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TEACHER-READY THEORY REVIEW

The Mind That Wanders: Challenges and Potential Benefits of Mind Wandering in Education

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Our minds naturally wander for much of our daily lives. Here we review how mind wandering, or task-unrelated thought, impacts comprehension during lectures and reading, and how it relates to general academic success. In some situations, mind wandering may not hinder performance, and may even aid in creativity, future planning, problem solving, and relief from boredom. We distill research on the negative and potentially positive effects of mind wandering to suggest ways that teachers can reduce and redirect mind wandering in the classroom. To conclude we suggest that, rather than attempt to eliminate mind wandering entirely, we should attempt to alleviate mind wandering at the most strategic times, using research to suggest what techniques should be applied, and when.

Keywords: mind wandering, learning, focused attention, education

It is unreasonable to expect students to continuously pay attention while listening to a lecture, reading a textbook, or studying for a test. The mind naturally wanders, shifting attention from the primary learning task at hand to internal, personally relevant thoughts (Smallwood & Schooler, 2006). Indeed, the prevalence of mind wandering makes it a critical topic for educators—estimates for off-task thought range from 30%–50% of the time during our daily lives (Giambra, 1995; Killingsworth & Gilbert, 2010) and 20%–40% of the time during educationally relevant tasks such as reading (Schooler, Reichle, & Halpern, 2004). Mind wandering also seems to occur more frequently as time spent on a task increases (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012; Smallwood, Obonsawin, & Reid, 2002; Szpunar, Khan, & Schacter, 2013), making lengthy lectures or study sessions even more problematic. A recent surge in mind wandering research has produced findings relevant to educators. In what follows, we summarize the theory and methods in this field of research, then review how mind wandering is related to lecture comprehension, reading, general academic ability, problem solving, and future planning. To conclude, we outline practical tips for educators to manage student attention in the classroom.

Theories of Mind Wandering

With mind wandering research still in its early stages, the theoretical underpinnings are not widely agreed upon and experimental methods are still developing. Nevertheless, some key principles have begun to emerge. Theoretical models of mind wandering often implicate an *executive control system*, thought to manage a number of higher-level cognitive processes related to the onset and maintenance of task-unrelated thought, including the direction of attention and creating new responses or solutions (Unsworth, Redick, Lakey, & Young, 2010). Of the the-

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oretical models that exist, we outline four hypotheses that capture the varied perspectives on mind wandering, many of which rely on the executive control system.

Perceptual Decoupling

The *perceptual decoupling* hypothesis assumes that certain mental processes are common to both mind wandering and task-related thought (Antrobus, Singer, Goldstein, & Fortgang, 1970). These mental processes cannot be optimally devoted to both task-related and task-unrelated thought simultaneously. When mind wandering occurs, the executive control system presumably allows these mental processes to decouple from the external environment, reducing attention to the external environment and thereby allowing an internal train of thought to be maintained without disruption (Kane & Engle, 2002). Critically, this hypothesis does not explain why mind wandering occurs, but describes what processes ensure the continuity of a bout of mind wandering (Smallwood, 2013).

Executive Failure Hypothesis

The *executive failure hypothesis* similarly implicates the executive control system in mind wandering, but expands the role of this system beyond perceptual decoupling; specifically, it is thought to reduce external *and* internal distractions to sustain attention to the primary task (McVay & Kane, 2009; Smallwood, 2013). According to this account, mind wandering occurs when the executive control system fails to inhibit distracting internal thoughts. In other words, this hypothesis classifies mind wandering as an unintentional failure of our cognitive system.

Current Concerns Hypothesis

Contrary to the mechanistic perspective of the two previously discussed hypotheses, the *current concerns hypothesis* focuses on why mind wandering occurs on a broader scale. It posits that an individual's goals and desires trigger mind wandering by drawing attention away from the current external environment (Klinger, Gregoire, & Barta, 1973). This line of thinking may work in conjunction with the more mechanistic hypotheses discussed above, where personally relevant concerns draw attention away from external stimuli due to a failure of the executive control system to maintain external attention (Smallwood, 2013).

