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Distinguishing How From Why the Mind Wanders: A Process–Occurrence Framework for Self-Generated Mental Activity

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Cognition can unfold with little regard to the events taking place in the environment, and such self-generated mental activity poses a specific set of challenges for its scientific analysis in both cognitive science and neuroscience. One problem is that the spontaneous onset of self-generated mental activity makes it hard to distinguish the events that *control the occurrence of the experience* from those *processes that ensure the continuity of an internal train of thought once initiated*. This review demonstrates that a distinction between process and occurrence (a) provides theoretical clarity that has been absent from current discussions of self-generated mental activity, (b) affords conceptual leverage on seemingly disparate results associating the state with both domain-general processes and task error, and (c) draws attention to important questions for understanding unconstrained thought in contexts such as psychopathology and education. It is suggested that identifying the moment that self-generated mental events begin is a necessary next step in moving toward a testable account of why the mind has evolved to neglect the present in favor of ruminations on the past or imaginary musings of what may yet come to pass.

Keywords: task-based and resting-state fMRI, mind wandering, daydreaming, self-generated thought, perceptual decoupling

Understanding cognition that is loosely related to current environmental input has become an important question in the fields of both psychology and neuroscience (Raichle et al., 2001; Smallwood & Schooler, 2006). The psychological states of daydreaming and mind wandering are examples of a class of cognition in which self-generated thoughts and feelings arise independently of the concurrent perceptual input and any external task being performed (known as stimulus-independent or task-unrelated thought). Experience-sampling studies suggest that these experiences occupy approximately half of waking thought (Killingsworth & Gilbert, 2010). In the domain of neuroscience, it is known that when individuals are at rest and are given no explicit task, continuous changes in neural activity occur in all of the neural systems that can be evoked by a task (Biswal, Yetkin, Haughton, & Hyde, 1995; E. E. Smith & Jonides, 2009), some of which are probably linked to spontaneous conscious thought (Andrews-Hanna, 2012). Therefore, research in both cognitive science and neuroscience has converged on the assumption that an important feature of the mind is self-generated cognitive activity that is minimally constrained by external perception.

The phenomenon of unconstrained self-generated mental activity raises at least two questions that a scientific account of the mind could address. First, science could ask, *Why* does the mind spend so much of its time generating cognition that is unrelated to ongoing perception? To understand *why the mind spends time decoupled from external input and engaged in self-generated mental activity* requires an explanation of at least three processes: (a) the events that trigger the onset of cognition that are independent of current perceptual information, (b) the value that is attached to this class of experience, and (c) how successful individuals are in regulating this aspect of their mental lives (e.g., by reducing its occurrence if they wish to do so). In general terms, the question of *why the mind wanders* is concerned with understanding the processes that directly influence the occurrence of episodes of unconstrained self-generated thought.

A second question that science could ask is, *How* is the mind able to support cognition whose content is unrelated to immediate perceptual input? This question requires the identification of the cognitive processes that allow an internally generated thought fragment to be transformed into a detailed internal train of thought and for this thought fragment to persist against external distraction. Processes that influence the integrity of self-generated thought are, therefore, those processes that ensure continuity within an internal train of thought once initiated. These are likely to include (a) buffering and enriching cognition so that internal thought forms a detailed and connected sequence and (b) reducing the distracting influence of external information that could otherwise disrupt the internal train of thought. Some of these processes may serve functions that are unique to self-generated thought, while others could be engaged by both internal and external trains of thought.

Aims of Review

This article argues that one source of confusion in scientific attempts to understand self-generated mental activity is a failure of current theories to explicitly address whether they are attempting to understand the *occurrence* of self-generated activity or the *processes* that ensue once the experience has been initiated and that act to ensure the continuity of mental content independent of

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its surroundings. To establish the theoretical validity of this claim, this article demonstrates that the distinction between process and occurrence (a) differentiates between four of the dominant psychological hypotheses on the cognitive processes engaged when the mind wanders, (b) provides conceptual leverage on experimental data on the role of domain-general processes in the mind-wandering state, and (c) resolves the paradoxical relationship between the experience of mind wandering and errors in a concurrent task. Next, this review considers the implications of this *process–occurrence* framework for two domains of applied research: education and psychopathology. Finally, by distinguishing between process and occurrence, this review presents suggestions on how to focus future research on the need to detect the onset of the experience. At present, our inability to covertly detect the onset of self-generated mental activity is *the* central barrier to addressing the fundamental question raised by the phenomenon at both the theoretical and applied level: *Why does the mind spend so much of its time engaged in cognitions unrelated to external perceptual input?*

Before considering the specific questions that the distinction between process and occurrence raise for unconstrained mental activity, it is necessary to build a working hypothesis regarding what must be explained. Studies using a variety of different psychophysiological measures have documented that within a single individual, the effectiveness of external attention fluctuates during task performance (and in daily life) and that periods when external information is neglected are accompanied by a statistically greater likelihood for reports of self-generated internally focused thought (for recent reviews, see Schooler et al., 2011; Smallwood, 2011b).

Figure 1 provides a schematized account of this ebb and flow in the focus of attention. In this figure, each panel reflects a schematic of how the focus of attention may evolve over time during a given context. The intensity of shading represents the coupling of attention to the external environment at each moment in time. Lighter shading indicates periods when attention is strongly coupled to perceptual information and mental events occur in response to stimuli in the external environment; darker shading indicates that attention is decoupled from perception and that self-generated mental activity forms the basis of cognition. Figure 1A represents a situation where a greater amount of time is spent engaged in externally focused thought with a few brief periods of internal focus, while Figure 1B represents a situation in which attention spends more time focused on internal processes, rather than being evoked by external events.

It is clear from Figure 1 that the ebb and flow in the coupling of attention to perception have at least two features: (a) periods when attention switches from the external to the internal (and vice versa) and (b) periods when attention is sustained in one or the other state. Operating together, these two different features lead to the emergence of a reliable sequence of internal and external mental states that can be seen in Figure 2. In this figure, the focus of attention is depicted by the dashed white line, and at least under certain conditions, the trajectory of this line is what we mean when we use the term *mind wandering.*[1] Viewed from this perspective, any comprehensive account of externally generated and self-generated experience requires that two basic questions are addressed: (a) *What events control the occurrence of mental shifts between states of internal and internal focus?* (b) *What processes sustain the current focus of attention (either internal or external) over time?*

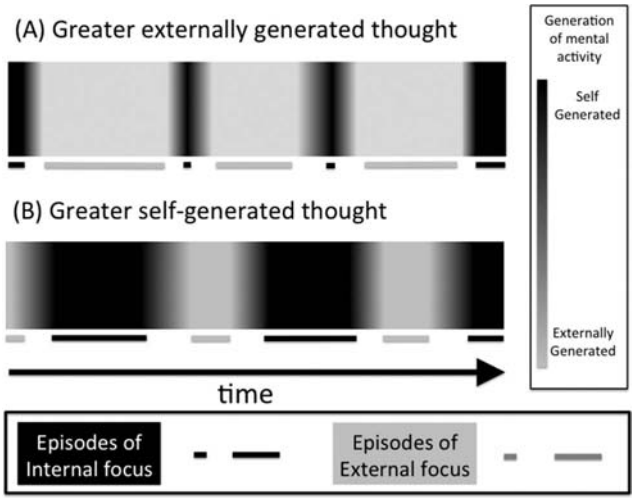

Figure 1. Schematic representation of the temporal ebb and flow between internal and external states that characterizes the mind-wandering state. In Panels A and B, the depth of shading in the figure represents the focus of attention at different times during a task. The dark bands correspond to periods of internal focus, whereas the white bands correspond to periods of external focus. The discrete moments of internal and external focus are indicated by the solid black and gray lines below each panel. In Panel A, the proportion of black to light bands is lower than in Panel B, indicating a situation with more frequent episodes of internal thought. These episodes of internal and external thought can also vary in duration, as is indicated by the different lengths of the solid lines. This figure illustrates the working hypotheses that scientific studies of mind wandering can consider: (a) What events control the occurrence of mental shifts between states of internal and internal focus? (b) What processes sustain the current focus of attention (either internal or external) over time?

