target probability were included as independent predictors. Preliminary analysis indicated that recollection was not related to response time, either in general or with any specific mental state. Our next analysis examined whether response time, irrespective of mental state, was associated with familiarity. Retrieval based on familiarity, in general, yielded a reliable model [$F(2,44) = 4.76$, $p < .01$; see Table 2]. In the analysis of overall retrieval, only target probability was a significant predictor. Next, we examined the relation between RT and retrieval in specific mental states. The analysis of the on-task experience was largely comparable to the previous analysis [$F(2,41) = 4.51$ $p < .05$], showing only an effect of target probability on familiarity. During mind wandering, however, the relation between RT and retrieval was noticeably different. In addition to the effect

Table 1
Response Time (RT) During Mind Wandering As a Predictor of Probability of Errors and RT Prior to Errors

Dependent Factor	Independent Factor	Standardized Coefficients Beta	*t*	Significance
Probability of errors	[Constant]		4.627	.000
	RT prior to zone outs	−.441	−2.716	.010
	RT prior to tune outs	−.170	−1.047	.302
RT prior to errors	[Constant]		1.339	.193
	RT prior to zone outs	.604	3.592	.001
	RT prior to tune outs	.120	0.713	.483

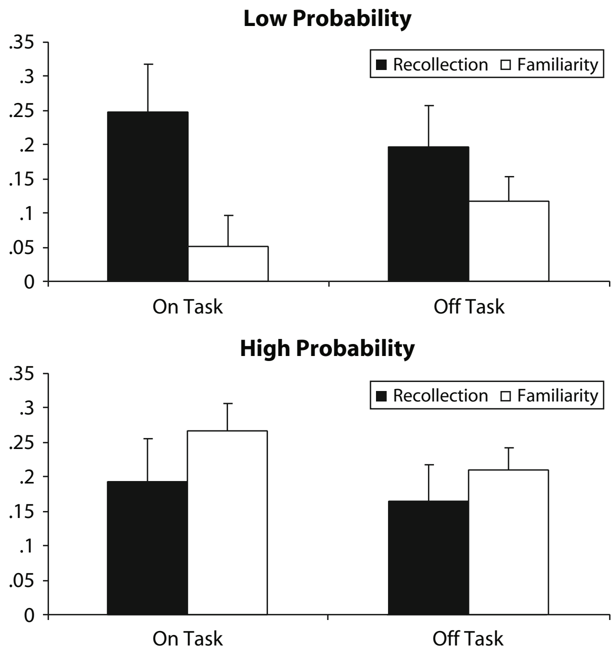

Figure 2. Relations between retrieval (recollection and familiarity), mental state (on and off task), and target probability (high and low).

of target probability, the RT associated with tune outs and zone outs made unique and contrasting contributions to retrieval based on familiarity [$F(2,33) = 5.32$, $p < .005$; see Table 2]. Irrespective of mental state or when the participant was on task, familiarity was predicted by target probability alone. During mind wandering, long zone outs and short tune outs were independently associated with retrieval based on familiarity.

DISCUSSION

Mental States

Consistent with expectations, mind wandering without awareness was associated with a short RT and poor response inhibition, indicating that these mental states were characterized by ineffective or careless supervision of the task. Mind wandering with awareness was not associated with poor response inhibition and was associated with longer RTs. This contrast illustrates the important role that meta-awareness plays in determining whether the experience of off-task episodes leads the primary task to be performed carelessly.

Under LP conditions, mind wandering, irrespective of awareness, was associated with an absence of recollection at retrieval. This is consistent with previous work (Smallwood et al., 2003; Smallwood et al., 2006) and provides evidence that mind wandering involves a configuration of attention in which the content of working memory is decoupled from the task. It is important to note that because mind wandering was more frequent only with practice in the HP condition, the relation between off-task thinking and retrieval cannot be attributed to enhanced familiarity by virtue of being more recent.

Target Probability

When target probability was low, the task provided only moderate exogenous support to attention and, so, required participants to continually supervise their task performance. In this context, the individual's mental state was important. Under LP, mind wandering was associated with careless performance of the task and poor encoding. The increased frequency of targets in the HP condition provided a source of external support to attention and, so, mitigated the extent to which attentional supervision of the task was necessary (Manly et al., 1999). This lack of need for the exogenous control of attention under HP conditions was evident in the relative lack of a performance correlate for mind wandering. On the other hand, the increase in the influence of familiarity under HP suggests that the improvements were distinct from the changes that resulted from the greater cognitive control gained when the participant was on task in the LP condition. Instead, the effects of target probability increased the effects of *automatic* aspects of memory, suggesting that participants in the HP condition relied on the frequent interruptions provided by the targets to sustain their attention to the task. Increasing target probability, therefore, acts as an *affordance* (Smallwood & Schooler, 2006), because it provides a task environment in which the structure of the external environment mitigates the negative consequences of mind wandering. Understanding the interaction between

Table 2
Response Time (RT), Mental State, and Target Probability As Predictors of Retrieval Based on Familiarity

Dependent Factor	Independent Factor	Standardized Coefficients Beta	t	Significance
Overall familiarity	[Constant]		−0.786	.436
	Overall RT	−.089	−0.639	.526
	Target probability	.419	3.006	.004
Familiarity when on task	[Constant]		−1.498	.142
	RT when on task	−.033	−0.227	.821
	Target probability	.434	3.003	.005
Familiarity during mind wandering	[Constant]		0.222	.826
	RT during tune outs	−.446	−2.618	.014
	RT during zone outs	.385	2.228	.034
	Target probability	.358	2.386	.024

internal and external influences on attention might be important for reducing the cost of an absent mind in safety-conscious and educational settings (see Smallwood, Fishman, & Schooler, 2007).

