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Counting the cost of an absent mind: Mind wandering as an underrecognized influence on educational performance

Jonathan Smallwood
University of Aberdeen, Aberdeen, Scotland

and

Daniel J. Fishman and Jonathan W. Schooler
University of British Columbia, Vancouver, British Columbia, Canada

Successful learning requires that individuals integrate information from the external environment with their own internal representations. In this article, we consider the role that mind wandering plays in education. Mind wandering represents a state of decoupled attention because, instead of processing information from the external environment, our attention is directed toward our own private thoughts and feelings. In principle, because mind wandering is a state of decoupled attention, it represents a fundamental breakdown in the individual's ability to attend (and therefore integrate) information from the external environment. We consider evidence that mind wandering impairs the encoding of information, leading to failures in building a propositional model of a sentence and, ultimately, impairing the building of a narrative model with sufficient detail to allow generating inferences. Next, because recognizing and correcting for mind wandering is a metacognitive skill, certain client groups, such as those suffering from dysphoria or attention deficit disorder, may be unable to correct for the deficits associated with mind wandering, and so may suffer greater negative consequences during education. Finally, we consider how to apply this research to educational settings.

Many of the activities that take place in schools and colleges require that students attend to the classroom environment for a sustained period. In many of these environments, it is common to catch our minds wandering and to notice that instead of paying attention for some time, our awareness has been directed elsewhere. We can refer to these inattentional private experiences as *attentional lapses* (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997), *daydreaming* (Singer, 1966), or *mind wandering* (Antrobus, 1968; Giambra, 1995; Singer, 1966; Smallwood & Schooler, 2006; Teasdale et al., 1995; Wegner, 1997). In this article, we consider the role that mind wandering plays in educational settings. First, we review studies that have demonstrated that mind wandering impairs performance on a range of tasks. Second, we examine evidence that individuals who show poor metacognitive skills are particularly vulnerable to the detrimental consequences of mind wandering. Finally, we consider the relation between the laboratory evidence on mind wandering and the classroom environment. Before doing any of this, however, it is necessary to consider conceptions of the educational process in which learning emerges from the dynamic interplay between students and the classroom.

Education As a Dynamic Interchange Between the Internal and External Worlds

Early in the last century, education was informed by the work of behaviorists such as Thorndike (1906). The teacher was seen as playing an active role in the process of education, having responsibility for the pace, sequence, and content of lessons (Baumann, 1988). As it did in other areas of psychology, the cognitive revolution led to an increased emphasis on the importance of internal representations in "meaning making" (Bruner, 1990), and educators began to integrate concepts such as scripts (Shank & Abelson, 1977) and heuristics (Newell & Simon, 1972) into their vocabulary. Most recently, educational researchers advocating a social constructionist perspective have suggested that learning emerges from the interaction of individual and collective meanings within the classroom environment (Yackel & Cobb, 1996). Those arguing from these perspectives have advocated interventions in which private expertise is made public—as in, for example, think-aloud protocols for problem solving (Duffy et al., 1986; Flower, Schriver, Carey, Haas, & Hayes, 1992). Educational psychology has, therefore, recognized that "learning and understanding are regarded as inherently social; and cultural activities and tools (ranging from symbol sys-

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

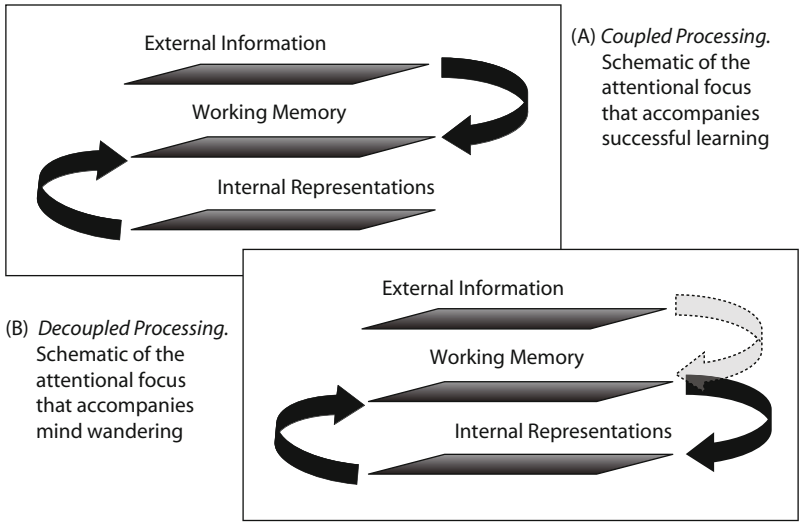

Figure 1. Schematic account of the contrast between the attentional coupling that accompanies successful discourse processing and the state of decoupled processing when the mind wanders.

