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The Restless Mind

Jonathan Smallwood
University of Aberdeen

Jonathan W. Schooler
University of British Columbia

This article reviews the hypothesis that mind wandering can be integrated into executive models of attention. Evidence suggests that mind wandering shares many similarities with traditional notions of executive control. When mind wandering occurs, the executive components of attention appear to shift away from the primary task, leading to failures in task performance and superficial representations of the external environment. One challenge for incorporating mind wandering into standard executive models is that it often occurs in the absence of explicit intention—a hallmark of controlled processing. However, mind wandering, like other goal-related processes, can be engaged without explicit awareness; thus, mind wandering can be seen as a goal-driven process, albeit one that is not directed toward the primary task.

Keywords: mind wandering, task-unrelated thought, stimulus-independent thought, meta-awareness, attentional control

Introspective evidence is often suspect; yet, certain mental phenomena are so self-evident their existence can hardly be questioned. Our propensity for mind wandering is such a phenomenon. We all experience our minds drifting away from a task toward unrelated inner thoughts, fantasies, feelings, and other musings. Although mind wandering is ubiquitous in mental life, it has largely escaped the interest of mainstream psychology. Indeed, we were unable to find a single mention of the topic in a recent perusal of cognitive psychology texts.

Perhaps part of the reason why mind wandering has escaped mainstream attention is that research addressing the issue has been framed in the context of a variety of disparate constructs including task-unrelated thought (Smallwood, Baracaia, Lowe, & Obonsawin, 2003; Smallwood, Davies, et al., 2004; Smallwood, Obonsawin, Baracaia, et al., 2003; Smallwood, Obonsawin, & Heim, 2003; Smallwood, Obonsawin, & Reid, 2003; Smallwood, O'Connor, Sudberry, & Ballantyre, 2004), task-unrelated images and thoughts (Giambra, 1995), stimulus-independent thought (Antrobus, 1968; Teasdale, Lloyd, Proctor, & Badgeley, 1993; Teasdale, Segal, & Williams, 1995), mind pops (Kvavilashvili & Mandler, 2004), and zone outs (Schooler, 2002; Schooler, Reichle, & Halpern, 2005). These various lines of research have all addressed the basic phenomenal characteristics of mind wandering, a shift of attention away from a primary task toward internal information, such as memories (Smallwood, Baracaia, et al., 2003; Smallwood, Davies, et al., 2004; Smallwood, Obonsawin, & Heim, 2003; Smallwood, O'Connor, et al., 2004; see also Christoff, Ream, & Gabrieli, 2004). By referring to this phenomenon as *mind wandering*, a term familiar to the lay person, we hope to elevate the status of this research into mainstream psychological thinking.

Aims

In this review, we frame the literature on mind wandering in a context that we hope will enable its integration into mainstream models of executive attention. We propose that mind wandering is a situation in which executive control shifts away from a primary task to the processing of personal goals. Mind wandering shares certain similarities with standard views of controlled processing, however, there is an important difference. Controlled processing is generally associated with the intentional pursuit of a goal. Mind wandering, however, often occurs without intention (Giambra, 1995) or even awareness that one's mind has drifted (Schooler, 2002; Schooler, Reichle, & Halpern, 2005).

Two considerations are necessary to resolve the apparent paradox that mind wandering involves executive control yet seems to lack deliberate intent. First, it is likely that executive control is not involved in the initiation of mind-wandering episodes. Rather, the activation of goal-relevant information may occur automatically through a process that does not require conscious intention (Bargh, 1997; Gollwitzer, 1999). Mind wandering involves executive control when a stimulus unrelated to the primary task automatically initiates mind wandering. The absence of explicit and deliberate intent associated with mind wandering may be enabled by the simple fact that we often lack explicit awareness of the current contents of our own experiences (herein termed *meta-awareness*; Schooler, 2002; see also Jack & Shallice, 2001; Lambie & Marcel, 2002). Thus, mind wandering may entail situations in which individuals temporarily fail to notice that their immediate goal of task completion has been temporarily displaced by another concern.

With the assumption that mind wandering can be accommodated into executive models of attention, it is possible to derive

Jonathan Smallwood, Psychology Department, University of Aberdeen, Aberdeen, Scotland; Jonathan W. Schooler, Psychology Department, University of British Columbia, Vancouver, British Columbia, Canada.

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Correspondence concerning this article should be addressed to Jonathan Smallwood, School of Psychology, William Guild Building, University of Aberdeen, Aberdeen AB24 2UB, Scotland. E-mail: j.smallwood@abdn.ac.uk

specific predictions about how these experiences should relate to controlled processing. First, tasks that rely heavily on controlled processing will leave few working-memory resources available for mind wandering because off-task thinking also requires resources. Thus, mind wandering should be less likely to occur when the primary task is demanding and more likely to occur when the task is simple or automatic. Moreover, when mind wandering occurs in demanding tasks, it should be associated with deficits in performance because fewer resources are available to complete the primary task.

Second, periods of mind wandering should be associated with less accurate awareness of external information than periods of task focus because mind wandering involves a shift of attention away from the outside world. The shift in attention from the primary task toward one's memories suggests that mind wandering is a state when information processing is decoupled from the primary task (Smallwood, Baracaia, et al., 2003). Attention is directed inwards during mind wandering; thus, representations of the external environment should be superficial. In contrast, detailed representations of the external environment should be available to awareness when attention is firmly directed at the current situation.

Finally, the central challenge for incorporating mind wandering into executive models of attention is that our mind often wanders in the absence of explicit intention. Generally, deliberate intent is considered a hallmark of controlled processing, so the apparent absence of intent from mind wandering challenges the suggestion that both mind wandering and controlled processing share working-memory resources. This challenge can be met if one recognizes that goal-related processes can be initiated automatically (Bargh, 1997; Gollwitzer, 1999; Klinger, 1999). Assuming that individuals have a hierarchy of goals, it is possible that mind wandering leads to a shift of attention away from the primary task because an alternative goal becomes activated in the absence of attention. A crucial difference between mind wandering and standard notions of controlled processing, therefore, is that mind wandering reflects controlled processing that is automatically initiated by a personally relevant goal. We review evidence that individuals often fail to notice that their attention has left the primary task and has become directed at a salient personal goal (Giambra, 1995; Schooler, Reichle, & Halpern, 2005).

In the following sections, we review the existing literature on mind wandering within the framework of a standard executive model of attention, also considering how future experiments may shed light on the processes involved in mind wandering. Before doing so, however, we discuss the methods used to measure these phenomena in the laboratory.

Methodological Issues for the Measurement of Mind Wandering in the Laboratory

Verbal Reporting

In this section, we review the literature on the thought-sampling techniques that are used to assess mind wandering (Antrobus, 1968; Giambra, 1995; Klinger, 1978; Schooler, Reichle, & Halpern, 2005; Smallwood, Baracaia, et al., 2003; Smallwood, Davies, et al., 2004; Smallwood, Obonsawin, & Reid, 2003; Smallwood, O'Connor, et al., 2004). Self-reports cannot always be taken at face value (Nisbett & Wilson, 1977); thus, we consider the limitations and barriers that such reports impose on the study of inner experience. Schooler and Schreiber (2004) observe that one important way to determine when self-reports accurately reflect internal states and when they may be misleading is to examine the relation between subjective reports and behavioral and physiological concomitants. Reliable behavioral or physiological temporal markers for mind wandering provide important sources of validity for these phenomena.