As mind wandering can be considered a specific example of a more general process by which attention shifts between internal and external experiences, these questions are also important in understanding how and why the mind wanders. The next section of this review considers how empirical difficulties in our ability to measure self-generated mental activity have limited our capacity to distinguish between these basic elements of the mind-wandering state.

Distinguishing Between Process and Occurrence in Self-Generated Mental Activity

The spontaneous occurrence of self-generated mental activity is at the heart of the theoretical value of the phenomenon as a tool for understanding the mind (Christoff, 2012; Christoff, Cosmelli, Legrand, & Thompson, 2011; Schooler et al., 2011). For example, understanding how consciousness is generated may depend upon disentangling stimulus-related from stimulus-independent brain states (Crick, 1996; Crick & Koch, 1992, 1998, 2003), and states of self-generated thought provide a paradigm in which truly

[1] Note that although this review focuses on the notion that attention switches between discrete internal and external states, this does not rule out the possibility that there are, in fact, a series of graded changes between internal and external focus (such as in a state of dual tasking).

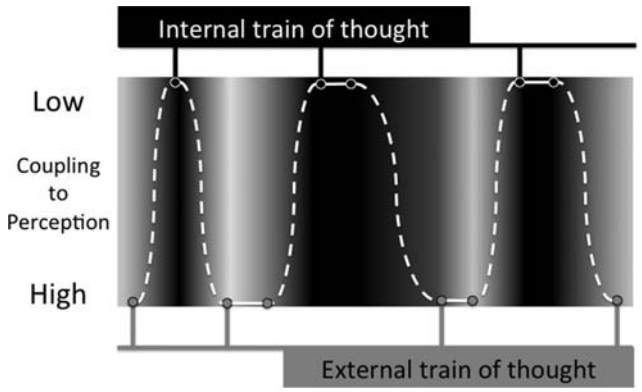

Figure 2. A schematic demonstration of how the sequence of internally and externally focused conscious experiences that makes up daily life can be seen as an emergent property of periods of internal and external focus. Note these transitions could be either discrete or gradual.

stimulus-independent features of consciousness can be understood (Smallwood, 2011c). At the same time, the lack of direct experimental control over self-generated thought provides a specific experimental hurdle that makes it difficult to integrate empirical data on mind wandering into the existing models of cognitive science (e.g., McVay & Kane, 2010; Smallwood, 2010), as well as neuroscience (e.g., Morcom & Fletcher, 2007). This review demonstrates that the absence of a clear indication of when self-generated mental activity begins makes it hard to distinguish the event that caused self-generated activity to start from those processes that ensure the continuity of the experience once initiated.

Understanding why a mental process occurs is usually achieved by isolating a causal chain linking the phenomenon in question to a preceding event, often referred to as the *imperative stimulus*. For example, when participants process a rapid stream of visual stimuli, detecting a target makes it statistically more likely that a subsequent target will be missed, a phenomenon known as the *attentional blink* (Raymond, Shapiro, & Arnell, 1992). It is now generally accepted that this blink occurs because of attentional commitment to the earlier target (Olivers & Meeter, 2008). By contrast, identifying how the mind supports a particular cognitive act is often determined through the logic of subtraction: Different psychological processes are compared with reference to an objective measure (such as response time, task accuracy, or blood-oxygen-level-dependent [BOLD] activity recorded during functional magnetic resonance imaging [fMRI]). For example, neuroimaging studies use this logic of subtraction to demonstrate that when information is retained in working memory, greater BOLD activity is observed in regions of the lateral prefrontal cortex (PFC). Such results implicate neural signals in lateral prefrontal regions in the process of working memory (e.g., E. E. Smith & Jonides, 1999).

The capacity to distinguish between cause and effect in a standard experiment is summarized schematically in Figure 3A. In this figure, the stars at the foot of the panel indicate the imperative stimulus that triggers the onset of a mental event. This leads to the engagement of a cognitive process (indicated by the white line) that can be subsequently measured, as indicated by the downward-facing arrow on the top of this panel. In this case, because the experimenter knows about the imperative event, he or she can clearly distinguish the processes of cause from those of effect.

When mind wandering is measured in the laboratory or in daily life, the experimenter simply measures the occurrence of the experience (for a review, see Smallwood & Schooler, 2006). In this case, we cannot know when the event began, and so, the measurement cannot be cleanly separated into an imperative stimulus and a subsequent process, as is the case in the aforementioned task-based approach. This uncertainty arises because there are several potential moments of onset that could have led to the thought that was captured by an experience-sampling probe, and these are indicated by the gray and black stars at the foot of Figure 3B. Without a clear idea about the onset of the mind-wandering

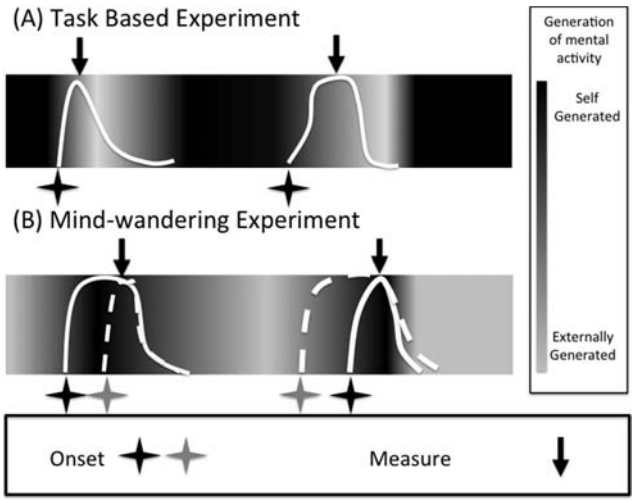

Figure 3. Schematic representation of the relation between the onset of a mental process and the subsequent engagement of cognitive processes in both a standard task-driven experiment (Panel A) and a study of mind wandering (Panel B). A: In a standard task-based experiment, the experimenter provides an imperative stimulus that can be considered the onset or cause (marked as a star) leading to the subsequent engagement of a process that can be sampled using a variety of different methods (indicated by the downward-facing arrows). In this context, the onset of the event is known to the experimenter, and so, the event that leads to the engagement of mental event and the subsequent psychological process that occur can be separated. B: In a study of mind wandering, the experimenter does not directly trigger the mental event and instead samples the event sometime after it has been initiated. This means that the data that the experimenter collects using experience sampling may contain information that (a) corresponds to an event that led to the initiation of the mind-wandering episode (this would be more likely if the event was actually triggered by the gray star) or (b) could also provide information on processes that are engaged to ensure the continuity of the train of thought (this would be more likely if the event was actually triggered by the black star). Simply detecting that self-generated thought is taking place using experience sampling (e.g., participants report an internal train of thought at the arrow) does not distinguish between these two situations. One implication of this is that experience sampling alone cannot distinguish whether the self-generated thought occurred some time ago (e.g., lower panel left) or was generated more recently (e.g., lower panel on the right). It also means that experience sampling cannot separate the frequency from duration of a given episode of self-generated thought. Thus, our current inability to characterize the onset of the mind-wandering state means that special care must be taken when interpreting data generated by experience sampling.

episode, it is difficult to separate those processes that acted as the imperative event, or the cause of the episode, from processes that are concerned with how these thoughts are sustained in attention over time.