tems to artifacts to language) are regarded as integral to conceptual development" (Palincsar, 1998, p. 348). In the next section, we consider how this integration occurs by examining theoretical accounts of discourse processing.

Understanding the Hierarchical Processes Involved in Discourse Processing

The majority of education tools, whether based on lectures or textbooks, involve discourse between individuals. Discourse comprehension is an ongoing process in which individuals encode information from the external environment and translate it into terms that are consistent with their internal representations: integrating the novel information when possible, modifying their schemas when necessary. Theories of discourse analysis suggest that such encoding occurs at a number of levels that are broadly hierarchical (Graesser & Ottati, 1995; Graesser & Wiemer-Hastings, 1999). The most superficial level of discourse is the *surface code*, which describes the exact phraseology of the syntactic statement. The *explicit propositional level* is more abstract and captures the meaning of the sentence in a form that transcends the explicit phrase. Finally, at the most abstract level is the *situational model* (Graesser, Olde, & Klettke, 2002), which describes what the text is about. Because the situational model is very general, it often requires information that is not contained in the explicit representation of the text, such as background knowledge. Moreover, the general nature of the situational model allows the reader to form the inferences that are necessary for comprehension.

Why Mind Wandering Is Relevant to Education

It is clear that advancement in learning depends on students' ability to integrate information from the "public" social environment with their "private" internal representations. The most obvious reason why mind wandering is relevant to education is that it represents a breakdown in the normal coupling between the internal and external environments (Smallwood & Schooler, 2006). When people's minds wander, the focus of awareness ceases to involve the external environment in a meaningful way.

Mind wandering occurs as part of the natural flow of experience. Unlike the processes studied in standard psychological research, mind wandering is an internally generated private experience, so we cannot manipulate its frequency. Instead, we can take advantage of the inevitable waxing and waning of attention throughout a cognitive task and use thought sampling to detect these changes in awareness as they occur. Mind wandering can be measured using either *self-caught* measures, in which participants report whenever they notice their minds have wandered, or *probe-caught* measures, in which participants are intermittently probed and asked whether at that particular time they were mind wandering. By combining these different approaches, it is possible to illuminate the separate processes that lead the mind to wander (Smallwood & Schooler, 2006).

The natural flux in attention that occurs when the mind wanders leads to a state of decoupled attention (Smallwood, Baracaia, Lowe, & Obonsawin, 2003; Smallwood & Schooler, 2006). Figure 1 illustrates the contrast between the normal coupling of attention, when learning proceeds successfully, and the state of decoupled attention, when the mind wanders. In the top panel, working memory is focused on information from both public and private sources, so that awareness is "coupled" to the task. On the bottom, working memory is focused on information that is private, so attention is decoupled from the primary task. In the context of discourse processing, we contend that mind wandering prevents the successful encoding of information from the environment and that this relative absence of facts puts the individual at a disadvantage when forming the more general models needed for reading.

A second reason why mind wandering is important in education follows from the fact that we often catch

our minds wandering: We come to realize that for some time—despite our intent to pay attention—our awareness has been directed to our own thoughts and feelings. This discrepancy between the contents of mind wandering and the awareness of the fact that we are off task suggests that mind wandering is a dissociation in the content of meta-awareness (Schooler, 2002; Schooler & Schreiber, 2004; Smallwood & Schooler, 2006). Below, we summarize research suggesting that among certain client groups, deficits in metacognitive skills may exacerbate the detrimental consequences of mind wandering and contribute to poor educational performance.