Resource Control Account

The more recent *resource control account* uniquely suggests that mind wandering is a default state of our cognitive system (Thomson, Besner, & Smilek, 2015). This account argues that both mind wandering and attention to external tasks draw on a limited pool of resources. Like the executive failure hypothesis, the resource control account implicates an executive control system in mind wandering. However, under this hypothesis, the executive control system allots the limited resources to both mind wandering and the current task in an attempt to promote optimal performance. As time progresses, the executive control system depletes and is less able to keep the default state from intruding, thus leading to mind wandering and poorer task performance. This hypothesis uniquely suggests that mind wandering is not necessarily a failure of our cognitive system, but inherent to it.

These theories conclude that mind wandering is a result of limited cognitive resources and can explain why it interferes with task performance. We cannot selectively attend to all important stimuli, so our cognitive system must have some mechanism for optimally allocating resources—a posited function of the executive control system. At the extreme, mind wandering is so prevalent that it may be inherent to the system, as the resource control account suggests.

Measuring Mind Wandering

It is useful to briefly review how researchers measure mind wandering. The most common method, known as experience sampling, involves periodically presenting participants with a thought probe in the form of a visual or auditory cue (e.g., a prompt appearing on a screen or the sound of a bell) and asking them to self-report their current state of mind wandering (Szpunar et al., 2013). The questions range from very direct (e.g., "Were you mind wandering just before the probe?" or "Was your attention focused on or off task just before the probe?") to less direct (e.g., "What were you thinking about just before the probe?"). These more general questions allow researchers to assess whether the contents of a bout of mind wandering are consistent with the current concerns hypothesis. Participants may also subjectively rate the quality of their attention—for example, whether it was superficial and accompanied by frequent distractions, or whether it was active and intentional (Szpunar et al., 2013). Probe results from classroom settings can also be correlated with the instructor's behavior and/or level of engagement (Szpunar et al., 2013). In sum, these direct probes of inattention can be used to understand when attention begins to fade during a task.

Although direct probes are the most common way to measure mind wandering, they are not without limitations. Specifically, direct probes rely on self-reports, meaning that measures of mind wandering may be underestimated if participants are unaware that their attention has drifted (Schooler et al., 2011) or reluctant to report that they were not paying attention to the task. Moreover, it is unclear what effect direct probes have on a participant's attention when they periodically interrupt task performance, and whether a participant's awareness that attention is being monitored affects levels of mind wandering (Seli, Carriere, Levene, & Smilek, 2013).

With these concerns, research has increasingly focused on objective measures of mind wandering, including brain wave signatures via electroencephalogram (EEG) and visual attention via eye tracking. Physiological signatures such as increased waves in the alpha frequency range of an EEG are associated with inattention and poorer learning outcomes (Pastötter, Bäuml, & Hanslmayr, 2008; Sederberg et al., 2006), but these results are mixed (Braboszcz & Delorme, 2011; van Dijk, Schoffelen, Oostenveld, & Jensen, 2008). Namely, the network of brain areas that show activity during a resting state when participants are not actively engaged in a task (i.e., the default mode network) also tends to be active when participants report mind wandering or inattention (Bonnelle et al., 2011; Christoff, 2012; Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). This connection between mind wandering and the default mode network is consistent with the idea that mind wandering is the default state, as discussed in the resource control account. Further research on the relation between default network activation and mind wandering is needed to determine whether it can be used to predict the presence of mind wandering specifically, as opposed to merely the absence of task-related activity.

Eye tracking has recently gained traction as another objective approach for detecting mind wandering. Researchers have been able to show that participants blink significantly more often when mind wandering than when on-task (Smilek, Carriere, & Cheyne, 2010). This finding supports an association between mind wandering and perceptual decoupling, which means external sensory cues are being blocked out—in this case, presumably through an increased number of blinks. While mind wandering, participants' eyes are also less likely to fixate on or look back through previously read text than when on-task, suggesting more superficial reading (Reichle, Reineberg, & Schooler, 2010). However, as with EEG, mind wandering research using eye tracking is still in its infancy and has only been used for reading tasks. With objective measurement approaches still in their early stages, researchers continue to rely on direct probes for measuring mind wandering in a variety of contexts.

Impact of Mind Wandering on Learning

Educational settings may be particularly conducive to mind wandering. Consider that students are often faced with competing demands and lengthy, mentally taxing tasks. Although mind wandering has been studied extensively using somewhat contrived laboratory paradigms, a growing body of research has begun to explore how mind wandering impacts learning in educationally relevant situations. In this section, we outline how mind wandering affects learning in the context of lectures, reading, and general academic abilities. We highlight the negative impacts of inattention, but also how mind wandering may help to strategically refresh attention.