Future Directions and Implications

Meta-awareness. These data emphasize the importance of meta-awareness of mind wandering in determining the consequences of off-task episodes. The importance of meta-awareness can be seen in the relative absence of markers for mind wandering with awareness and in the regression equation, which predicts retrieval of information based on familiarity when one is mind wandering (Table 2). Not only do the data presented in Table 2 suggest that the two experiences make unique contributions to familiarity, but also the directions of the RTs are opposite one another. This dissociation rules out a simple demand characteristic account of our data and underlines that awareness of mind wandering is critical in documenting how this phenomenon relates to information processing. In the future, it will be useful to explore how awareness of other mental states, such as mood, mediates the consequences of these experiences.

Response time as an index of mental states. It is clear that we gain significant power by using RT to complement verbal reports. This power is derived from the fact that RT varies with psychological processes, allowing us to employ ordinal, rather than categorical, descriptions of mental states. In the future, by studying changes in variables such as RT, it may be possible to distinguish between mental states without resorting to verbal report and the inherent limitations that this process brings.

The sequence of mental states. The experience of catching our minds wandering illustrates that many off-task episodes begin with an absence of meta-awareness. On the basis of this observation, it may be possible to determine a predictable sequence in which mental states unfold. This *sequential* account could explain the dissociation in the relations between RT, meta-awareness of mind wandering, and retrieval (Table 2). When we included the RT during mental states as a predictor of retrieval, we observed a contrasting relation between mind wandering with and without awareness. Longer RTs during zone outs and shorter RTs during tune outs were associated with the influence of familiarity on retrieval. Mind wandering without meta-awareness was associated with short RTs (Figure 1), and so it is possible that short tune outs and long zone outs represent a transition between mental states, although at present we cannot determine the specific order in which these experiences unfold. It is possible that mind wandering will often occur before the participant is aware that his or her attention has shifted, and only after some time will he or she catch his or her own thoughts. It is equally plausible, however, that as attention begins to wander from the task, more attentional resources are devoted to the task-irrelevant thoughts, so that there is a period of *divided* attention before attention is completely divorced from the task. In the future, it should be possible to test these sequential accounts of mind wandering in a number of ways. First, we could employ probes that are separated by different temporal intervals, to determine how long, on average, each mental state requires to evolve. Alternatively, we could contrast the RT pattern associated with *probe-caught* mind wandering and *self-caught* mind wandering. Because self-caught mind wandering systematically samples experiences after participants have gained awareness of being off task, this contrast would allows us to compare the information-processing concomitants of *early* and *late* mind wandering. One advantage to understanding the sequence of mind wandering is that it would specify the time course and, therefore, the temporal window within which to seek an independent marker for off-task episodes (see Mason et al., 2007; Smallwood, Beech, Schooler, & Handy, in press; Smallwood, O'Connor, Sudbery, & Obonsawin, 2007).

Mind wandering, causality, and cognitive science. Finally, it is important to note that the data in this article involve the post hoc classification of objective information on the basis of verbal reports and that, although the data are robust, our lack of direct control over off-task episodes means that we cannot determine the direction of causality. It is possible that short RTs occur when participants find a task easy, committing few cognitive resources to the task and, so, making awareness more susceptible to internal distractions, such as mind wandering. It is equally plausible that an internal event captures an individual's attention leading him or her to mind-wander and, subsequently, cease to supervise his or her performance. Although we cannot discriminate between these two perspectives, either interpretation forces us to recognize that our awareness of our mental states varies systematically over the course of even a short cognitive task and that these fluctuations contribute to changes in objective measures of task performance. Although the study of mind wandering is interesting in its own right, it clear that as cognitive scientists, we cannot ignore the contribution that these covert attentional shifts make to the detailed measurements gained in our cognitive laboratories. In the future, we must develop methods that publicize these *private* mental states and, so, reduce a hitherto unrecognized source of error in our own experiments.

AUTHOR NOTE

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NOTE

1. No targets occurred in the last 12 sec of the block, making the direct comparison of mental states and response inhibition impossible.

APPENDIX
Instructions Given to Participants

During this experiment you will be asked at various points whether your attention is firmly directed towards the task, or alternatively you may be aware of other things than just the task. Occasionally you may find as you are reading the text that you begin thinking about something completely unrelated to what you are reading; this is what we refer to as "**mind wandering**." We believe there are two forms of mind wandering:

TUNING OUT: Sometimes when your mind wanders, you are aware that your mind has drifted, but for whatever reason you still continue to read. This is what we refer to as "tuning out"—i.e., when your mind wanders and you know it all along.

ZONING OUT: Other times when your mind wanders, you don't realize that your thoughts have drifted away from the text until you catch yourself. This is what we refer to as "zoning out"—i.e., when your mind wanders, but you don't realize this until you catch it.

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