Mind wandering as decoupled processing. The most straightforward reason why mind wandering impacts on educational performance is that mind wandering represents a breakdown in the integration between the public and private representations necessary for learning. In this section, we review evidence from studies on mind wandering across a range of tasks. Some of these tasks require only superficial engagement with the environment, such as simple signal detection (Antrobus, 1968; Giambra, 1995). Others involve moderate engagement, such as word learning (Seibert & Ellis, 1991; Smallwood et al., 2003; Smallwood et al., 2002/2003; Smallwood, O'Connor, Sudberry, Haskell, & Ballantyne, 2004; Smallwood, Riby, Heim, & Davies, 2006). Tasks such as reading, however, involve the deepest engagement, because they involve the creation of a narrative (Schooler, Reichle, & Halpern, 2004). These hierarchical relations between mind wandering and task engagement are summarized on the left side of Figure 2. Below, we have organized the literature on mind wandering using this broad classification because it parallels the hierarchical nature of discourse processes.

Superficial engagement with the environment. Signal detection only requires participants to attend to the environment in a superficial manner. Successful performance requires detecting a single unique target from a stream of nontargets and responding appropriately. Mind wandering occurs frequently in signal detection, during which studies have suggested that 30%–50% of time is spent off task (Giambra, 1995; Smallwood, Davies, et al., 2004; Smallwood, O'Connor, et al., 2004). Even when participants are engaged in simple signal detection tasks, mind wandering has been associated with poor performance (Antrobus, 1968; Giambra, 1995; Smallwood, Davies, et al., 2004).

Moderate engagement with the environment. Tasks such as learning a word list require individuals to identify a stimulus and retain it for retrieval. Mind wandering is less frequent during word learning than during signal detection because of the greater demands for encoding (Smallwood, O'Connor, et al., 2004). Nonetheless, mind wandering still leads participants to perform poorly during word learning: Participants are less accurate in their ability to recall stimuli that were presented when verbal reports indicate that attention was off task (Seibert & Ellis, 1991; Smallwood et al., 2003; Smallwood et al., 2002/2003). When mind wandering is disrupted by an external event, participants return their attention to the task, and their memory for environmental information returns (Smallwood et al., 2006). Finally, the consequences of mind wandering on encoding under laboratory conditions are predictive of the specificity of a participant's autobiographical memories from outside the laboratory, suggesting that this phenomenon is stable over time and shows ecological validity (Smallwood, O'Connor, Sudberry, & Obonsawin, in press).

Deeper engagement with the environment. Reading requires individuals to detect and retain information and then to create a narrative of events that extend in time beyond current sensory input. Reading differs from signal detection and word learning because of the need for online coupling between public and private information

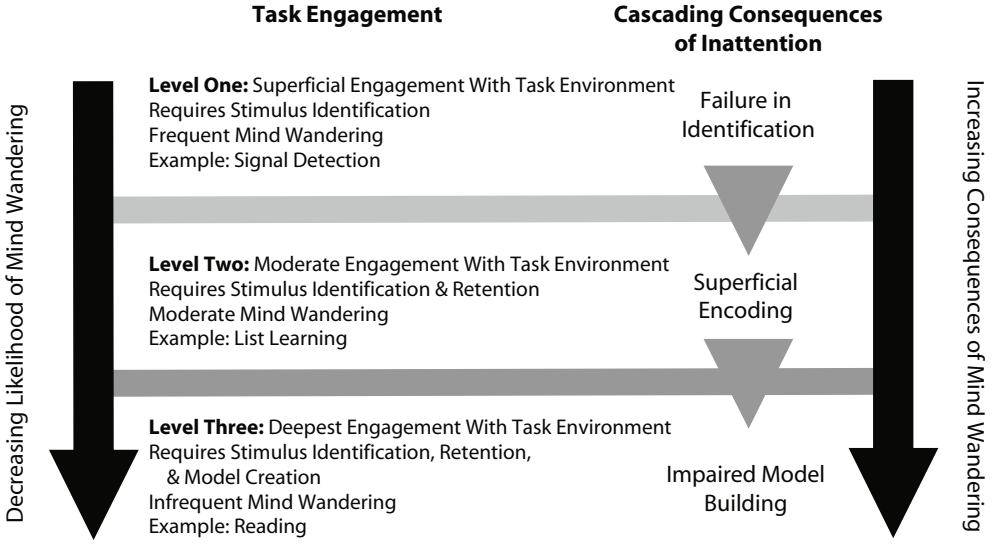

Figure 2. Schematic account of how mind wandering leads to impaired model building by preventing the encoding of information.