Lectures

Lectures remain the primary mode of content delivery in postsecondary education. The lecture format is typically an effort to transfer knowledge from an expert (the instructor) to a novice (the student). In practice, lectures vary in length, quality, and engagement. Studies examining both simple attention tasks (e.g., Helton & Russell, 2011; Thomson, Seli, Besner, & Smilek, 2014) and lectures (e.g., Lindquist & McLean, 2011; Risko et al., 2012; Szpunar et al., 2013; Young, Robinson, & Alberts, 2009) report that attention wanes over time (however, see Wammes, Boucher, Seli, Cheyne, & Smilek, 2016 for recently published conflicting evidence from a large classroom study). Predictably, mind wandering impairs task performance. For example, in a study by Risko, Anderson, Sarwal, Engelhardt, and Kingstone (2012), participants watched an hour-long video lecture and responded to mind wandering probes throughout. A comprehension test was administered following the lecture. Participants mind wandered more in the second half of the lecture than in the first half and were correspondingly less likely to correctly answer questions drawn from content in the second half of the lecture. Thus, it seems the more a participant's mind wandered, the poorer their comprehension. These findings are closely mirrored in other lecture-based studies (Lindquist & McLean, 2011; Szpunar et al., 2013). In sum, the relation between attention and lecture comprehension is intuitive and direct: Students poorly retain information they were not paying attention to in the first place.

In recent work examining mind wandering during classroom lectures, involving over 5,000 individual observations, Wammes, Boucher, Seli, Cheyne, and Smilek (2016) explored an interesting distinction between intentional and unintentional forms of mind wandering. Intentional mind wandering was defined as willfully engaging in thoughts unrelated to the current lecture, whereas unintentional mind wandering was defined as having thoughts unrelated to the lecture despite trying one's best to remain focused. Using this distinction, the authors found that unintentional mind wandering rates occurred only 14% of the time, and that mind wandering did not increase over time during the lectures as had been hypothesized based on prior evidence. In a separate analysis, intentional mind wandering was most strongly linked to short-term performance costs (i.e., in-class quiz performance), whereas unintentional mind wandering was most strongly related to longer-term performance (i.e., midterm or final exam performance; Wammes, Seli, Cheyne, Boucher, & Smilek, 2016). Interestingly, the association between mind wandering and academic performance did not depend on other known determinants of performance such as GPA or class attendance.

In addition to its direct effects on academic performance, mind wandering also appears to *indirectly* hinder learning. With increased mind wandering, students are less likely to participate in other activities that promote comprehension, such as note taking (Lindquist & McLean, 2011; Szpunar et al., 2013). Note taking benefits learning both by allowing deeper acquisition of knowledge at the time of the lecture and by providing external storage to study the course material at a later date (Kiewra, 1989). Thus, fewer or poorer quality notes taken during a lecture can impair performance on future examinations. Mind wandering is also closely linked to interest in the presented material (e.g., Lindquist & McLean, 2011; Smallwood & Schooler, 2006), which may indirectly link mind wandering to learning. Of course, increased mind wandering may be a result of disinterest in the course content, which may reduce the amount of time students spend with that content outside the classroom, further impairing their learning (Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000).

Students are increasingly relying on computers to take notes in class, introducing further distractions to the lecture environment. Although little research has been conducted on how computer use affects mind wandering during lectures and subsequent comprehension, a study by Risko, Buchanan, Medimorec, and Kingstone (2013) tried to simulate a lecture environment with computer distractions. Participants watched an hour-long video lecture, but only some were given a computer with Internet access. During the lecture, participants with Internet access received e-mails and executed a variety of common tasks (e.g., checking social media, responding to e-mails). As expected, these participants reported paying less attention to the lecture and exhibited poorer comprehension of lecture material compared with participants who did not have Internet access. Interestingly, the distracting effects of computer use extend beyond the individual user and also promote inattention and impoverished learning for nearby students who have the computer in view (Sana, Weston, & Cepeda, 2013).