Methods of Thought Sampling

The most common method for investigating mind wandering is thought sampling, assessing the inner experience of an individual as they complete a task in a controlled experimental setting. A similar procedure, the experience-sampling procedure, assesses subjective experience in an ecologically valid setting (for reviews see Csikszentmihalyi & Larson, 1987; de Vries, Dijkman-Caes, & Delespaul, 1990; Hulburt, 1997; Shiffman, 2000). In this paradigm, participants are asked to carry pagers during their day. An individual's experience is sampled at either random or quasirandom intervals via the electronic device. When probed, the participant is asked to describe his or her internal experiences, providing detailed information on the nature of the experience and also the context in which it occurred.

The measures of mind wandering used in empirical investigations can be grouped into two broad categories: probe-caught mind wandering and self-caught mind wandering. In probe-caught mind wandering, individuals are interrupted during the performance of a task and asked to report their experiences (Giambra, 1995; Schooler, Reichle, & Halpern, 2005). These probe-caught mind-wandering episodes can be recorded via either computer (Antrobus, 1968; Giambra, 1995; Schooler, Reichle, & Halpern, 2005) or verbal report (Smallwood, Baracaia, et al., 2003; Smallwood, Davies, et al., 2004; Smallwood, Obonsawin, & Heim, 2003; Smallwood, O'Connor, et al., 2004; Teasdale, Dritschell, et al., 1995). In self-caught mind wandering, participants are asked to monitor their awareness for off-task episodes (Cunningham, Scerbo, & Freeman, 2000; Giambra, 1993). Self-caught mind wandering, unlike probe-caught mind wandering, requires individuals to be aware of the content of their own experiences.

Probe-caught measures have been used to examine mind wandering with two different methods. In the first, the individual is trained to recognize an example of mind wandering and is probed at intervals throughout a task to determine whether any mind-wandering episodes occurred during predefined intervals (Giambra, 1995; Schooler, Reichle, & Halpern, 2005), typically responding with a simple yes/no judgement. We refer to this as the *self-classification* probe method. The second method requires participants to report what was passing through their mind at a point preceding the thought probe (Teasdale, Dritschell, et al., 1995; Teasdale et al., 1993). Before beginning the primary task, participants are informed that thought probes will occur, but are not informed about the category of thinking being investigated. These verbal reports are recorded and can be coded using published criteria (Smallwood, Obonsawin, & Reid, 2003). We refer to this as the *experimenter-classified* probe method. Both sampling methods produce good estimates of mind-wandering frequency because

they do not rely on participants' awareness of their own experiences.

The self-caught mind-wandering measure has been used to investigate changes in mind wandering with age (Giambra, 1993, Experiments 1 and 2) and changes in electroencephalograms (EEGs; Cunningham et al., 2000). In addition, studies have used retrospective measures of thought sampling, such as thought listing (Seibert & Ellis, 1991) and questionnaire measures of off-task thinking (Smallwood, O'Connor, et al., 2004). In these studies, mind-wandering frequency was confounded with awareness/memory of mind wandering because the sampling measure depended on an individual's ability to monitor attention (Schooler, Reichle, & Halpern, 2005). Consider the interpretation of changes in the EEG band associated with mind wandering wherein "activity levels recorded immediately after the reported mind wandering might be higher because observers realize that they had been daydreaming and must now redirect their attention back to the task at hand" (Cunningham et al., 2000, p. 64). It is unclear whether the self-monitoring approach indexes changes that result from engaging in mind wandering or changes that result from catching oneself mind wandering; thus, this method is not a good gauge of overall mind-wandering frequency. It is possible, however, that the self-caught method will ultimately prove useful in illuminating the process by which individuals catch their minds wandering and thereby shed light on how they become aware of their conscious experiences.

Dissociations Between Methods of Thought Sampling

Both self-caught and probe-caught measures of mind wandering provide complementary evidence about the nature of mind wandering. An important research strategy, therefore, is to combine the methods to highlight differences between mind wandering with and without awareness. We first consider the possibility that the manner in which mind wandering is measured influences results and then discuss the theoretical advantages of combining self-caught and probe-caught mind wandering in a research program.

A strong case can be made that rigorous control of participants' beliefs regarding the purpose of an experiment is important in psychological studies. In particular, knowledge of a psychological phenomenon is especially important when the focus of an investigation depends on self-report (Nisbett & Wilson, 1977). It is possible, therefore, that the self-classification method of mind-wandering episodes (Antrobus, 1968; Giambra, 1995) in which participants receive a description of mind wandering and are asked to monitor their awareness for such episodes, may encourage individuals to assign an artificially high priority to mind wandering. In contrast, the experimenter-classified approach to mind wandering (Smallwood, Baracaia, et al., 2003; Smallwood, Obonsawin, & Heim, 2003; Smallwood, Obonsawin, & Reid, 2003; Teasdale, Dritschell, et al., 1995; Teasdale et al., 1993) merely requires that individuals report what is passing through their minds, often without overt mention of the category in question. These ratings can be subsequently corroborated by providing participants with a retrospective questionnaire at the end of the task. Generally, these two measures are reliably correlated ($r = .60$, Smallwood, Baracaia, et al., 2003; $r = .50$, Smallwood, Davies, et al., 2004; $r = .50$, Smallwood, O'Connor, et al., 2004).

Although the self-classification method of assessing mind wandering may inflate estimates of mind-wandering frequency, it has a number of important practical advantages over the experimenter-classification approach. First, the method does not require that individuals report detailed personal information regarding the content of their experiences, presumably reducing the potential for demand characteristics. Second, it is considerably easier for individuals to classify their own mental experiences than it is for experimenters to classify participants' experiences. Considering the potential advantages of the self-classification method, it is important in future research to gain understanding of how participants' beliefs regarding the purpose of the research may bias experimental results.

A more general methodological issue concerns the difference between self-caught and probe-caught methods. Although self-caught mind wandering offers important insights into participants' meta-awareness of their off-task episodes (Schooler, 2002), its requirement that participants continuously attend to their own awareness has a potential methodological downside. Self-monitoring may increase mind wandering in a manner similar to what occurs in thought-suppression studies (Wegner, 1994). The instruction not to think about a white bear leads to experiences of the target at a level above baseline (for a review see Wegner, 1994; Wenzlaff & Wegner, 2000).

Although attending to mind wandering may alter our experience, there has been little empirical support for this premise. Schooler, Reichle, and Halpern (2005) examined mind wandering during reading. They compared the effects of self-monitoring on (a) the frequency of probe-caught zone outs and (b) attention to the task, as measured by subsequent text comprehension. They compared three groups: One group monitored their thoughts, a second group was probed and also monitored their thoughts, and a final group merely read the text. No group differences were observed in the frequency of probe-caught mind-wandering episodes, nor did either manipulation influence reading-comprehension scores. The results suggest that self-monitoring did not appreciably alter the phenomenological experience of mind wandering during text comprehension. Similarly, Smallwood, Baracaia, et al. (2003) demonstrated a consistent relation between mind wandering and retrieval from memory, irrespective of whether participants were asked to report their thoughts when probed during a task (Experiments 1 and 2) or to retrospectively report their thoughts at the end of the task (Experiment 3).

It should be possible to shed light on the processes underpinning the representation of information in awareness (meta-awareness) by combining the probe-caught and self-caught measures. The self-caught measure requires that participants notice when their attention has drifted from the task (Schooler, 2002). In contrast, probe-caught mind-wandering episodes do not require awareness and, as a result, provide a reliable baseline for the overall frequency with which mind wandering occurs. Differences in reported frequencies of self-caught and probe-caught mind wandering should yield important insights into the intermittent nature of conscious experience.