In the field of neuroimaging, the analytic strategy employed in task-based fMRI exploits the onset of external events to understand the psychological correlates of neural activity in different regions. By contrast, resting-state analysis records brain activity while participants perform no task in order to understand the functional connectivity of spatially separate brain regions (Biswal et al., 1995). Although initial approaches to understanding resting-state data assumed that it simply reflected the architecture of the mind, recent work has documented that the data are sensitive to psychological changes, such as mood (Harrison et al., 2008), and to the content of thought (Preminger, Harmelech, & Malach, 2011); at least certain elements of the data derived from resting-state analysis must, therefore, reflect the psychological processes that the individual engages when the mind is not constrained by an external task (Andrews-Hanna, 2012). However, a key distinction between the neural responses that are observed in task-based fMRI and those observed in the resting state is that, in the former, the *cause* of the neural activity is apparent, while, in the latter, it is not. Thus, just as the imperative event is unknown in studies of mind wandering, the resting-state method of analysis provides no information on what event caused self-generated mental activity to take place. This inability to characterize the onset of self-generated mental activity is one reason why its interpretation is an area of debate in the field of cognitive neuroscience (Buckner & Carroll, 2007; Buckner & Vincent, 2007; Kelly, Biswal, Craddock, Castellanos, & Milham, 2012; Morcom & Fletcher, 2007).

It is clear, therefore, that when self-generated mental activity is investigated in both cognitive science and neuroscience, the researcher is unable to identify the moment of onset for the experience. Special care, therefore, must be taken when considering whether data should be interpreted as evidence for why the thought occurred or in terms of processes that take place once a train of thought has been initiated (or a combination of both).[2] For example, the inability to determine the moment when a self-generated mental event began has a bearing on the terminology that should be employed when discussing the data produced by experience-sampling methods. It is clear from Figure 1 that periods of thought can vary on at least two parameters: the number of times attention shifts from the external to the internal (known as *frequency*) and the length of time spent in a given state (known as *duration*). However, without the capacity to determine when the episode began and ended, it is impossible to distinguish between frequency and duration of mind-wandering episodes. For example, as long as the frequency of experience-sampling probes is kept relatively low, an individual who reports mind wandering at a large proportion of probes could experience either a large number of short episodes (some which are never caught at a probe) or a small number of longer episodes (most of which are caught by a probe). Thus, in the absence of knowledge of when an episode of self-generated mental activity began, the correct way to describe the data produced in an experience-sampling experiment is that they provide an estimation of the *amount of time* spent in a state of self-generated thought, not the frequency or number of episodes, as has been commonly done in the past (see, e.g., Smallwood & Schooler, 2006). The amount of *time spent* engaged in self-generated thought corresponds to the amount of darker shading in each panel in Figure 1.

The current article proposes that processes that influence the occurrence of externally and self-generated experience and those that aid the continuity of thought operate in tandem to determine the content of thought at any given moment. Although this review argues that the two different influences serve distinct functions, they can interact and so influence each other indirectly. For example, controlling the occurrence of self-generated thought could influence the continuity of the experience, for example, by the motivated termination of a self-generated experience and reinstating a focus on perception. This influence is indirect because instantiating a different type of thought is not a solution to the specific information-processing problems associated with allowing thought to persist in lieu of perceptual input. Likewise, problems in the capacity to sustain and buffer thought can also exert an indirect influence on the occurrence of externally and self-generated mental content because failures to coordinate, buffer, or insulate experience will lead to an early termination of self-generated experience and, so, a more rapid return to a perceptual focus.

Four Hypotheses on the Cognitive Basis of the Mind-Wandering State

Having documented the consequences of our inability to determine the onset of self-generated mental activity, this section explores the viability of the process–occurrence framework as a tool for providing conceptual leverage on different psychological hypotheses regarding self-generated mental activity. This is examined with respect to four cognitive hypotheses that assess the psychological basis of mind wandering: the current concerns hypothesis, the decoupling hypothesis, the executive failure hypothesis, and the meta-awareness hypothesis.

The Current Concerns Hypothesis

One of the earliest formulations for mind wandering was the current concerns hypothesis (Klinger, Gregoire, & Barta, 1973). This argues that the experience of mind wandering occurs because the individual has goals, wishes, and desires that extend beyond the perceptual moment. The current concerns hypothesis assumes that mental life is drawn to the most salient experiences, and so, whenever there is a dearth of salient external events, self-generated thought will form the focus of the mental experience of the individual. In a situation where the environment is full of salient perceptual information (such as when engaged in a stimulating social interaction or watching an absorbing film), external events draw attention to perception. In circumstances

[2] Neither do current methods afford the identification of the moment that a given mind-wandering episode ends. Participants may forget to indicate that they had mind-wandered or may not even notice that they had temporarily lost track of what they were doing. The inability to characterize the termination of a mind-wandering episode makes it difficult to develop reliable empirical data on the circumstances that afford the spontaneous redirection of attention back to the task at hand. Without the capacity to know when an internal train of thought ended, it is difficult to identify how mind-wandering episodes are regulated by the individual—an important question given the potential problems that too much mind wandering can cause in daily life (see Schooler et al., 2011, for a discussion).

when the internal system has greater salience, attention focuses on self-generated material. In simple terms, therefore, the current concerns hypothesis argues that mind wandering occurs more frequently when self-generated thought has higher incentive value than incoming perceptual information.

Many different models of mind wandering assume that automatic processing of current concerns produces the content of the internal train of thought. For example, one formulation proposes that current concerns provide the impetus to engage in mind wandering and that these experiences are supported by domain-general processes, a Control × Concerns hypothesis (Smallwood & Schooler, 2006, p. 953). More recently, it was suggested that pressing current concerns cause the executive control of task-relevant information to fail, leading the mind to wander, a Control Failure × Concern hypothesis (McVay & Kane, 2010, p. 194).

The Decoupling Hypothesis

This view assumes that certain classes of mental processes are common to self-generated and externally maintained trains of thought (Antrobus, Singer, Goldstein, & Fortgang, 1970; Smallwood, Baracaia, Lowe, & Obonsawin, 2003; Smallwood & Schooler, 2006; Teasdale et al., 1995). Many different models argue that cognition can depend on shared processes, such as the working memory model (Baddeley, 1992), and formulations of consciousness, such as the global neuronal workspace model (Baars, Ramsoy, & Laureys, 2003; Dehaene & Changeux, 2011); the decoupling hypothesis simply extends this assumption to the internal/external dimension. Mental processes are described as *decoupled* when the onset of their activity is not directly related to an external event.

Based on the decoupling hypothesis, the most likely mental processes that can serve overlapping functions during self- and externally generated thought are those that are domain general in nature because these are already known to operate on multiple modalities. For example, it has been suggested that the process of executive control can aid the continuity of self-generated thought in much the same way as would happen if cognition was directed by an external task (Smallwood, Fishman, & Schooler, 2007).[3] Generally, the process of executive control reflects "the capability to prevent attentional focus from being captured by mental or environmental distractors, and thus drawn away from the actively maintained target information" (Kane & Engle, 2002, p. 638). According to the decoupling hypothesis, processes such as executive control *do not* directly control the occurrence of self-generated thought (Smallwood & Schooler, 2006, p. 946) but instead are engaged once this information becomes the target of attention and act to ensure the continuity of an internal train of thought (Smallwood, Brown, Baird, & Schooler, 2012).