in order to create a narrative. Reading, therefore, requires the deepest engagement of the three task environments covered in this review. Mind wandering during reading occurs about 20%–40% of the time (Schooler et al., 2004) and is less frequent than in signal detection (Reichle et al., 2007). When probe- and self-caught measures of mind wandering are combined in the same condition, individuals are often caught mind wandering by probes before they notice it themselves, demonstrating that individuals can lack meta-awareness of mind wandering. Moreover, when the two measures are combined in the same condition, probe-caught measures often have a greater ability to predict text comprehension than do self-caught measures (Schooler et al., 2004). Thus, problems in text comprehension may arise from situations in which participants fail to recognize their minds' wandering. In the next section, we consider the specific mechanism by which mind wandering interferes with reading comprehension.

Mind wandering and model building during discourse. If mind wandering denies participants the opportunity to encode information in the first instance, the absence of this basic factual information could put them at a disadvantage when creating both the propositional and (ultimately) situational models required for a deep understanding of text (Graesser & Ottati, 1995). The consequences of poor encoding could "cascade" downward through the cognitive system, so that simple deficits in superficial processing could lead to more obvious deficits at a deeper level of analysis. This cascading model of comprehension failure is described schematically on the right side of Figure 2.

We have recently developed two paradigms to test whether the consequences of mind wandering during reading obey this cascading principle. Both paradigms employ word-by-word text comprehension, so that participants are forced to sustain their attention on the text over time. To examine the consequences of mind wandering on the explicit propositional meaning contained in a sentence, we examined the process of comprehension monitoring. Comprehension monitoring (see, e.g., Brown & Palincsar, 1989; Palincsar & Brown, 1984; Palincsar, Brown, & Campione, 1993) involves asking participants to actively determine whether the text is currently making sense—a process that forces individuals to generate a deeper understanding of the text, leading to better comprehension.

We (Schooler, Smallwood, McSpadden, & Reichle, 2007) investigated the relationship between mind wandering and a participant's ability to detect periods when the text has stopped making sense and turned to gibberish. We used a simple second-grade text to ensure that the college-level student participants would have no comprehension difficulties. Gibberish was created by modifying sentences so that text-relevant words were used in a grammatical manner, but the order was changed so as to render the sentences meaningless. For example, instead of reading "We must make some money for the circus," participants would read "We must make some circus for the money." Participants were instructed to indicate whenever they noticed the text had become meaningless. The word-by-word presentation ensured that detecting these semantic irregularities required the participant to separately encode and retain each word for long enough to create and evaluate a propositional model of each sentence.

The results indicated that participants frequently failed to immediately notice when the text had turned to gibberish (approximately 30% of the time), and that they often continued reading for a significant number of words (on average, 17) before catching the problem. Probe-caught mind wandering was predictive of the likelihood of failing to detect periods when the text turned to gibberish (Experiments 1 and 2). Moreover, when participants were probed at periods when the text had turned to gibberish but was not detected (Experiment 3), more examples of mind wandering were reported than when participants were probed randomly. Mind wandering was, therefore, associated with periods in which participants failed to build a propositional model of the text, impairing their ability to detect violations of meaning at the level of the sentence.

To examine whether mind wandering impairs the formation of models over a longer time interval, we (Smallwood, McSpadden, & Schooler, 2007) exploited the fact that detective stories often provide the reader with a number of specific facts that, if properly encoded, provide the reader a chance to build a model that can predict the outcome of the story. We asked participants to read a Sherlock Holmes story, "The Red-Headed League," which contained four inference-critical events that could be used to determine the identity of one of the villains.

In our study (Smallwood et al., 2007), we measured mind wandering using two types of thought probe. The first type, random probes, occurred at random intervals throughout the text, whereas the second type, inference-critical probes, occurred at junctures in the text that revealed a fact critical to subsequently identifying the villain. Participants who were mind wandering when probed with inference-critical probes were less able to identify the name of the villain. In contrast, random probes were not predictive of the participants' ability to answer the same question. The specific relationship between participants' responses to the inference-critical probes and their ability to name the villain suggests that even brief failures in attention, if they occur at critical junctures in the narrative, can impair an individual's ability to create a model of the discourse, leading to downstream failures in the formation of a situational model of discourse.