Schooler, Reichle, and Halpern (2005) explored mind wandering during text comprehension using a combination of the probe-caught and self-caught methods. Participants were asked to report each episode of mind wandering, and they were periodically probed about whether they were off-task at that moment. Schooler,

Reichle, and Halpern caught participants' minds wandering on approximately 13% of the trials in which they were probed. Similar proportions of episodes without meta-awareness have been reported with use of the thought-suppression paradigm (Fishman, Smallwood, & Schooler, 2006). Because participants were asked to report mind wandering as soon as possible, the probe-caught rate indicates the proportion of time that participants lacked meta-awareness of mind wandering.

A second research strategy is to systematically manipulate the ratio of probe-caught and self-caught mind wandering. If monitoring processes are compromised (either as a consequence of individual differences or due to some manipulation), then self-caught mind wandering should decrease, whereas probe-caught mind wandering should either remain invariant or increase because individuals fail to catch their mind wandering. Sayette, Kirchner, Reichle, and Schooler (2006) reported results consistent with this hypothesis. They examined the effects of alcohol—known to reduce self-awareness (Hull, 1981)—on the frequency of both self-caught and probe-caught mind wandering during reading. Alcohol had a distinctly different effect as revealed by the two measures. Participants who received alcohol reported more mind-wandering episodes when probed than did their sober compatriots. The inebriated participants, however, reported fewer mind-wandering episodes than did sober participants. The probe-caught measure was sensitive, therefore, to the overall frequency of mind wandering (which was increased in the alcohol condition), whereas the self-caught measure also required meta-awareness of mind wandering (which was compromised in the alcohol condition).

In sum, evidence to date suggests that the self-caught and probe-caught techniques used to assess mind wandering provide valid and informative appraisals of the occurrence of mind wandering. At the same time, these measures appear to reveal somewhat different aspects of the experience. The probe-caught method provides an estimate of how often mind-wandering episodes occur, whereas the self-caught method provides an estimate of the awareness of mind wandering. In the future, it may be possible to gain insights into the potentially distinct processes that mediate the occurrence and awareness of mind wandering by examining discrepancies between these two methods, particularly when supplemented with indirect measures of awareness.

Mind Wandering and Executive Processes

Controlled Processing

The first component of our hypothesis about the relation between mind wandering and executive control is that mind wandering requires the coordination of information using resources under executive control. This component is often referred to as *controlled processing* (Baddeley, 1993). Definitions of *controlled processing* emphasize four features: (a) "conscious intention of what control will accomplish," (b) "a sense of feeling of control," (c) "an expenditure of effort in the control of action," and (d) "a (closed-loop) monitoring of the control output" (see Wegner & Bargh, 1998, p. 463). If mind wandering is associated with the control of information in awareness, we can make two specific predictions. First, tasks that rely on controlled processing should suppress mind wandering. If the primary task requires the individual to maintain and coordinate task-relevant information in awareness, then few resources will be available to coordinate a mind-wandering episode. Second, an individual's ability to coordinate task-relevant information in awareness will be impaired when mind wandering is experienced because control processes that are normally involved in the task are directed elsewhere (see Baddeley, 1993). In principle, impairments resulting from mind wandering should increase as a function of the controlled processing involved in the primary task.

The experience of mind wandering and controlled processing. This section addresses our hypothesis that mind wandering decreases when an individual is engaged in a primary task that involves controlled processing. During a simple signal-detection task, Antrobus (1968) demonstrated that mind wandering decreased as function of the stimulus presentation rate. The reduction of mind wandering when stimulus presentation rate is high has been replicated independently (Giambra, 1995; Grodsky & Giambra, 1990; Smallwood, Davies, et al., 2004). A plausible explanation for why increasing the stimulus presentation rate reduces mind wandering is that the two processes compete for the same limited working-memory resources. As more resources are allocated to the primary task, fewer are available to support mind wandering.

Teasdale et al. (1993) hypothesized that tasks in which participants must maintain task-relevant information in awareness should suppress mind wandering if working memory is implicated in the experience. Consistent with their hypothesis, mind wandering occurred at a lower frequency when participants received information for subsequent retrieval than when they verbally shadowed the same information (Teasdale et al., 1993). The reduction in mind wandering occurred irrespective of whether the manipulation was within the same participant (Teasdale et al., 1993, Experiment 1) or between different participants (Teasdale et al., 1993, Experiment 2). Moreover, mind wandering was reduced by a simple visual-motor task relative to a control condition, suggesting that suppression does not depend solely on the involvement of the phonological loop (Teasdale, Dritschell, et al., 1995). The authors concluded that working memory provided a "temporary workspace for the production of thought streams consisting of connected segments" (Teasdale et al., 1993, p. 432).

A second influence on controlled processing is practice with a given task. Practice diminishes the need for attention in skilled activities (Newell & Rosenbloom, 1981; Schneider & Shiffrin, 1977). Well-practiced tasks become functionally transparent (Vera & Simon, 1993) because task-relevant information becomes represented at an increasingly abstract level (Anderson, 1983). As tasks become skilled, fewer decisions are made consciously; for example, skilled drivers simply drive instead of concentrating on the relevant microbehaviors involved in driving a car (i.e., checking the mirror or ensuring that the steering wheel is held in the correct manner). Put simply, practice decreases the need for executive control in performing a task.

If practice on a task reduces the working-memory resources allocated to the task, then mind wandering should increase as performance becomes skilled. Experimental evidence confirms that mind wandering increases when a task is well practiced (Antrobus, 1968; Cunningham et al., 2000; Giambra, 1995; Smallwood, Baracaia, et al., 2003; Smallwood, Davies, et al., 2004). Furthermore, an increase in mind wandering in well-practiced situations has been observed using both self-caught (Cunningham et al., 2000) and probe-caught methods (Giambra, 1995; Small-

wood, Obonsawin, & Reid, 2003) and has been observed in a variety of contexts: simple signal detection (Cunningham et al., 2000; Smallwood, Davies, et al., 2004), visual motor (Teasdale, Dritschell, et al., 1995), and verbal encoding (Smallwood, O'Connor, et al., 2004; Smallwood, O'Connor, Sudberry, & Obonsawin, in press). One can also observe the effects of practice at a microlevel by examining the frequency of mind wandering in blocks with short and long durations. Mind wandering occurs more frequently in signal-detection and verbal encoding tasks when blocks are of a long duration (1 min) than when they are of a short duration (30 s; Smallwood, Obonsawin, & Reid, 2003).

One problem in interpreting the relation between mind wandering and practice is that manipulations of practice confound skill with the possibility of fatigue. A more direct test of the role of practice in mind wandering was conducted by Teasdale, Dritschell, et al. (1995) who examined the role of practice (a between-participants manipulation) and time on task (a within-participants manipulation) in the context of two tasks: a pursuit-rotor task and a memory-load task. They found that both manipulations increased the frequency of mind wandering (Teasdale, Dritschell, et al., 1995, Experiment 3). Their results suggest that practice affects mind wandering independent of fatigue.

Increased mind wandering with time on task does not generalize to all types of tasks. Fluency tasks, for example, require that the individual consistently generate novel information. In this case, extensive practice does not reduce the role of controlled processing. Smallwood, Obonsawin, and Reid (2003) found that block length had no effect on mind wandering in fluency, whereas block length increased mind wandering in simple signal detection.