Reading

As with lectures, mind wandering during reading can come at a significant cost to comprehension (Franklin, Smallwood, & Schooler, 2011; Reichle et al., 2010; Smallwood, 2011). The brain only superficially encodes what is being read during episodes of mind wandering; in other words, incoming information is only partially retained (Reichle et al., 2010). This affects not only immediate understanding, such as the recall of factual information, but also more complex forms of understanding, such as the ability to make inferences from the text (Smallwood, McSpadden, & Schooler, 2008). Indeed, the point at which a student's attention lapses while reading seems to determine the extent to which their understanding is impaired. Smallwood, McSpadden, and Schooler (2008) demonstrated that students who mind wander at critical points in a narrative (toward the beginning when foundational ideas are presented) have poorer comprehension of the text than those who mind wander elsewhere in the text. In missing key details early on, students have difficulty understanding and remembering later narrative points (Smallwood et al., 2008).

As new learning media like audiobooks are introduced, students may read material differently than before. Some of these media, particularly those for which students are passive listeners, may be more conducive to mind wandering than others. For example, a study by Varao Sousa, Carriere, and Smilek (2013) examining mind wandering under three reading conditions—being read to, reading silently, and reading aloud—reported that mind wandering was most prevalent when students were being read to, and least prevalent when they were reading aloud to themselves. Consistent with the correlation between mind wandering and poor reading comprehension, students in the passive listening condition performed the worst on tests of reading comprehension and also reported the least interest in the material. Interestingly, while students who read the material aloud reported the least amount of mind wandering, they performed equally well on tests of retention as students who read the material silently, and also reported about the same level of interest. This is contrary to results from a similar study by Franklin, Mooneyham, Baird, and Schooler (2014), which found that, although retention was similar during reading aloud and reading silently, mind wandering was more prevalent in the silent reading condition. This discrepancy could be accounted for by differences in the way that participants were required to read between the two studies: Participants read one page at a time in Varao Sousa et al.'s (2013) study, whereas participants read only one sentence at a time in Franklin et al.'s (2014) study with no other text present, which does not mirror the way reading aloud occurs in real life. Nonetheless, the study by Varao Sousa et al. (2013) still suggests mind wandering is reduced during more active forms of reading, such as reading aloud or reading silently, compared to more passive forms of reading like being read to.

General Aptitude

General aptitude is a broad term used to reflect cognitive capabilities that are predictive of success (Mrazek et al., 2012). Although it is challenging to pinpoint and measure the exact characteristics of general aptitude, prior work has shown that tests of working memory capacity (WMC) and general fluid intelligence (gF) are predictive of an individual's general aptitude (e.g., Deary, Strand, Smith, & Fernandes, 2007; Kane, Hambrick, & Conway, 2005; Rohde & Thompson, 2007). Working memory is a mental system that allows information to be transiently held and processed, which is crucial for reasoning, learning, and memory (Cowan, 2008). For example, if a teacher read his or her students a math problem in class without writing it down, students would simultaneously need to keep all of the numbers in mind, decide which operation to use, and write the relevant equation. In this regard, WMC represents an important individual difference between students (Barrett, Tugade, & Engle, 2004). Those with low WMC likely have difficulty holding onto and processing the information they need to solve the problem, whereas those with a high WMC likely find this much easier. gF is the capacity to think logically and solve problems in novel situations, independent of acquired knowledge (Gray, Chabris, & Braver, 2003). It is required for all logical problem solving and is, therefore, also predictive of academic success. Both WMC and gF appear to be stable (i.e., relatively unalterable) and reliable constructs, but some studies focusing on training these abilities have shown that improvements are possible (e.g., Mrazek, Franklin, Phillips, Baird, & Schooler, 2013). These improvements may reflect participants more effectively harnessing the stable WMC or gF they already possess or a lack of sound experimental methodology, but ultimately more research is needed (Shipstead, Redick, & Engle, 2012).

Experimental studies have shown a strong relationship between mind wandering, WMC, and gF. Mrazek et al. (2012) showed that higher mind wandering (measured using thought probes) was correlated with poorer performance on common measures of working memory capacity. On a test of general fluid intelligence (Raven's Progressive Matrices), a higher level of mind wandering was associated with poorer performance. Interestingly, participants' scores on this test also predicted their performance on the standardized aptitude test (SAT), which students had taken before participating in the study. These results suggest that mind wandering during WMC or gF tasks can have rather costly effects on one's academic performance, particularly in situations where heavy reliance is placed on general aptitude measures such as standardized testing.