Awareness of Mind Wandering and Metacognition

At some point during this article, you have certainly noticed that you were not giving the text your full attention. Noticing and correcting for this mind wandering episode was no mean feat. To do so, you needed to do at least two things: First, you recognized the content of your attention, and second, you determined that this particular content was inconsistent with the intention of reading this article. Recognizing and correcting for mind wandering, therefore, requires a certain amount of metacognitive skill (Schooler, 2002). As with all psychological abilities, the prevalence of mind wandering varies across populations. In this section, we identify two populations in which mind

wandering is frequent and examine whether this variation results from deficits in metacognitive control.

Depression and mind wandering. Research has demonstrated a consistent relationship between dysphoria and elevated mind wandering in a variety of task environments. For example, dysphoric students show elevations in mind wandering across a wide range of tasks, including simple signal detection (Smallwood, Davies, et al., 2004), encoding (Smallwood et al., 2002/2003; Smallwood et al., in press), and word fragment completion (Smallwood et al., 2004/2005).

It is possible that the elevation in mind wandering for dysphoria could result from the individuals' adopting poor metacognitive strategies for controlling their attention. The literature suggests that this client group may have metacognitive problems (Teasdale, 1999), so the high frequency of mind wandering during dysphoria may be a consequence of the fact that these individuals employ counterproductive strategies to control their thinking.

To shed light on whether metacognitive problems are responsible for the elevation in mind wandering we see in dysphoria, we compared the frequency of mind wandering in undergraduate students identified as high and low in dysphoria (Smallwood et al., in press). These participants were asked to encode a selection of words and were then exposed to a second list, which they were asked not to encode. The task of encoding information requires that individuals maintain attention on the task at hand over a prolonged period, and thus it places a greater emphasis on the metacognitive control of attention. We reasoned that if dysphoric thinking is associated with mind wandering because its sufferers adopt counterproductive metacognitive strategies, this would predict high frequencies of mind wandering in dysphoric individuals during the encoding condition.

The results confirmed that, although all individuals were more likely to mind wander when asked not to encode the words, an effect of dysphoria was a specific increase in mind wandering as the session progressed when participants were instructed to encode information (Smallwood et al., in press). The fact that dysphoric individuals experienced more mind wandering when asked to encode information suggests that poor metacognitive control in this population may lead to their high level of mind wandering. This suggestion is consistent with the fact that treatments that replace attempts at metacognitive control with a meditative focus on the here and now have been shown to reduce depressive relapse and to facilitate the formation of detailed autobiographical memories (Teasdale et al., 2000; Williams, Teasdale, Segal, & Soulsby, 2000).

Attention deficit hyperactivity disorder and mind wandering. A second population with elevated mind wandering is individuals with attention deficit hyperactivity disorder (ADHD; Shaw & Giambra, 1993). ADHD is associated with a history of poor inhibitory skills (Barkley, 1997; Nigg, 2001). According to Barkley (1997), the deficits that underpin ADHD result from a constellation of impairments, including failure to inhibit a prepotent response, difficulty terminating ongoing behavior, and impaired inhibition of interference. As a result of these problems, children and adolescents who suffer from ADHD are impaired in everyday problem solving and perform poorly in educational settings (Johnston, 1998).

In a study of college-level students, individuals with a history of ADHD reported high frequencies of mind wandering relative to control participants (Shaw & Giambra, 1993). In this study, the authors differentiated between deliberate mind wandering (i.e., experiences that the individual was aware of having) and nondeliberate mind wandering (i.e., episodes that occurred spontaneously). The results indicated that ADHD-prone college students were particularly likely to report that their mind wandering occurred in the absence of deliberate intent—that is, spontaneous mind wandering. The fact that mind wandering is more likely to be spontaneous in ADHD implies that the individuals may lack the necessary metacognitive skills to catch off-task episodes when they occur. Such a metacognitive deficit in the ability to recognize mind wandering may be one of the reasons why children with ADHD gain an educational benefit from a combination of neurofeedback and metacognitive training (Thompson & Thompson, 1998).