Finally, not only does mind wandering increase with time on task, the nature of thinking also changes. Practice over an extended period yields a shift from thoughts that are related to the primary task (e.g., an event in previous blocks of the same task) toward thoughts related to less immediate concerns (termed *experimenter-remote concerns*, see Antrobus, 1999). Comparable findings are observed in studies investigating block length and mind wandering (Smallwood, Obonsawin, & Reid, 2003). In simple signal-detection and encoding tasks, moderate increases in block length (30–60 s) are associated with a shift from thinking about ones' own task performance toward thoughts that are unrelated to the task (i.e., mind wandering). No change in the direction of thinking is observed in fluency suggesting that the shift results from automating task performance.

Interference between mind wandering and controlled processing. If mind wandering monopolizes working-memory resources, then performance on a primary task should suffer because few resources will be available to perform it (Baddeley, 1993). In many of the studies described above, however, processing demands were so slight that the effects of mind wandering on task performance could not be analyzed. For example, in the studies by Teasdale et al. (1993), participants performed at high levels of accuracy (96%–100%), indicating that mind wandering was not associated with poor performance.

Mind wandering is associated with poor performance, however, when a primary task requires substantial controlled processing. One such task is random number generation. Baddeley (1996) argues that random number generation requires controlled processing because individuals must refrain from using an automatic response pattern (e.g., even numbers) to generate numbers in a random order.

Teasdale, Dritschell, et al. (1995) demonstrated decrements in random-number generation during mind wandering. Their results are consistent with the hypothesis that mind wandering competes with the primary task for the control and coordination of working-memory resources; "when more control resources are allocated to the production of stimulus-independent thoughts, fewer resources are available to control the generation of random numbers" (Teasdale, Dritschell, et al., 1995, p. 558).

As outlined above, mind wandering and task performance are unrelated in many circumstances (see Smallwood, Obonsawin, & Heim, 2003). This is likely due to the fact that mind wandering is frequently studied in situations in which task performance is functionally transparent and can proceed without supervision by awareness (see previous section). Although mind wandering can lead to deficits on difficult tasks, these tasks reduce the frequency with which participants report mind wandering. Without a reasonable number of mind-wandering episodes, it is difficult to obtain reliable data concerning the influence of off-task episodes on task processing.

The sustained attention to response task (SART, Robertson, Manly, Andrade, Baddeley, & Yiend, 1997) is sufficiently simple that attention frequently leaves the primary task, yet it is sensitive to the tendency for participants to automate their behavior. The SART is a simple go/no-go task. A single infrequent target is presented (often the digit 3) amongst a background of frequent nontargets (0–9), and the participant is asked to respond to the nontarget and to inhibit their response to the target. To perform well, individuals must remain "sufficiently attentive to their responses, such that, at the appearance of a target, they can substitute the directly antagonistic response" (Manly, Robertson, Galloway, & Hawkins, 1999, p. 664). Performing the SART in a functionally transparent manner should increase rather than decrease the likelihood of errors. In this sense, errors on the SART can be considered a behavioral example of a failure in controlled processing.

An important feature of the SART is that it is possible to moderate the strength of the prepotent response by manipulating the frequency of the nontarget. In principle, a low target frequency will lead to the development of stronger prepotent responses than a high target frequency. Responses are faster to nontargets that precede an error than to nontargets that precede a correct response, particularly in circumstances of low target probability (Manly et al., 1999; Robertson et al., 1997). Errors on the SART predict (Robertson et al., 1997) and are predicted by (Manly et al., 1999) questionnaire measures of absentmindedness, suggesting that these mistakes reflect a drift of attention from the primary task (Robertson et al., 1997).

Investigations of the experience of mind wandering during the SART support the interpretation suggested by Robertson et al. (1997). First, blocks in which mind wandering occurs are associated with faster response times than are blocks in which attention is directed toward the task (Smallwood, Davies, et al., 2004). Second, high levels of mind wandering reported with retrospective questionnaires are associated with a tendency to make an error during periods of task disengagement. These errors are most frequent for targets with brief stimulus durations (Smallwood, Davies, et al., 2004, Experiment 2). Finally, the likelihood of errors when off task can be predicted by response times in blocks in which individuals report mind wandering, but not in blocks in which individuals are focused on the task. These

findings validate the interpretation of SART performance (Robertson et al., 1997) and confirm that participants are adopting a "mindless stimulus-press stimulus-press style" (Manly et al., 1999, p. 662) during mind wandering.

Summary and future directions. The evidence presented in this section suggests trade-offs between mind wandering and task performance. Mind wandering is reported frequently when the primary task does not require the executive control of task-relevant information in awareness. Moreover, it is possible to observe subtle impairments in the efficiency of task processing when processing and mind wandering compete for working-memory resources. There are several areas, however, in which future research could provide a more complete test of this relation.

Evidence has suggested that (a) mind wandering increases with time on tasks that can be readily automated, and (b) mind wandering interferes with the successful completion of nonautomated tasks. It is plausible that the relation between task familiarity and mind wandering could be tested in the following, more detailed, manner: During the onset of a novel task, when controlled processing is involved, mind wandering should be infrequent. When it occurs, however, it should lead to deficits in task performance. As task performance becomes automated, the interference between mind wandering and task performance should decrease, and the frequency of mind wandering should increase. This increase reflects the functional transparency that accompanies skill acquisition. The dynamic relation between automaticity and mind wandering could be readily tested in the alphabet-addition task, a task that is often used to examine the time course of automatic processing (e.g. Logan & Klapp, 1991). This experiment would provide robust evidence that mind wandering is simultaneously inhibited by, and interferes with, the executive control of task-relevant information in working memory.

Second, it is important to determine whether mind wandering should be viewed as a modality-specific process or as a more general one, as is the case for standard notions of executive control. It is possible to address this issue through comparison of interference between different task modalities and mind wandering. Work by Teasdale et al. (1993; Teasdale, Segal, & Williams, 1995) suggested that mind wandering is suppressed by both visual-spatial tasks and tasks with a phonological component. Similarly, Antrobus, Singer, Goldstein, and Fortgang (1970) demonstrated that auditory and visual tasks interfere with auditory and visual mind-wandering episodes, respectively. In contrast, Stuyven and van der Gouten (1995) demonstrated that a letter-generation task suppressed mind wandering to a greater extent than either a fast or slow random-time interval task with no verbal component. The nature of the resources involved in mind wandering bears directly on the extent to which mind wandering involves executive control; thus, this issue is clearly worthy of further research. It is likely that neuropsychological measures, such as ERP or functional magnetic resonance imaging (fMRI), will be important in resolving this issue by identifying the brain areas involved in the competition between mind wandering and the primary task.

The Decoupling of Attention From the External Environment

When the mind wanders, attention may become divided between internal and external information, a phenomenon initially described by John Antrobus and Jerome Singer as "decoupling" (see also Smallwood, Obonsawin, & Heim, 2003). Mind wandering can be viewed as a state of decoupled attention, because instead of monitoring online sensory information, attention shifts inward and focuses on one's thoughts and feelings. If this hypothesis is correct, the period when the mind is wandering should be associated with measurable differences in an individual's access to representations of environmental stimuli. Some activities (such as reading) involve the creation of online representations of the external task environment. Such activities are ideal for testing our hypotheses about mind wandering, unlike the simple tasks (e.g., signal detection) reviewed in the previous section.