Researchers have also studied whether attentiveness can be improved through mindfulness training. Unlike mind wandering, mindfulness is an attentional state in which one's awareness is actively, intentionally, and nonjudgmentally[1] focused on emotions, thoughts, and sensations occurring in the present moment (Brown & Ryan, 2003; Kabat-Zinn, 1982). Mindfulness-based exercises are often used as therapeutic techniques to reduce stress, depression, and anxiety (Brown & Ryan, 2003). To explore whether mindfulness could also reduce mind wandering and improve learning, Mrazek et al. (2013) had participants attend a 2-week mindfulness training course (45 minutes four times per week, plus 10 minutes of daily meditation outside of the course) that emphasized physical posture and strategies of focused-attention meditation. Mindfulness strategies explored during the workshop included: focusing on posture; being conscious of thoughts and learning to reframe elaborated or distracting thoughts; focusing on breathing and using the breath as an anchor for attention during meditation; and mental relaxation to prevent forceful suppression of thoughts. Mindfulness training improved students' performance on a WMC task and reading comprehension scores on the graduate record examination (GRE), reducing mind wandering during both tasks (Mrazek et al., 2013). Mindfulness meditation appears to have an important effect on sustained attention (e.g., MacLean et al., 2010). In other studies, mindfulness has been associated with improved academic achievement, improved cognitive and emotional regulation, increased pro-social behavior, and decreased aggression (Britton et al., 2014; Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Lutz, Brefczynski-Lewis, Johnstone, & Davidson, 2008; Schonert-Reichl et al., 2015).

Potential Benefits of Mind Wandering

While much research has been devoted to studying the costs of mind wandering, particularly in the context of learning, some researchers have begun studying whether there are benefits to lapses in attention. Potential benefits explored to date include: future-oriented thinking, creative thinking, dishabituation, and relief from boredom.

Future-Oriented Thinking

While some educators may assume that mind wandering is inherently unproductive, preliminary research points to the idea that many of the thoughts had during bouts of mind wandering are related to things that we must accomplish in the future. For example, Baird, Smallwood, and Schooler (2011) had participants complete a choice reaction time (CRT) test,[2] which is known to induce mind wandering because it is relatively easy and does not place a heavy demand on cognitive resources. The researchers

[1] This refers to the idea that during mindfulness, individuals should refrain from making any judgments about what they are thinking or feeling at that time (e.g., whether what they are thinking or feeling is good or bad). Instead, they should focus only on the thoughts and feelings themselves.

[2] In the CRT, stimuli are presented that point to either the left or right side of the screen. The subject must press the arrow key on the keyboard that appropriately corresponds to the direction of the arrow on the screen. Outcome measures include correct and incorrect responses, errors of commission and omission, and response speed (Cambridge Cognition, 2015).

then classified the content of participants' self-reported thoughts during the test, and found that a significant proportion of thoughts during episodes of mind wandering were future-directed, and involved a combination of self-relevant and goal-directed content. These results can be seen as an extension of the current concerns hypothesis, described previously, which stipulates that personally relevant concerns (e.g., things we need to do in the future) can draw our attention away from external stimuli, perhaps outside of our conscious control. While these findings may confirm that mind wandering is not always pointless, it is not clear whether future planning typically takes place during mind wandering bouts, or whether this planning is as effective as deliberate planning that takes place outside the context of mind wandering.

Creative Thinking

Another interesting benefit that may stem from mind wandering is enhanced creativity. A study by Baird et al. (2012) had participants name as many uses as possible for a common, everyday object (e.g., a brick) in a set amount of time (known as the unusual uses task [UUT]). Baird et al.'s (2012) study showed that the benefit of an "incubation interval" (i.e., a 12-min break between two iterations of the UUT) was the greatest when students were given an undemanding task to complete during the break (Smallwood, Nind, & O'Connor, 2009), relative to either a demanding task or no task at all. Importantly, levels of mind wandering are highest during undemanding tasks. The more that students mind wandered during the break between two UUT tasks, the more creative ideas they came up with for possible uses of the common item. However, this benefit only held true when students were generating uses for an item that they had previously encountered prior to the 12-min break (i.e., if they were working on a task that they had already seen once before). Given that mind wandering did not seem to improve performance for items that had not previously been encountered, Baird et al.'s (2012) study suggests that rather than playing a general role in enhancing creativity, mind wandering might instead provide an opportunity to generate new solutions to problems that have previously been encountered (however, see Hao, Wu, Runco, & Pina, 2015 for conflicting evidence).