More generally, evidence from neuroscience indicates that all of the known task-related systems can exhibit neural activation in lieu of an external stimulus (S. M. Smith et al., 2009). Such evidence suggests that many different regions of cortex could participate in ensuring continuity of, as well as embellishing, self-generated mental activity. For example, visual imagery is defined as a brain state similar to those that arise during perception without the perceptual stimulus (Kosslyn, 1988), and neuroimaging suggests that two thirds of the neural systems that are engaged in visual perception are also engaged in visual imagery (Kosslyn, Thompson, & Alpert, 1997).

The assumptions of the decoupling hypothesis are presented schematically in Figure 4A. The boxes at the top and bottom of the figure represent domain-specific processes of an internal (e.g., memory) and external nature (e.g., perception). Domain-general processes, which are represented by the hatched box in the middle, coordinate both internal and external forms of thought, and this is represented by the symmetrical influence of this system (black arrows) and the input of domain-specific information (gray arrows) from both internal and external sources.

The Executive Failure Hypothesis

A recent account of mind wandering is the executive failure hypothesis (McVay & Kane, 2009, 2010, 2012), which proposes that sustained external attention requires that executive control reduce distractions of both an internal and perceptual nature. In this framework, mind-wandering-associated mental content is viewed as a form of distraction, and so when the attention control system fails, task-irrelevant internally generated information flourishes and mind wandering can ensue.

Figure 4B represents a schematic representation of the assumptions of the executive failure hypothesis. Unlike the decoupling hypothesis, the executive failure view *does not* assume that domain-general processes ensure the continuity of internal thought but instead proposes that task-unrelated thought is maintained in a *resource-free manner* (McVay & Kane, 2010). This absence of domain-general processes in internal thought is schematically represented in Figure 4B by the absence of upward white arrows.

The Meta-Awareness Hypothesis

A fourth process that has been hypothesized to be important for mind wandering is a metarepresentation of awareness that functions to correct conscious experiences whenever it gets absorbed by the wrong process (Schooler, 2002). Unlike the aforementioned viewpoints, the meta-awareness hypothesis postulates that the capacity to re-represent the current contents of consciousness allows the individual the chance to identify conscious thoughts that deviate from the desired goal state. In an early theoretical formulation of mind wandering, a breakdown in meta-awareness allowed attention to be decoupled from perception and so facilitated self-generated thought (Smallwood & Schooler, 2006). More generally, the capacity to reinstate meta-awareness could help the individual regulate the amount of time he or she spends mind wandering (for further discussion, see Schooler et al., 2011). Meta-awareness, or, more specifically, an absence thereof, can be seen as a factor that influences the likelihood that mind wandering will occur.

A schematic representation of how meta-awareness could regulate the amount of time spent mind wandering is presented in Figure 4C. In this panel, domain-specific information competes with access to a domain-general system (the hatched box in the

[3] It is important to note that this is not simply an act of changing the goalposts (McVay & Kane, 2012, p. 315); instead, it reflects the fact that active cognitive processes are involved in ensuring the integrity and continuity of an internally generated train of thought and that these must be explained by a comprehensive theory.

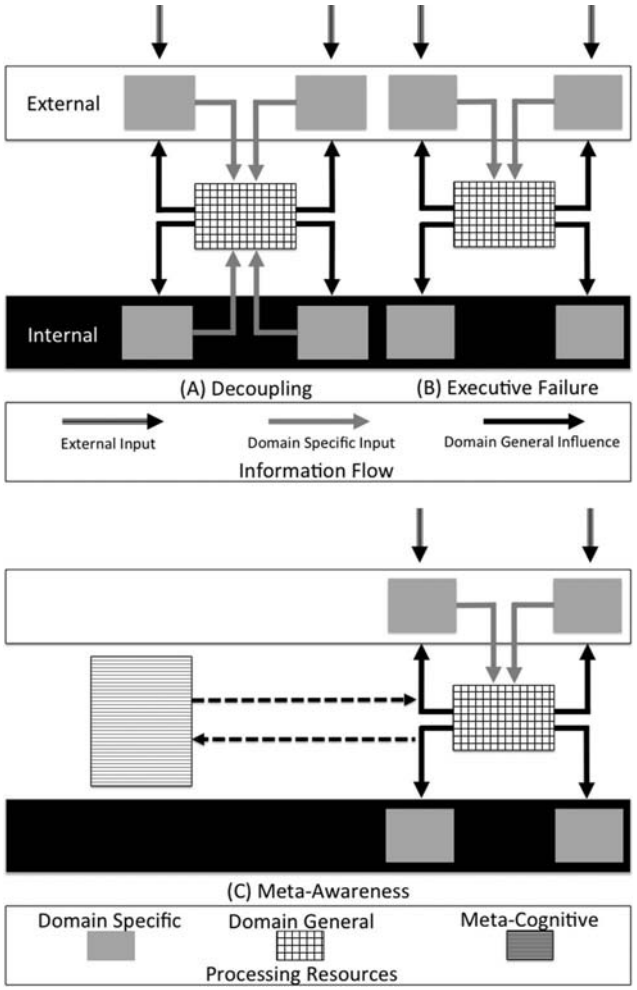

Figure 4. Comparison of three different hypotheses for the mind-wandering state. In this figure, the upper and lower gray-colored boxes reflect domain-specific systems concerned with the processing of external and internal information. The black box in the center of the figure reflects a domain-general process of attentional control. A: *The decoupling hypothesis.* According to the decoupling hypothesis, the continuity and integrity of self-generated thought are achieved by domain-general processes that serve the same functions in both internal and external trains of thought. A possible architecture that supports this hypothesis is presented in which the domain-general processes (indicated by the black box in the center) have reciprocal output (black lines) and input (gray lines) that connect to both perceptual and memorial systems. B: *The executive failure hypothesis.* According to the executive failure hypothesis, mind wandering occurs when a system that controls attentional constraint fails. An architecture that could support this hypothesis is presented in this panel. In this view, attentional control exerts influence on both the internal and external domain-specific processes. Unlike the decoupling hypothesis, the executive failure hypothesis assumes that domain-general processes of control do not receive input from internal sources. In this view an internal train of thought is produced in a resource-free manner. C: *The meta awareness hypothesis.* According to the meta-awareness hypothesis, mind wandering occurs because the contents of consciousness are only monitored intermittently. A hypothetical architecture that could support this hypothesis is presented in this panel. In this view, conscious thought occurs when domain-specific information is represented by the domain-general processes, while this is monitored at the metalevel by an additional metacognitive system.

middle). Critically, this domain-general content can be re-represented at a higher or metalevel (the striped box at the side), which allows for the explicit correction of undesired conscious states. The capacity for metalevel representations to coordinate conscious states is schematically displayed by the connections between this system and the domain-general systems; these lines are dashed to represent the intermittent nature of the metarepresentations of mental content.