In this section, we review studies of mind wandering in the context of tasks such as reading and encoding. These studies demonstrate that individuals have superficial representations of the environment when their minds wander. The study of mind wandering in the context of semantically rich tasks such as reading is also important because it involves the investigation of subjective experience in situations in which task focus is the norm rather than the exception (see Smallwood, Obonsawin, & Heim, 2003, for a discussion of this issue).

Mind wandering is not the only form of internally focused attention studied in psychology. For example, research on mental imagery, typified by the mental-rotation paradigm (Sheppard & Metzler, 1971), also requires the shift of attention away from sensory sources. However, in this case, attention is intentionally directed toward the primary task. Other tasks that involve shifts of attention away from the external environment include reasoning (Laird, 1999) and autobiographical memory recall (Williams & Scott, 1988). These situations may share important information-processing characteristics with mind wandering and may ultimately provide important control conditions for the investigation of mind-wandering episodes. For example, Smallwood, O'Connor, et al. (2004) compared mind wandering with the overt maintenance of images in attention. The comparison between explicit imagery and mind wandering suggested that information-processing similarities exist between mind wandering and the maintenance of dynamic images in awareness (i.e., images that change over time), but not static ones. Tasks that involve the explicit internalization of attention could provide a useful baseline for future neuropsychological investigations of mind wandering.

Text comprehension. Work by Grodsky and Giambra (1990) demonstrated that the likelihood of mind wandering during reading was positively associated with its likelihood in a simple signal-detection task. The positive correlation between mind wandering during reading and signal detection indicates a reasonable level of consistency in mind wandering across two quite different contexts: the first, a stimulus environment that is rich, and the second, a relatively impoverished one.

Despite the consistency between mind wandering in the context of reading and simple signal-detection tasks, the factors that determined mind wandering varied across experimental situations (Grodsky & Giambra, 1990). In signal detection, mind wandering was more frequent during easy rather than hard blocks, whereas mind wandering during reading was unrelated to passage difficulty. Instead, mind wandering was frequent during reading when passages were rated as uninteresting. In the context of semantically meaningful tasks, factors such as absorption or interest, rather than simple resource-driven factors, appear to play an important role in

determining when the mind wanders. The influence of interest or absorption on mind wandering has been termed an *affordance* (Smallwood, Baracaia, et al., 2003).

According to our hypotheses about the relations between mind wandering and executive control, mind wandering leads to superficial representations of the current external environment. In the context of reading, frequent mind wandering should lead to poor performance on measures of text comprehension. Schooler, Reichle, and Halpern (2005) examined this issue by requiring participants to read passages from *War and Peace* during which both mind wandering (self-caught and probe caught) and text comprehension were assessed. Comprehension was assessed immediately after probes. Periods of probe-caught mind wandering were associated with poorer text comprehension than were periods in which attention was on task, confirming that mind wandering interfered with participants' ability to comprehend the text. Similar results have been observed when mind wandering is induced by asking participants to suppress thoughts relating to a previous romantic relationship (Fishman et al., 2006) and when text is presented one item at a time in a self-paced reading task (Schooler, Smallwood, McSpadden, & Reichle, 2005). These results confirm that superficial representations of the environment tend to occur as attention drifts from task-relevant material.

Encoding. Research has suggested that the formation of detailed episodic memories depends on the executive control of attention during encoding. For example, dividing attention at study reduces the formation of detailed episodic memories (Jennings & Jacoby, 1993). In this section, we examine evidence that mind wandering leads to a measurable difference in the quality of episodic memories formed during encoding.

According to dual process accounts of memory, retrieval can occur through two distinct processes (Jacoby, 1998): recollection and familiarity (Jacoby, 1998; Jennings & Jacoby, 1993) or explicit and implicit retrieval (Szymanski & Macleod, 1996). Broadly, recollection/explicit recall can be understood as the "conscious retrieval of an event" (Szymanski & Macleod, 1996, p. 165), whereas familiarity/implicit retrieval arises "when a previously encountered stimulus affects behaviour without conscious knowledge" (Szymanski & Macleod, 1996, p. 165).[1] Both dividing attention (Jacoby, 1998; Jennings & Jacoby, 1993) and directing attention to superficial stimulus features (Szymanski & Macleod, 1996) impair recollection, leaving stimulus familiarity unaffected.

If mind wandering is associated with a shift of attention away from the current environment, then subsequent retrieval may occur via familiarity rather than recollection. Initial studies have indicated that manipulations increasing mind wandering, such as inducing positive or negative mood, also reduce retrieval from memory (Seibert & Ellis, 1991). Similarly, elevated frequencies of mind wandering are associated with high frequencies of false alarms in immediate retrieval (Smallwood, Baracaia, et al., 2003; Smallwood, Obonsawin, Reid, & Heim, 2002). Moreover, situations that promote high levels of encoding also encourage the maintenance of attention on task-relevant information. In particular, the presentation of stimuli in the form of semantic categories for subsequent recall tends to increase subsequent task performance and decrease mind wandering, relative to either alphabetical or randomly organized stimuli (Smallwood, Baracaia, et al., 2003; Smallwood, Obonsawin, & Heim, 2003).

More recent evidence has demonstrated that mind wandering is associated with a shift toward retrieval of information on the basis of familiarity rather than recollection (Smallwood, Baracaia, et al., 2003). The effects of mind wandering during study are robust across a variety of different situations. For example, mind wandering has been associated with elevations in familiarity, regardless of whether recollection/familiarity was measured at the point of study (Smallwood, Baracaia, et al., 2003, Experiment 2) or at retrieval using the process-dissociation procedure (Smallwood, Baracaia, et al., 2003, Experiment 3). Second, a shift in retrieval as a result of mind wandering has been demonstrated on word-fragment completion (Smallwood, Baracaia, et al., 2003, Experiments 1 and 2) and word-stem completion (Smallwood, Baracaia, et al., 2003, Experiment 3) but not with simple word recognition (Smallwood, Baracaia, et al., 2003). Third, the debilitating effects of mind wandering on retrieval have been observed in immediate recall (Smallwood et al., 2002) and delayed retrieval (Seibert & Ellis, 1991; Smallwood, Baracaia, et al., 2003, Smallwood, O'Connor, et al., 2004).

Research has also investigated whether failures in controlled processing, defined in behavioral terms as errors, are associated with superficial representations of the environmental context. The relation between encoding of the environment and behavioral lapses was addressed using a variation on the SART, called the semantic SART (Smallwood, Heim, Riby, & Davies, 2006). In this task, participants were asked to respond to a frequent nontarget stimulus (a five-letter word) and inhibit their response to a target stimulus (*XXXXX*). On completion of the initial task, participants received a word-fragment completion test for words presented during the first phase. Retrieval was measured using the process-dissociation procedure (Jacoby, 1998). Words that were presented before an individual made an error were equally likely to be retrieved on the basis of familiarity or recollection. Those items that were presented after participants made an error were more likely to be retrieved on the basis of recollection. The pattern of retrieval before and after an error confirms observations in the literature that, in tasks like the SART, periods before an error index intervals when attention is directed away from the primary task. The rebound in recollection following an error demonstrates that attention returns to the primary task following an explicit failure in task performance (Manly et al., 1999; Robertson et al., 1997).