Mind Wandering in the Classroom

Research on mind wandering is still in its infancy, and although we can be sure that it occurs outside the laboratory (Klinger & Cox, 1987/1988), no study has directly assessed mind wandering in the classroom. To do so, we must develop measures that can meet the specific requirements of research in a classroom environment. These requirements are likely to include overcoming the demand characteristics of working with children and developing online measures of mind wandering that are less obtrusive than thought probes, and that therefore could be applied in the classroom.

Despite the lack of direct evidence from the classroom, research on mind wandering could relate to education in a number of ways. One possibility is that classroom practices that promote participation using either think-aloud protocols (Duffy et al., 1986; Flower et al., 1992) or comprehension monitoring (see, e.g., Brown & Palincsar, 1989; Palincsar et al., 1993) could enhance performance because they increase engagement with the materials. Such practices could lead to greater immersion and, therefore, to lower levels of mind wandering (see the left panel of Figure 2). It could be informative to examine whether educational techniques that increase immersion, such as the use of tutorials rather than lectures, are successful because they reduce the frequency of mind wandering, and so reverse the cascading consequences of mind wandering on model building.

A second possibility is that metacognitive training could ameliorate the consequences of mind wandering. Techniques such as mindfulness-based cognitive therapy (MBCT) train participants to reduce mind wandering by changing the relationship between individuals and their thoughts (Williams et al., 2000). Thus, it is possible that with the correct targeting, techniques such as MBCT could improve performance in education contexts.

Conclusion

This article considered the implications of mind wandering research for education. We suggested that because mind wandering involves a state of decoupled attention, it prevents individuals from encoding information in the first instance. These failures in encoding cascade downward through the cognitive system, leading to downstream impairments in the model building required for reading. Second, we suggested that poor metacognitive control in certain client groups impairs the ability of those individuals to control their minds or catch them wandering, exacerbating the consequences of mind wandering and impairing the educational performance of these individuals. Finally, we considered how research on mind wandering relates to educational performance in the classroom.

When researching mind wandering, we cannot directly manipulate the critical relationship. Instead, we simply measure the extent to which attentional experience flows from one focus to another and examine the consequences of these fluctuations. All the studies reviewed here are, therefore, observational in nature, and thus cannot determine causality. As such, it is possible that the ability to make sense of the environment waxes and wanes over the course of a task, and that when lapses occur, attention may become sensitive to internal distractions such as mind wandering. Alternatively, internal events may spontaneously capture attention, leading it to become decoupled from the text and leading to the cascading deficits in comprehension outlined in this article. It is clear, however, that irrespective of the direction of causality, the frequency with which the mind wanders provides an important marker for the frequency with which text comprehension fails.

Mind wandering can clearly hinder educational performance, but the ubiquity of off-task episodes has led certain theorists to consider whether these experiences may have some functional role (Christoff, Ream, & Gabrieli, 2004; Klinger, 1999; Singer, 1966; Smallwood & Schooler, 2006). One finding in the literature is that mind wandering decreases with age (Giambra, 1993). Because mind wandering requires an intact executive system (Christoff et al., 2004; Smallwood & Schooler, 2006), the relative lack of mind wandering as age increases could simply indicate the steady decline of the brain's ability to generate novel behavioral strategies. In this light, the relative lack of dynamism in the subjective experience of older individuals could parallel the reduction in flexibility that accompanies aging, impairing learning and shifting intelligence from fluid to crystallized states.

If adolescence and early adulthood are periods associated with both dynamic subjective experience and spontaneous and flexible learning, the study of mind wandering could provide a window into how the waking mind generates and processes information that transcends the limitations of the current context. The processing of memories or goals while decoupled from the task environment could be important in the process of building bridges between different knowledge domains or elaborating upon already-learned information. Because the content of mind wandering is often in our immediate past or present (Klinger & Cox, 1987/1988), these episodes could act to keep us in touch with our hopes and desires. Similarly, the sense of spontaneity associated with mind wandering could readily serve a prospective memory function, or even contribute to the brief moments of insight (Schooler, Falshore, & Fiore, 1995) that are essential in problem solving (Smallwood & Schooler, 2006). The possibility that mind wandering allows us access to contextually unbounded information, with all the advantages that these private experiences bring, could explain why off-task experiences are both ubiquitous across cultures and yet associated with the negative educational consequences described here.

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