Differentiating Between How and Why Mind Wandering Occurs Can Discriminate Between Different Hypotheses of the Cognitive Processes Engaged During Self-Generated Thought

The process–occurrence framework allows for a meaningful dissociation between the four hypotheses offered as explanations for mind wandering. The current concerns hypothesis argues that the experience of mind wandering is motivated because of a bias toward the personal relevance of internally represented information, thus exploiting salience, or the incentive value of one's current concerns, as an explanation for the occurrence of mind-wandering: *According to the current concerns hypothesis, attention will be most likely to shift to self-generated material when such information offers larger incentive value than does the information in the external environment*. The executive failure hypothesis also makes a prediction regarding the occurrence of mind wandering; a failure in attentional control of external task-relevant material allows the mind to shift from the current goal: *According to the executive failure viewpoint, attention is likely to shift to self-generated information when executive control of external task-relevant information has lapsed.* Finally, the meta-awareness hypothesis suggests that mind wandering occurs in periods when the contents of consciousness are not being re-represented, while meta-awareness of consciousness is reinstated when the episode of mind wandering ends (see Schooler et al., 2011): *According to the meta-awareness hypothesis, attentional shifts between self-generated and external material occur when consciousness is not being re-represented in meta-consciousness*. Although each of these hypotheses targets a different mechanism, each offers an explanation for the occurrence of the mind-wandering state.

By contrast, the decoupling hypothesis argues that certain elements of self-generated and externally generated thought can depend upon a set of shared information-processing resources. For example, the decoupling hypothesis proposes that the same domain-general processes that support external thought are engaged *as a consequence of the initiation of mind wandering* and are necessary for ensuring continuity and integrity of a stream of thought unrelated to current environmental input (Smallwood, Brown, Baird, & Schooler, 2012): *Continued attention on self-generated material depends upon the processes that aid the integrity of a train of thought*. In this context, the extent that attention is decoupled after internal thought has been initiated would determine the level of detail, or the duration, of an internal train of thought, but it could not influence the onset as this would have already have taken place. Unlike the other approaches, therefore, the decoupling hypothesis is an explanation for *the continuity of*

self-generated thought rather than a proposal for *why the episode began or is subsequently regulated*.[4]

The process–occurrence distinction, therefore, allows clarity regarding which elements of mind wandering the different theoretical frameworks are aimed at explaining (summarized in Table 1). One important implication of this analysis is that it allows for a consideration of how the different theories can be reconciled. For example, based on the current framework, it is not possible to make generalizations regarding the variables that impact upon the occurrence of the experience of self-generated mental activity based on those related to the process that are engaged when the episode is generated (or vice versa). For example, it has been suggested that the decoupling and executive failure views offer alternative explanations for the experience of mind wandering (McVay & Kane, 2009, 2010; McVay, Kane, & Kwapil, 2009). By making the distinction between process and occurrence explicit, it is clear that the claim that "mind wandering requires the coordination of information using resources under executive control" (Smallwood & Schooler, 2006, p. 949) would not be *falsified* by the observation that people with more resources do not mind-wander more frequently (McVay & Kane, 2009); the former is a prediction on processes relating to the continuity of the internal train of thought, while the later statement relates to the occurrence of the experience.[5] In other words, the process–occurrence framework suggests that the executive failure hypothesis and the decoupling hypothesis *are not* competing explanations because they offer accounts of how executive control can influence different features of the mind-wandering state. The executive failure account specifies how executive control aids continuity of an externally guided train of thought, while the decoupling hypothesis explains how the same control system can perpetuate a self-generated train of thought.

The process–occurrence framework also makes it possible to highlight theories that may offer different explanations for the same elements of the mind-wandering state. For example, according to the executive failure view, mind wandering occurs when the proactive control of information in attention fails (McVay & Kane, 2010). By contrast, the meta-awareness hypothesis argues that mind wandering occurs due to intermittent lapses in a metacognitive re-representation of the desired goal state. As the processes of metacognition are thought to be mediated by the anterior medial PFC (Miele, Wager, Mitchell, & Metcalfe, 2011), whereas proactive cognition recruits lateral areas of the PFC (Braver, 2012), the executive failure and meta-awareness hypotheses make differential predictions for what processes must lapse before mind wandering occurs. Neuroimaging studies that contrast meta-awareness and executive failure accounts of mind wandering could help understand whether these views offer competing or complementary perspectives for the occurrence of mind wandering.

Having demonstrated the value of the process–occurrence framework in helping distinguish between different theories, the next two sections of this article demonstrate that the distinction is also useful in integrating the empirical evidence from studies of mind wandering in two related areas: the role of domain-general processing and the relationship to error. A subsequent section explores its applications for research in applied domains.

Domain-General Processes and the Wandering Mind

Many different disciplines of cognitive science assume that certain mental processes have the capacity to perform general computations that are known as *domain general*. For example, in language research, a domain-general system is assumed to be responsible for the universal use of syntax in all known human languages (e.g., Chomsky, 1964; Pinker, 1979). Consciousness researchers suggest that domain-general processes are an explanation for the linear nature of conscious thought (e.g., Baars et al., 2003). In cognitive science, domain-general processes are offered as an explanation for diverse phenomena such as dual-task competition (e.g., Baddeley, 1992) or logic (Johnson-Laird, 1981). Domain-general processes, therefore, are a construct used to explain why different content can be processed by the mind using a smaller set of underlying processes. Given that self-generated thought occupies almost half of daily life (Killingsworth & Gilbert, 2010), domain-general processes could be involved in the coordination of at least some mind-wandering episodes.

One stumbling block in incorporating self-generated thought into cognitive science rests on a debate regarding how domain-general processes coordinate the experience. According to the decoupling hypothesis, domain-general processes are engaged during the mind-wandering state to ensure the integrity and continuity of mental processes that do not arise through perception (e.g., Smallwood, Brown, Baird, & Schooler, 2012; Smallwood, Brown et al., 2011; Smallwood & Schooler, 2006; Smallwood et al., 2003). This is based on the assumption that the capacity for continuity in self-generated thought, similar to most other complex mental operations, depends on reducing the interference of information that would otherwise derail the train of thought, that is, a process of buffering and distraction reduction usually attributed to domain-general executive control (e.g., Kane & Engle, 2002).

Alternatively, it has been argued that domain-general processes primarily function to maintain attention on task and that their failure, coupled with the presence of pressing current concerns, leads to mind wandering (e.g., McVay & Kane, 2009). This has led to a discussion within the literature on how to incorporate mind wandering into models of cognitive science (McVay & Kane, 2009, 2010, 2012; Smallwood, 2010; Smallwood & Schooler, 2006). Parallel discussions have also taken place in the domain of neuroscience regarding whether brain systems concerned with executive control (such as the dorsolateral PFC [dLPFC]) are fundamentally anticorrelated with elements thought to be involved in the generation of self-referential or episodic thought (e.g., the medial PFC [mPFC]; Fox & Raichle, 2007; Spreng, Stevens,

[4] The fact that the decoupling hypothesis is the only theory covered in this article concerned with ensuring the continuity of the mind-wandering state, while the other theoretical approaches provide explanations for the occurrence of the state, simply reflects the fact that the question of *why* mind wandering occurs is a broader question than *how* it manifests in the waking brain.

[5] It is of course the case that if a domain-general process is involved in supporting the mind-wandering state, greater capacity in this process would allow the individual to spend more time engaged in mind wandering. This, however, is an indirect mechanism for an increase in the amount of time spent in mind wandering because the existence of a capacity to support mind wandering is a necessary rather than sufficient reason for the experience to occur at any given moment.