Dishabituation and Relief from Boredom

It has repeatedly been shown that long-term learning is enhanced when learning episodes are widely spaced in time (i.e., distributed practice) than when they are closely spaced in time (i.e., massed practice; see Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013 for a review). Besides forcing students to recall what they have learned after the original learning event has "faded," and thereby enhancing memory, the advantage of distributed practice over massed practice may also in part be due to dishabituation, which allows for attention to be temporarily diverted away from the primary task so that the mind refreshes its capacity for attention (Schooler et al., 2011). Mind wandering is thought to serve as a mechanism by which dishabituation can occur (Mooneyham & Schooler, 2013; Schooler et al., 2011). In a learning environment, this may give a student's mind a temporary "break" from the primary task, allowing their attention to be refreshed and eventually redirected back to the task once again. Similarly, mind wandering may also serve as a way of relieving boredom while performing monotonous tasks (Mooneyham & Schooler, 2013). This may serve an adaptive function, allowing one to continue an activity (e.g., a bout of learning) that has become tedious or uninteresting but is nonetheless important to sustain. The mind may not be optimized for long, cognitively demanding tasks, which might make the "break" provided by mind wandering important if a student is to cope with these demands.

Strategies to More Effectively Manage Student Attention in the Classroom

From the research discussed above, we can glean a number of promising strategies to improve attention during learning. However, before discussing these strategies, it is important to reiterate that mind wandering is an inevitable part of our lives. We all experience mind wandering at some point during the day, with some studies estimating that we are mind wandering approximately 30%–50% of the time (Giambra, 1995; Killingsworth & Gilbert, 2010). Although some of the following strategies may help to reduce mind wandering, as educators it is critical that we maintain reasonable expectations. Students will not pay attention constantly for long periods of time, whether it is due to an inherent limitation of the cognitive system or a lack of motivation—and we may not want them to. Emerging evidence suggests that mind wandering appears to play a role in future planning (Baird et al., 2011), problem solving and creativity (Baird et al., 2012), and dishabituation and relief from boredom (Mooneyham & Schooler, 2013; Schooler et al., 2011), although more research is needed in these areas. If we wish to reduce mind wandering during critical points in learning, the most potent strategies to reduce mind wandering may simply be introducing regular breaks (e.g., Baird et al., 2012; Ross, Russell, & Helton, 2014; Schooler et al., 2011) or motivating students to learn (e.g., Antrobus, Singer, & Greenberg, 1966; Unsworth & McMillan, 2013). Nonetheless, in this section, we discuss other methods for improving attention in educational settings by providing concrete tips for educators.

Tip 1: Integrate "Checkpoint" Questions Throughout Lectures

Testing, also known as *retrieval practice*, can dramatically improve retention of course content compared with other common study strategies like rereading (Roediger & Karpicke, 2006; see Dunlosky et al., 2013 for a review). During retrieval practice, students solidify their knowledge and pinpoint logical gaps, promoting long-term retention of information. Interpolated testing takes these benefits of testing and adds the benefit of breaking the lecture into smaller, more manageable segments, which together result in reduced mind wandering during lectures. In one study, breaking a lecture into smaller chunks and separating them with questions related to the previous lecture section resulted in reduced mind wandering and improved comprehension, as assessed by a cumulative test following the lecture (Szpunar et al., 2013). These benefits were not attributable solely to the short breaks inherent in this design, as participants who reviewed the previously presented content during these breaks instead of answering practice questions did not show the same improvement in attention and comprehension. Interpolated tests provide the additional benefit of allowing students who previously mind wandered to review what content they missed, allowing students to more accurately judge their knowledge (Szpunar, Jing, & Schacter, 2014). Regularly including "checkpoint questions" within a lecture may lead students to pay more attention to the presented material, reset their concentration, check their comprehension, and solidify their knowledge moving forward (see Schacter & Szpunar, 2015 for a relevant review).