Summary and future directions. The literature reviewed in this section is consistent with the claim that, when the mind wanders, attention that is normally directed toward the primary task shifts away from the external environment, leading to more superficial representations of the external environment than when attention is on task. Evidence from studies of text comprehension and encoding has illustrated that individuals have less detailed access to representations of the external environment when their attention is off task, providing support for the claim that, during mind wandering, attention is decoupled from the external environment. From a methodological perspective, the majority of the findings in the literature measure the awareness of target stimuli indirectly. For example, research on mind wandering during encoding often

[1] For the sake of clarity, we use the terms *recollection* and *familiarity* to refer to these phenomenon.

measures retrieval at the end of the encoding phase (e.g., Smallwood, Obonsawin, & Heim, 2003). Given the intervening time between the initial presentation of the stimulus and the subsequent retrieval of the memory, it is hard to ensure that deficits result from mind wandering and not from some other intervening variable. It is important, therefore, for future research to address this issue using a paradigm that measures retrieval immediately. Schooler, Reichle, and Halpern (2005) have used this methodology to examine comprehension failures in reading, and it would be informative to use this paradigm in the context of immediate measures of encoding.

An alternative method would be to use indirect measures of encoding, such as ERPs, to provide temporal information about fluctuations in an individual's ability to encode information. Recent work has provided preliminary evidence that those individuals who report a high frequency of mind wandering show differences in the ERP correlates of episodic memories when asked to retrieve these stimuli (Riby, Smallwood, Cooper, Finnigan, & Annett, 2006). It would be worthwhile to explore the possibility that ERPs could be used to detect fluctuations in awareness during the encoding phase of a memory task.

Deliberate and Nondeliberate Processes and Mind Wandering

Executive systems are generally involved in the deliberate control of behavior (Baddeley, 1996; Norman & Shallice, 1986). However, we review empirical studies in this section demonstrating that people often fail to notice their minds wandering (Giambra, 1995; Schooler, Reichle, & Halpern, 2005). Thus, mind wandering is a paradox; mind wandering clearly shares many features of traditional executive systems, yet some of these episodes occur in the absence of explicit intention. Indeed, mind wandering may occur specifically as a consequence of intentions to avoid it. Wegner (1997) suggested that the "mind wanders as a result of our attempts to control it" (p. 298). According to ironic processes theory (Wegner, 1994), attempts to control awareness create conditions in which the intentional control of attention is undermined, leading in turn to an increase in the frequency of mind-wandering episodes.

A resolution to the fact that mind wandering occurs when executive control is engaged without deliberate intent can be achieved by adding two assumptions to standard executive models: (a) the assumption that individuals possess multiple goals, some of which can be triggered automatically by salient stimuli (Bargh, 1997; Gollwitzer, 1999; see also *current concerns* theory in Klinger, 1978, 1999), and (b) the assumption that consciousness and meta-awareness are distinct (Schooler, 2002). We discuss each assumption in turn.

Automatic goal activation. Satisfactory goal completion requires that an individual's cognitive system be sensitive to environmental opportunities that facilitate a given behavior (Gollwitzer, 1999; Klinger, 1999). These goal-driven sensitivities can be referred to as implementation intentions (Gollwitzer, 1999) or current concerns (Klinger, 1999), and they facilitate behavior by heightening the accessibility of goal-relevant stimuli. According to auto-motive theory (Bargh, 1997), the heightened accessibility of goal-relevant information results in the processing of these stimuli preconsciously; this, in turn, leads to the direct activation of a behavior without conscious intent (Bargh, 1997). This framework suggests that mind wandering can occur against our best intentions because the automatic activation of a personally relevant, but task-unrelated, goal has temporarily drawn our attention away from the primary task.

The automatic activation of goals has previously been applied to mind wandering research with the current concerns framework (Klinger, 1978, 1999). Current concerns are "hypothetical processes active during the time that one has a goal" (Klinger, 1999, p. 43) and elicit effects on cognition, because to commit to a goal is to become sensitive to cues associated with the relevant behavior. These goal sensitivities, in turn, lead the cognitive system to automatically process behaviorally relevant cues (Klinger, 1999; Nikles, Brecht, Klinger, & Bursell, 1998). Empirical evidence has provided support for the sensitivity of attention to self- or goal-relevant information. First, during dichotic listening, attention is rapidly and efficiently drawn to both self-relevant stimuli (Bargh, 1982; Klinger, 1978) and goal-relevant information (Gollwitzer & Bargh, 1996), in a manner similar to the cocktail party effect (Cherry, 1953). Briefly presenting either self-related (Bargh, 1982) or goal-related stimuli (Gollwitzer & Bargh, 1996) in one channel of a dichotic listening task activates relevant adjectives in awareness. Similarly, stimuli related to an individual's current concerns presented in one channel of a dichotic listening task leads an individual's attention to switch to that channel and subsequently increases the number of thoughts related to that concern (Klinger, 1978). Therefore, it seems possible that the shift of attention away from the external environment—mind wandering—occurs in opposition to the goal of task completion because of the direct activation of a personally relevant goal.

Meta-awareness. Throughout this review, we have emphasized the value of distinguishing between the occurrence of an experience (experiential consciousness) and one's explicit awareness of the experience (meta-awareness, Schooler, 2002; see also Jack & Shallice, 2001; Lambie & Marcel, 2002). This distinction becomes particularly important when we attempt to explain how mind wandering occurs. Empirical evidence demonstrates that individuals often fail to recognize that their attention is off task in both simple signal-detection (Giambra, 1995) and reading tasks (Schooler, Smallwood, et al., 2005). Given the fact that goal-directed processing can occur automatically, individuals may lack meta-awareness of mind wandering in the same manner that they occasionally fail to recognize why they engage in certain other goal-driven acts (Bargh, 1997). Awareness will be absent in mind-wandering episodes if goal-driven processes attract attention without the individual (at least for a period of time) perceiving a conflict.

In this final section, we consider evidence that mind-wandering episodes occur when executive control becomes temporarily usurped by a more personally relevant goal. The relation between mind wandering and intention is speculative, largely because few studies have directly addressed the relation between the directed control of attention and mind wandering. Nonetheless, two lines of experimental evidence shed light on whether mind wandering occurs without intention.

First, we consider evidence demonstrating that, on occasion, individuals describe their mind-wandering experiences as either lacking intentionality (Giambra, 1995) or lacking awareness that they were off task (Schooler, Reichle, & Halpern, 2005). Second,

we discuss the possibility that mind wandering in everyday life plays an important role in attempts at problem solving. Evidence suggests that personal concerns form the basis of mind wandering and that states involving elevations in these concerns, such as dysphoria (Ruehlman, 1985), are accompanied by high frequencies of mind wandering (Smallwood, Davies, et al., 2004; Smallwood et al., in press; Smallwood, Obonsawin, & Reid, 2003; Smallwood, O'Connor, et al., 2004; Smallwood, O'Connor, & Heim, 2006). This evidence provides a critical link between mind wandering and the need to resolve ongoing personal problems.

Intentions, awareness, and mind wandering. Research by Giambra and colleagues examined the role of intentions in mind wandering. They distinguished between two forms of mind wandering: spontaneous and deliberate (Giambra, 1995; Grodsky & Giambra, 1989). Spontaneous mind wandering reflects "task-unrelated thought intrusions that spontaneously come into your head without any effort on your part," whereas deliberate mind wandering reflects "intrusions that occur when you deliberately try to think about something other than the vigilance task" (Giambra, 1995, p. 12). In the context of simple signal detection, volitional mind wandering was reported on a greater proportion of probes than was nonvolitional mind wandering (71% vs. 50%, respectively; Giambra, 1995). This suggests that a high proportion of mind-wandering episodes are directed toward the explicit or volitional pursuit of an individual's goals or current concerns during a simple signal-detection task. Nonetheless, individuals reported that they were not experiencing deliberate mind wanderings during approximately half of the probes—in other words, individuals were often caught mind wandering before they noticed it themselves.