Table 1
A Summary of Four Different Hypotheses Offered as an Explanation for Mind Wandering

Hypothesis	Focus	Mechanism	Dependent measure
Current concerns	Occurrence of internal thought	Attention is drawn to information with the greatest incentive value	Frequency of onset of self-generated thought
Decoupling	Continuity of internal thought	Processes that support the transformation of a thought fragment into an internal train of thought	Continuity of self-generated thought
Executive failure	Occurrence of internal thought	Failure in attentional control leads to a sensitivity to distraction, and mind wandering can ensue	Frequency of onset of self-generated thought
Meta-awareness	Occurrence and regulation of internal thought	Monitoring processes intermittently evaluate the contents of consciousness to assess whether current mental contents are in line with the local goal	Frequency of onset and offset of self-generated thought

Chamberlain, Gilmore, & Schacter, 2010). The current section of this review demonstrates that in both cases, the explicit distinction between process and occurrence of self-generated thought allows the two views to be reconciled.

Evidence of Domain-General Processes in Mind Wandering

There are three main lines of evidence for why domain-general processes are involved in the mind-wandering state. One is based on the assumption that if mind wandering depends upon domain-general processes, then the experience will be facilitated when these resources are not required by a task. Consistent with this assumption, unpracticed motor tasks or tasks like random number generation with an executive control component reduce reports of mind wandering (Mason et al., 2007; Teasdale et al., 1995), and under these circumstances, self-generated cognition is less structured (Teasdale et al. 1995).

One recent observation is that mind wandering is often focused on the future; this *prospective bias* has been observed in different countries, including the United States and the United Kingdom (Smallwood, Brown, et al., 2011; Smallwood & O'Connor, 2011; Smallwood, Schooler, et al., 2011), Belgium (Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011), and China (Song, 2010). Laboratory studies have documented that the bias toward prospective thought is also reduced when performing a working memory task (Smallwood, Brown, et al., 2011; Smallwood, Nind, & O'Connor, 2009; Smallwood, Schooler, et al., 2011). Based on the logic of process competition, the fact that tasks with a working memory load reduce the time spent in the mind-wandering state suggests that the availability of domain-general processes increases the opportunity for these processes to be engaged in mind wandering. This, in turn, suggests that domain-general processes are involved in coordinating the mind-wandering state, especially when the experience entails the coordination of complex information, for example, during autobiographical planning (Smallwood, Brown, Baird, & Schooler, 2012).

A second approach to examining whether domain-general processes are involved in mind wandering is to use covert measures of information processing, provided by neuroimaging, to assess the cognitive processes that are engaged when internally generated thought ensues. In this context, studies have consistently shown that periods of mind wandering identified by experience sampling involve activity in the midline structures of the default mode network, for example, the mPFC and the posterior cingulate (Mason et al., 2007; Raichle et al., 2001), as well as in structures in the lateral PFC and dorsal ACC (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011). Recently, connectivity between the dACC and elements of the default mode network was shown to be greater during mind wandering than task-related thought (Christoff, 2012). Importantly, activation in the left inferior frontal gyrus and bilateral dLPFC activity have been observed in task-unrelated thought (Christoff et al., 2009), while the left inferior frontal gyrus was also observed during periods of stimulus-independent thought in the context of the same task (Stawarczyk, Majerus, Maj, et al., 2011). The dLPFC may implement selected top-down plans (Holroyd & Yeung, 2012), while the left inferior frontal gyrus has been implicated in the coordination of memorial information in attention, for multiple purposes, including working memory (Badre & Wagner, 2007; E. E. Smith & Jonides, 1999), as well as a large number of processes in language (Friederici, 2002). Such results provide support for the general claim that domain-general processes are shared between externally motivated and self-generated thought, perhaps coordinating language processes that underpin the inner voice that can occur during mind wandering (Smallwood et al., 2003) or ensuring the integrity of the internal train of thought through a process of inhibition and facilitation (see Smallwood, Brown, Baird, & Schooler, 2012).

If the engagement of both midline and prefrontal cortical structures are implicated in a process required for the coordination of memories, as well as sustaining an internal train of thought, it should be possible to activate these processes in a task-based setting. Recently, studies that have explicitly explored the neural correlates of autobiographical planning have documented that the same combination of midline and lateral activity in the cortex is engaged when individuals plan for the future (Gerlach, Spreng, Gilmore, & Schacter, 2011; Spreng et al., 2010). As an analysis of mind-wandering reports indicates that it is often a form of autobiographical plans (Baird, Smallwood, & Schooler, 2011; Smallwood, Nind, & O'Connor, 2009; Smallwood, Schooler, et al., 2011; Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011), the common recruitment between experimenter-cued future thinking and spontaneous mind wandering suggests that a parsimonious account for the activation of lateral cortical structures and the dACC is that it coordinates and ensures continuity within the internal stream of thought, rather than attempting to suppress internally generated thought, as has been suggested elsewhere

(McVay & Kane, 2010, p. 194). From a neuroscience perspective, evidence that the default and executive can be coactivated by the task of autobiographical planning (e.g., Spreng et al., 2010) demonstrates that these systems are not fundamentally anticorrelated at a process level. Instead, because the executive system can interact with other systems (such as perception) the anticorrelation between these systems likely reflects the relative occurrence of trains of thought in which the processes served by the default mode network are less important.

A third and final method involves the assessment of whether individual differences in domain-general capacities are predictive of the amount, or quality, of mind wandering that an individual engages in. This logic is based on the assumption that those individuals who have the greatest domain-general capacity will spend the most time mind wandering. Unlike the reasonably straightforward evidence from the studies reviewed above, the role of individual differences in mind wandering is mixed. Some studies demonstrate that when individuals with smaller working memory capacity perform demanding tasks such as sustained attention, reading, and working memory, they spend more time mind wandering (McVay & Kane, 2009; McVay et al., 2009). By contrast, during tasks without an executive or perceptual demand, studies demonstrate that attentional control either does not predict the amount of time spent mind wandering (McVay & Kane, 2012) or instead leads to more reports of task-unrelated thinking (Levinson, Smallwood, & Davidson, 2012). Finally, in tasks with low levels of demand, participants with a higher working memory tend to report the highest levels of future-directed mind wandering (Baird et al., 2011). In daily life, higher working memory capacity leads to a situational moderation of mind wandering, with individuals with a larger capacity limiting self-generated thought to situations with lower demands (Kane et al., 2007).

Differentiating Between How and Why Mind Wandering Occurs Provides a Unified View of the Role of Attentional Control in Internally Generated Thought

Of the three different methods used to examine the role of domain-general processes during mind wandering, the methods of process competition and covert measurement suggest that domain-general processes are engaged when the mind wanders. By contrast, the method of individual differences in domain-general capacities provides evidence both for (Baird et al., 2011; Levinson et al., 2012) and against this claim (McVay & Kane, 2009, 2012). This discrepancy between approaches occurs because the former methods provide a direct way of assessing the processes engaged during mind wandering but not the occurrence. For example, by denying individuals the chance to mind wander or by measuring what happens when mind wandering ensues, we gain insight into the processes engaged during the experience. However, such methods do not provide any evidence on what motivates the experience of mind wandering in the first place, that is, it is not necessarily the case that availability of working memory resources is an imperative stimulus for mind wandering to occur (see Levinson et al., 2012). Instead, domain-general processes are engaged during self-generated thought to ensure continuity of the experience. Although domain-general processes could make the self-generated thoughts last longer, they play no direct role in determining the occurrence of mind wandering.