Tip 2: Promote Active Learning Through Demonstrations, Discussions, or Other Activities

Active learning strategies encompass teaching techniques that foster student engagement with their own learning. Although interpolated testing could fall into the category of active learning strategies, there are a number of other methods that can be incorporated into the classroom to reduce mind wandering. Peer discussion and having students generate their own questions are two strategies that have also been shown to improve attention during lectures (Burke & Ray, 2008). In a study where students reported their own self-caught mind wandering during chemistry lectures, reports of mind wandering tended to decrease following in-class quizzes and demonstrations (Bunce, Flens, & Neiles, 2010). Other methods of active learning include think-pair-share exercises, where students individually consider a problem, then discuss their ideas in small groups, before finally taking up the problem as a class, or minute papers, in which students answer a brief and often general question about the preceding lecture (Butler, Phillmann, & Smart, 2001). In situations where mind wandering may be prevalent, avoiding purely didactic lectures by incorporating active learning opportunities will likely increase attention.

Tip 3: Encourage Students to Try Mindfulness Meditation Training Through Campus or Online Resources

Mindfulness meditation training is a promising solution to many issues of attentional, emotional, and behavioral regulation. Mindfulness meditation practices often include exercises such as awareness of breath, body scans, and yoga (see Grossman, Niemann, Schmidt, & Walach, 2004 for a review of mindfulness based stress reduction programs). Mindfulness training has been implemented in a variety of classroom settings with students from first grade to postsecondary education (see Meiklejohn et al., 2012 for a review of implementations in K–12), and has repeatedly been shown to improve attention (MacLean et al., 2010; Napoli, Krech, & Holley, 2005), working memory capacity (Jha et al., 2010), or both (Mrazek et al., 2013) in the short-term. One interpretation for the reduction in mind wandering bouts during a learning situation could be that mindfulness meditation promotes awareness of the present, which may help students catch themselves mind wandering more quickly and redirect their attention, thereby reducing the amount of learning time lost to internal thoughts. Therefore, in addition to having many other positive effects on well-being, training students to regulate their attention, emotions, and behaviors can reduce attentional lapses while learning (see http://marc.ucla.edu/body.cfm?id=22 for audio resources by the UCLA Mindfulness Awareness Research Centre, 2015).

Tip 4: Allow Students to Mind Wander When it will not Significantly Affect Learning

What many of the previous strategies have in common is that they not only reduce mind wandering but also allow students to recover from inattention. Interpolated testing and other active learning strategies allow an inattentive student to see what they may have missed and redirect their attention to the learning task. Mindfulness meditation may reduce the tendency for a student to mind wander and allow them to identify these bouts earlier to redirect attention. It is unlikely that mind wandering will ever be eliminated entirely in a learning situation, but it is important to provide students with the opportunity to mind wander without serious detriments. Shorter lectures periods, more breaks, and lower stakes learning opportunities (i.e., opportunities to relearn information that was missed or misunderstood) are just some of the ways this can be incorporated in the classroom.

We also previously described potential creative benefits fostered by incubation during mind wandering (e.g., Baird et al., 2012). Although this research is still in its infancy, there is evidence to believe that students' minds may still be engaged in problem solving even when they are not actively engaged in a specific problem-solving task. In other words, students who take a break (e.g., engaging in an undemanding task) during the process of solving a challenging problem may be more effective at generating solutions. This approach not only has implications for student studying, but also for educators. Giving a student one problem one time may actually be less effective than asking them to do it once, giving them something else less demanding to work on, and then allowing them to return to the problem once again. Nonetheless, more work is needed to address the effectiveness of this strategy.

Concluding Remarks

Attention is a limited resource necessary to maximize learning: Simply put, students cannot learn what they are not paying attention to. Despite the complexities of our educational systems, there are a number of promising techniques that can be employed to reduce mind wandering at opportune moments and promote learning. Interpolated testing, active learning strategies, and mindfulness training are but a few potential candidates for attaining this lofty goal. But in employing these strategies, educators must also maintain realistic expectations for a student's capacity for focused attention. It may not be possible or even desirable to eliminate mind wandering entirely. By this logic, developing a realistic understanding of mind wandering, and circumventing it at the most strategic times, is imperative for educators to effectively manage student learning.

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