The notion that mind wandering often lacks meta-awareness is supported by research in which the meta-cognitive status of mind wandering was examined (Schooler, Reichle, & Halpern, 2005). In the text-comprehension study described earlier, individuals were unaware of the direction of their thinking on approximately 13% of thought probes in which mind wandering was reported. Similar frequencies (20%) have been observed with both a self-paced word-by-word text-comprehension task (Schooler, Smallwood, et al., 2005) and a task using alternative text (Fishman et al., 2006). Thus, in both reading and simple signal-detection situations, individuals frequently lack meta-awareness that they are mind wandering, even when specifically instructed to be vigilant for such lapses. Empirical evidence, therefore, supports the position that a substantial proportion of mind-wandering episodes occur without intent.

Mind wandering and personally relevant problem solving. If mind wandering occurs when executive control leaves the primary task in favor of an alternative personally relevant goal, then off-task episodes should be closely tied to problem solving. Since Singer (1966), several authors have suggested that mind wandering is associated with important functional consequences. In particular, mind wandering has been associated with facilitating problem solving by the conceptual manipulation of semantic information (Binder et al., 1999). The role of mind wandering in problem solving is exemplified in the following quotation: "By storing and manipulating internal information we organise what could not be organised during stimulus presentation, solve problems that require computation over long periods of time, and create effective plans governing behaviour in the future" (Binder et al., 1999, p. 85). Mind wandering could clearly facilitate problem solving by helping individuals solve problems in awareness before they encounter them in the real world. In more general terms, this process has been referred to as *problem solving in the neural workspace* (Cleeremans & Jiménez, 2002; Dehaene & Naccache, 2001).[2] Evidence linking mind wandering to problem solving would provide informative evidence that off-task episodes occur when a personally relevant goal is activated in awareness.

Research supports the notion that mind wandering plays an important functional role in resolving problems in everyday life. When mind wandering occurs in either naturalistic (Klinger, Barta, & Maxeiner, 1980) or laboratory settings (Klinger, 1978), individuals are likely to be processing their current concerns (Klinger, 1999). First, the content of a participant's thinking as sampled on a day-to-day basis through the use of a pager is often associated with the contents of the participant's concerns as sampled by a questionnaire. These concerns are associated with the individual's present life (67%), past or future life (12%), or no particular time period (23%; Klinger & Cox, 1987). Second, an experimental induction of a personal salient concern with extensive implications for an individual (e.g., a broadcast indicating that China had entered the Vietnam War) increases the likelihood of mind wandering (from 0.32 to 0.45) and the frequency of errors (from .045 to .055) relative to a neutral control broadcast (Antrobus, Singer, & Greenberg, 1966). Finally, similarities can be seen in the overlap between the content of mind wandering and coping strategies (Greenwald & Harder, 1995, 1997). A consistent and reliable association has been observed between the content of mind wandering experienced on a day-to-day basis and the content of sustained fantasies evoked as a source of comfort to an individual in situations of distress (Greenwald & Harder, 1995).

The relation between dysphoria and mind wandering provides additional support for the claim that mind wandering occurs in the pursuit of self-relevant goals. Dysphoria has been recently conceptualized as a state of repetitive self-relevant processing (Pyszczynski & Greenberg, 1987; see also Higgins, 1987). Consistent with this emphasis on the self in depression, research suggests that dysphoria reflects a state of elevated current concerns (Ruehlman, 1985). The current concerns of undergraduate students who were dysphoric were less positive and less related to active goal pursuits than those who were not dysphoric. In addition, dysphoric undergraduate students reported a greater number of concerns than did nondysphoric students, particularly in three areas: (a) love and sex, (b) employment and money, and (c) mental health (Ruehlman, 1985). If mind wandering is associated with solving personal problems, then dysphoric individuals constitute an important population in which to test the association between off-task thinking and problem solving.

Mind wandering has been consistently associated with questionnaire measures of dysphoria across a wide range of tasks: encoding (Smallwood, Obonsawin, Baracaia, et al., 2003; Smallwood, O'Connor, et al., 2004), sustained attention (Smallwood, Davies, et al., 2004), and word-fragment completion (Smallwood, O'Connor, & Heim, 2006). Moreover, recent evidence has sug-

[2] Similar perspectives have been advanced in evolutionary accounts of conscious awareness, notably Dennet (1996), who emphasized the development of infovores: organisms whose ideas can die instead of themselves.

gested that mind wandering is more frequent in a dysphoric population than in a nondysphoric one, and when off-task thinking occurs in this population, it leads to physiological arousal and inefficient information processing (Smallwood et al., in press).

Finally, recent advances in the treatment of depression—such as mindfulness-based cognitive therapy (MBCT; Teasdale, 1999; Teasdale et al., 2000)—provide an important source of evidence for the association between mind wandering and on-going personal problems. In MBCT, participants are trained in meditative techniques that are focused on reducing mind wandering. MBCT shows promise in reducing the likelihood of depressive relapse and, posttherapy, in helping participants form more detailed autobiographical memories (Williams et al., 2000).

The evidence on the relation between dysphoria and mind wandering suggests that (a) populations who have elevated personal problems are more likely to engage in mind wandering across a wide range of tasks and (b) therapeutic interventions that focus on reducing mind wandering are effective in reducing relapse in recovering depressive individuals. Taken together, the relation between mind wandering and dysphoria provides important indirect evidence for the association between off-task experiences and goal-resolution processes.

A recent fMRI study has provided a physiological mechanism to explain the manner in which periods of off-task thinking may be activated by an individual's current concerns (Christoff et al., 2004). In the context of neuroimaging studies, one consistent finding has been that periods of rest resemble periods of problem-solving activity. Recently, evidence has demonstrated that brain activity during the resting state, presumably a period when high frequencies of mind wandering occur, is closely related to activity during conceptual processing (Binder et al., 1999), memory retrieval (Buckner, Raichle, Miezin, & Petersen, 1996), and problem solving (Christoff & Gabrieli, 2000). Christoff et al. (2004) demonstrated that periods of rest, interspersed throughout a simple visuomotor task, showed high levels of activation in lateral prefrontal and visual cortex. The most robust activation during rest, however, was observed in temporal lobe structures, including lateral anterior and medial temporal regions. This pattern of activation was interpreted as an indication that long-term memory processes form the basis of spontaneous thinking (Christoff et al., 2004). The results of Christoff et al.'s study provide a plausible physiological mechanism through which higher order goals derived from our past experience may overshadow the primary goal of task completion.

Summary and future directions. In this section, we examined the paradoxical fact that mind wandering reflects an executive process that occasionally occurs in the absence of intention. To overcome this paradox, we suggested that goal-relevant processing can be instigated automatically (Bargh, 1997; Gollwitzer, 1999) and that individuals possess multiple goals, some of which are unrelated to the current goal of task completion (Klinger, 1999). When mind wandering occurs against our intentions, it is possible that personally relevant goal-driven processes are automatically activated, leading to the withdrawal of attention from the primary task.