By contrast, the inconsistent relationship between individual differences in domain-general capacity and the amount of time spent mind wandering arises because the relation is *context dependent.* In situations demanding a high degree of external attention, the tendency to mind wander will be decreased because such situations require an almost continuous perceptual train of thought and so, domain-general processes will act to sustain the continuity of externally generated thought and therefore act in opposition to mind wandering. By contrast, in situations that make only moderate demands on external attention, domain-general processes can be used to ensure the continuity of internal thought as participants let their minds wander. Indeed, a close analysis of individual differences in the role of working memory capacity in mind wandering supports this interpretation. Working memory capacity tends to inhibit mind wandering under situations that depend heavily on an undistracted perceptual focus (e.g., reading and sustained attention; McVay & Kane, 2009, 2012), while facilitating it in less demanding contexts (e.g., simple choice reaction time; Baird et al., 2011; Levinson et al., 2012). Critically, this capacity to provide similar operations across diverse domains is a hallmark of a domain-general process.

By acknowledging the distinction between process and occurrence, the evidence from studies of individual differences can be reconciled with other methods of estimating the involvement of domain-general processes in the mind-wandering experience. The process–occurrence framework leads to the following formulation of the relation between domain-general processes and mind wandering: *Because domain-general processes are involved in ensuring continuity/integrity of a train of thought, control can limit mind wandering in tasks that rely on concentrated thought if participants are motivated to do so. However, once self-generated thought is initiated and a coherent train of thought emerges or when participants are motivated to let their minds wander, domain-general processes can ensure the continuity of the experience.* Having demonstrated the value of the distinction between process and occurrence in the role of domain-general processes, the utility of this distinction in clarifying the relationship between mind wandering and performance is considered next.

Mind Wandering and Absent-Minded Error

A consistent observation in the literature on mind wandering is that when the mind generates thoughts unrelated to the task in hand, the efficient processing of external task-relevant information is reduced (for reviews, see Smallwood, 2011b; Smallwood et al., 2007; Smallwood & Schooler, 2006). Elevations in mind wandering have been implicated in poor performance in tasks including reading (Smallwood, McSpadden, & Schooler, 2008), listening to lectures (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2011), list learning (e.g., Smallwood et al., 2003), and sustained attention (McVay & Kane, 2009).

The observation of a link between self-generated thought and absent-minded error has been a source of tension in cognitive science because it is hard to explain why a common everyday experience would exist primarily to impair performance on demanding tasks. This has led to a large amount of coverage in the popular press for research on both the costs and benefits of mind

wandering (e.g., Lehrer, 2011; Zimmer, 2009). On the one hand, the capacity to perform well on a complex, demanding task is likely to depend on attentional control, supporting the assumption that the link between mind wandering and error indicates that it is an unintended lapse. On the other, the assumption that conscious thought has a limited capacity would suggest that concentrating on self-generated material requires that external information must be neglected, otherwise our capacity to sustain an internal train of thought would be compromised (Smallwood, 2010). In this later view, error is linked to self-generated information because sustaining detailed internal thought requires that perceptual input be neglected.

Mind-Wandering Error Is Linked to Poor Attentional Control

Because attentional control has a well-established role in facilitating good performance across many different domains (Posner & Rothbart, 1998, 2005, 2007), one question is whether the link between mind wandering and error can be related to variations in attentional control. Across a range of tasks (including reading and sustained attention), individuals who tend to score poorly on measures of attentional control tend to engage in more mind wandering, leading to greater absent-minded error (McVay & Kane, 2009, 2012). The observation that attentional control can influence the relationship between mind wandering and error is a primary source of evidence for the executive failure view of mind wandering.

Mind Wandering Reduces Attention to Both External Task-Relevant and Task-Irrelevant Events

In addition to evidence that individual differences moderate the link between mind wandering and error, a second line of research has examined the mechanism that links mind wandering to absent-minded lapses. The decoupling hypothesis proposes that when self-generated information becomes the target of attention, the process of perceptual decoupling acts to insulate an internal train of thought against the distracting impact of the outside world (Smallwood, Brown, et al., 2011). Although this insulation of the internal train of thought has adaptive value because it facilitates behavioral guidance by consciousness (Baumeister & Masicampo, 2010), it also ensures that self-generated information commandeers attention and so can lead to errors on a concurrent external task.

To understand the mechanism linking mind wandering to concurrent error, studies have investigated the processing of both relevant and irrelevant events in a task in order to disambiguate the mechanism by which self-generated thought leads to error. According to the executive failure hypothesis, the occurrence of mind wandering is kept in check by a process of attentional constraint that focuses attention on relevant events while simultaneously ensuring that internal and external distractions receive minimal processing. If the characterization of mind wandering as a state of poor attentional constraint is correct, then those individuals who mind-wander the most should spend more time in a state where (a) attention to task-relevant events is reduced and (b) attention to the processing of external irrelevant distracter events (which is normally reduced by the process of attentional constraint) is either unaffected or increased.

By contrast, the decoupling hypothesis proposes that the experience of mind wandering is associated with error because this is a requirement for an efficient focus on self-generated information. In this case, those individuals who mind-wander the most should show a reduced processing of external events regardless of their relevance to an external task. Thus, both the executive failure hypothesis and the decoupling hypothesis make parallel predictions regarding the association between mind wandering and reduced attention to task-relevant events. However, the two hypotheses make *distinct* predictions for the relationship between mind wandering and irrelevant events in a task; because the executive failure hypothesis predicts that task-unrelated thought persists in the absence of control processes, it should be linked to *similar or greater* levels of distraction, while the decoupling hypothesis assumes that mind wandering involves a process of perceptual neglect that ensures the continuity of the train of thought and so predicts *lower* levels of external distraction.

Studies have indicated that mind wandering reduces the processing not just of task-relevant events (Smallwood, Beach, Schooler, & Handy, 2008) but also of events that are irrelevant to task performance (Barron, Riby, Greer, & Smallwood, 2011). This reduction in attention to task-irrelevant information has been documented to apply to both the auditory and the visual domains, suggesting it is cross-modal in nature (Kam et al., 2011), and it has been observed in a range of physiological responses, such as pupil dilation (Smallwood, Brown, et al., 2011), as well as the electroencephalogram (EEG; Barron et al., 2011; Kam et al., 2011). Mind wandering also suppresses behavioral measures of distraction such that the effects of orienting cues on response time are reduced (Hu, He, & Baihua, 2012). More generally, Smilek, Carriere, and Cheyne (2010) demonstrated that periods of mind wandering during reading are associated with greater rates of eye blinking and argued that this functions to disrupt the processing of external information and so facilitates the continuity of the internal train of thought. Together, these results suggest that mind wandering is associated with a general reduction in external attention regardless of their relevance to a task thus indicating that the experience is distinct from a state of external distraction.

Differentiating Between How and Why Self-Generated Thought Occurs Provides a Unified View of the Relationship Between Mind Wandering and Error

As with evidence on the relationship between mind wandering and domain-general processes, the conflation between explanations for the process and the occurrence of mind wandering is one reason why integrating the evidence linking mind wandering to error into standard models of cognitive science has proved troublesome. Studies exploring the relationship between individual differences in attentional control and the performance cost of mind wandering on demanding tasks are examining *why* certain individuals mind-wander at inopportune moments and others do not. By contrast, the impact of mind wandering on concurrent events occurs because attending to an internal train of thought requires that perceptual information is neglected. In other words, the observation that attentional control can reduce mind wandering can be easily reconciled with the observation that mind wandering can also be associated with reduced external distraction once it is recognized that the former claim is related to what motivates the

experience in circumstances when it can be disruptive, while the latter is related to the fact that a concentrated internal focus to attention requires that external processes are neglected.