The evidence reviewed in this section demonstrates two clear features of mind wandering that are consistent with this claim. First, evidence shows that the mind wanders without individuals themselves registering this fact in both simple signal-detection and text-comprehension tasks (Giambra, 1995; Schooler, Reichle, & Halpern, 2005). Second, evidence has suggested that personal information from memory may form the content of mind-wandering episodes. Moreover, those individuals who have high frequencies of personal problems show evidence for frequent mind-wandering episodes and periods in which attention is withdrawn from the current situation.

One limitation of research into the relation between mind wandering and executive control is that research has examined verbal reports only. Self reports are a crude measure of awareness and are potentially susceptible to demand characteristics. Research has identified five markers that may index the experience of mind wandering: (a) response time (Smallwood, Baracaia, et al., 2003; Smallwood, Davies, et al., 2004; Smallwood, O'Connor, et al., 2004), (b) changes in heart rate (Smallwood, Davies, et al., 2004; Smallwood, O'Connor, et al., 2004), (c) skin conductance (Smallwood et al., in press), (d) electro-cortical activity including both EEGs (Cunningham et al., 2000) and ERPs (Riby et al., 2006), and (e) fMRI activity (Christoff et al., 2004). We may be able to exploit these physiological or behavioral markers to provide more reliable evidence about the role of intention in mind wandering than can be provided by the analysis of self-reports alone. In particular, a psychophysiological contrast between self-monitored and probe-caught mind wandering may illuminate the process by which information becomes re-represented in awareness (Schooler, 2002). Advances in technology such as real time fMRI and source-localization ERP make the development of a physiological marker for mind wandering a viable possibility.

A second possible direction for future research is to investigate the emotional nature of current concerns as determinants of whether mind-wandering episodes lack meta-awareness. Evidence has shown that stimuli related to an individual's current concerns can trigger a mind-wandering episode (Klinger, 1978, 1999; Smallwood, Davies, et al., 2004; Smallwood, Heim, et al., 2006; Smallwood et al., in press; Smallwood, Obonsawin, Baracaia, et al., 2003; Smallwood, O'Connor, et al., 2004) and has shown that personally salient internal information can dominate awareness at the expense of external task-relevant stimuli. A large body of experimental evidence suggests that emotive material tends to attract an individual's attention (e.g., Ohman, Flykt, & Esteves, 2001) and may do so automatically (MacLeod, 1991; McKenna & Sharma, 1995). If information-processing during mind wandering is aimed at personally salient goal resolution, then the emotional nature of this information may be responsible for whether the subjective experience of mind wandering is associated with meta-awareness. A study of mind wandering with and without awareness by experimentally inducing positive and negative moods in depressed and control participants could address this issue.

Conclusions and Final Thoughts

We have provided a framework for describing the empirical evidence on mind wandering gathered over the last 30 years by combining assumptions from previous theoretical accounts of mind wandering (e.g., Antrobus, 1999; Klinger, 1999; Teasdale et al., 1993; Teasdale, Dritschell, et al., 1995) with contemporary views of executive control and meta-awareness (Jack & Shallice, 2001; Lambie & Marcel, 2002). First, we have suggested that executive control becomes disengaged from a primary task during

mind wandering and becomes directed toward the processing of internal information, such as memories. Both the consequences and distribution of mind wandering suggests that our minds are apt to wander when the primary task does not require executive control. Furthermore, when mind wandering occurs, the ability to perform complex working-memory tasks is often impaired. Second, in tasks such as reading and encoding, our ability to represent task-relevant stimuli is impaired during mind wandering. This provides evidence that mind wandering is a state of decoupled information processing, which occurs because of a shift in attention away from the immediate environment. Finally, we speculate that mind wandering involves both the redirection of executive control and a failure of goal-oriented processing toward the primary task. In mind wandering, it seems that the automatic activation of a pertinent personal goal temporarily overshadows the more immediate goal of task completion. Such goal switching may be enabled by the tendency for experience to become decoupled from meta-awareness, such that individuals temporarily fail to notice that their task-related processing has been hijacked by a more personally relevant goal.

Two questions emerge regarding the relation between executive control and mind wandering. The first question concerns the advantages that we derive from mind wandering. Klinger (1999) suggested that one advantage to mind wandering is that it could foster creative problem solving. Similarly, Singer (1966) argued that processes associated with fantasy, particularly in early life, facilitate the development of problem-solving skills. In this article, we have argued that mind wandering may be a mode of problem solving. In particular, we have suggested that mind wandering is a situation when controlled processing becomes hijacked in the service of a goal reflecting our current concerns. If this is correct, then this process is linked to the pursuit of ideas or problems that have, so far, eluded solution. Considered in this light, mind wandering may share important similarities with incubation processes related to creativity. Accordingly, the experience of sudden "eureka" or "ah-ha" moments (Schooler, Fallshore, & Fiore, 1995), which apparently occur out of the blue, may sometimes occur because mind wandering addresses more remote goals (e.g., discerning the solution to a heretofore unsolved problem). In the future, research on mind wandering could be informed through use of frameworks that have been successfully developed for the study of creativity.

A second outstanding question that emerges from consideration of the relation between executive control and mind wandering is the specific relation between task load and mind wandering. Much of the research on mind wandering has been influenced by a simple limited-capacity account of cognition. However, it is clear from this review that mind wandering requires at least two components of cognitive processing: (a) a control process that coordinates information within awareness and (b) a decoupling process that allows cognitive resources to become captured by internal rather than external information. Schooler (2002) has suggested that for individuals to catch their minds wandering requires a self-monitoring process that detects periods when idle cognitive resources become directed to off-task material. When task demands are low, idle cognitive processes are available for redirection to an individual's current concerns, thus facilitating the experience of mind wandering; however, sufficient resources are also available to monitor task awareness in a satisfactory manner. This could account for the sense of focus brought about by simple information-processing states such as meditation. When task demands are high, idle processes are reduced, preventing both the mind's tendency to wander and the monitoring process from operating. In the case of highly demanding tasks, however, the absence of self-monitoring is nondetrimental because too few resources are available to support mind wandering. At a moderate level of task demands, however, the competition for resources will be greatest. In these circumstances, the individual may spend a significant period of time off task because too few resources are available for self-monitoring. If executive control and mind wandering are linked, as the evidence in this article suggests, we might expect the relation between task load and mind wandering to reflect this competitive process.

Although mind wandering has largely been relegated to the backwaters of mainstream psychology, our review of the literature has demonstrated that the phenomenon readily lends itself to empirical investigation and directly maps onto a simple model of executive control. Moreover, the evidence suggests that mind wandering may be one of the most ubiquitous and pervasive of all cognitive phenomena. Across a diverse variety of tasks, verbal reports have indicated that between 15% and 50% of a participant's time is spent mind wandering (15% fluency and encoding, Smallwood, Obonsawin, & Heim, 2003; 20% reading, Schooler, Reichle, & Halpern, 2005; and 50% simple signal detection, Antrobus, 1968; Giambra, 1995; Smallwood, O'Connor, et al., 2004). These ratings from laboratory tasks may be higher than those recorded in day-to-day living, as a result of the lack of stimulation that occurs in controlled experimental settings (Klinger & Cox, 1987). The frequency of mind wandering, even in demanding cognitive tasks such as encoding and reading, suggests that every laboratory study is at least partially a study of mind wandering. It seems that, in almost any cognitive task, mind wandering inevitably accounts for a substantial proportion of an individual's time. As psychologists, we must confront this phenomenon directly, recognizing the importance of mind wandering as a psychological phenomenon.

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