A careful consideration of the literature on the link between mind wandering and error supports this view. In a comprehensive study of the link between mind wandering, executive control, and reading, McVay and Kane (2012) demonstrated that the effect of executive control is associated with a "domain-general vulnerability to mind-wandering experiences" (p. 313). Analysis indicated that executive control measurements explained the occurrence of mind wandering (e.g., the mind-wandering rate), and it was the subsequent task-unrelated thought that accounted for reading comprehension problems. Similarly, task-unrelated thought still accounted for approximately 8% of the variance in errors during sustained attention even after individual differences in the influence of attentional control were accounted for (McVay & Kane, 2009). Thus, a significant proportion of errors could be linked to self-generated thought *even* for the participants with high working memory.

If the reduction of attentional resources to perceptual events is a property of a process engaged by an internal train of thought, it should be possible to create this situation in the context of a task. Indeed, fMRI investigations of the competition between concurrent recollection and encoding indicate that the process of memory retrieval leads to perceptual decoupling *even if it is relevant to the task* (Huijbers, Pennartz, Cabeza, & Daselaar, 2009). This experiment asked participants to identify previously encountered words that were presented simultaneously with visual scenes. On the trials when the verbal items were successfully retrieved, participants did not incidentally encode the visual scenes. This encoding deficit was coupled with a suppression of learning-related activity in visual and medial temporal areas, indicating that perceptual decoupling occurred during memory retrieval. Critically, the task of successfully retrieving information from memory led to perceptual neglect, demonstrating that successful task-relevant memory retrieval can compromise external encoding.

As with the question of the involvement of domain-general processes, the process–occurrence distinction provides a unified view on the manner by which the mind-wandering state is implicated in error: *Under tasks demanding continual external focus, attentional control can limit the occurrence of self-generated thought by ensuring the continuity of a task-relevant train of thought; however, when self-generated thought occurs, the process of perceptual decoupling associated with internal focus insulates cognition from external disruption. Because the process of perceptual decoupling allows self-generated information to commandeer attention, it can result in impaired performance on an external task.* The next section considers the implications of the process–occurrence framework for applied research on mind wandering in the domain of education and psychopathology.

Implications of the Process–Occurrence Framework for Applied Research Into Mind Wandering

Mind Wandering and Education

One clear result from studies on mind wandering is that when individuals engage in too much off-task thought during reading, it reduces their comprehension of what was read (Schooler, Reichle, & Halpern, 2004). This correlation between greater off-task thought while reading and worse comprehension has been replicated in several different studies (Franklin, Smallwood, & Schooler, 2011; McVay & Kane, 2012; Smallwood, McSpadden, & Schooler, 2008) and creates a situation that is especially detrimental to the creation of mental models of the narrative (Smallwood, McSpadden, & Schooler, 2008). Given that scholastic success depends on reading comprehension, reducing the amount of time spent engaged in off-task thought would be one way to improve educational performance.

It is also known, however, that the capacity to become immersed in the story that one is reading entails activation of many of the same neural processes that are engaged during mind wandering. A recent meta-analysis indicates that neural structures such as the precuneus, the mPFC, and the left inferior frontal gyrus are all linked to being absorbed in what is being read (Mar, 2011). It has been suggested that they may represent inferences on "the mental states of characters" (Mar, 2011, p. 123) because these areas also overlap with those neural regions involved in theory of mind. These regions activated during immersive reading, however, also overlap with regions active during mind wandering. More generally, research has shown that the development of imaginative thought through play and fantasy in childhood is important for educational success (Singer, 1961). Finally, in adults, the capacity for mind wandering under undemanding situations affords the capacity for autobiographical planning (Baird et al., 2011), as well as enhancing creativity (Baird et al., in press). These data lead to the question as to why similar imaginative processes that govern our absorption during reading and more generally afford planning and creativity (which are both important in educational success) can also impair the capacity to comprehend what is being read.

By recognizing that mind wandering can be dissociated into different elements, the process–occurrence framework suggests one way that this apparent contradiction can be explained. In line with the current framework, a failure to constrain experience to information relevant to the task in hand prohibits the reader from building imaginative models of what is being read (see Smallwood, McSpadden, & Schooler, 2008). Instead, when the mind wanders while reading, individuals use their capacity for imagination to build internal models that project themselves into simulations that are unintended by the author. By contrast, because attention remains coupled to the text under normal reading conditions, individuals can engage in acts of imagination that add to, rather than detract from, immersion within the text. In other words, the same mental processes can be both beneficial and counterproductive to reading once it is recognized that the coupling of their processes to events in the external environment determines whether or not they facilitate task processing. This underlines the value of the notion of perceptual coupling and decoupling in the context of understanding thought processes. Moreover, it suggests that the most effective programs to reduce mind wandering would be those that enhanced task-relevant coupling of mental processes without hindering an individual's capacity to deploy those same processes in a self-generated manner (such as by performing a task that depends on imagination).

Mind Wandering and Psychopathology

Another area of psychology in which mind wandering has been implicated is in the domain of psychopathology. Studies have demonstrated that several different psychiatric problems have been linked to elevations in the experience of mind wandering. For example, states of depression have been linked to greater mind wandering in subclinical samples from within the normal population (Smallwood, O'Connor, & Heim, 2004–2005, 2007; Smallwood et al., 2003) and within clinical groups (e.g., Watts, MacLeod, & Morris, 1988). In more general terms, greater mind wandering has been observed in individuals in an unhappy mood (Smallwood, Fitzgerald, Miles, & Phillips, 2009) and may undermine future happiness (Killingsworth & Gilbert, 2010). Studies have also shown that elevations in mind wandering have been observed for individuals who are high in attention-deficit/hyperactivity disorder (ADHD; e.g., Shaw & Giambra, 1993) or are more generally impulsive in nature (Helton, 2009). Finally, studies have shown that the engagement of internally generated thoughts is also higher in individuals who suffer from schizophrenia (Elua, Laws, & Kvavilashvili, 2012).

While states such as mind wandering are undoubtedly a component of different psychopathological states, for this experience to meaningfully dissociate clinical disorders, it is necessary to distinguish which elements of the experience are unique to different populations. Based on the process–occurrence framework, it is possible for individuals to spend greater time mind wandering for at least two reasons. One reason why the time engaged in mind wandering could increase is through a failure to constrain attention to the task in hand. Such a mechanism could easily explain why individuals with poor impulse control (such as those with ADHD), who have problems in controlling their attention (Nigg, 2000), might engage in more frequent mind wandering. Accordingly, ADHD would be associated with a greater occurrence of mind wandering, resulting from more general difficulties in stabilizing attention on any particular train of thought (either internal or external).

Alternatively, individuals could spend increased time in the mind-wandering state because they are engaged in internal attempts to readdress or overcome problems in their personal lives (e.g., their current concerns; Klinger, 1999). Because negative life events have a key role in the development of depressive disorders, mind wandering could be frequent in certain psychopathological states because of the incentive that individuals place on reconciling their current concerns. Such a perspective is supported by experimental evidence that the trait of rumination (which can exacerbate or prolong a depressive state) can be characterized by problems in knowing when to cease in the generation of solutions to problems (Watkins & Baracaia, 2002). Similarly, rumination has also been linked to difficulties in relinquishing a previous mental set during task-switching paradigms (Whitmer & Banich, 2007). Finally, studies have demonstrated that a ruminative self-focus engages both areas of the default mode network (e.g., the posterior cingulate) and areas that are implicated in top-down control (such as the dLPFC; Cooney, Joorman, Eugene, Dennis, & Gotlib, 2010). Perhaps, therefore, forms of ruminative mind wandering arise because of the emphasis that is placed on resolving personal problems, a problem that is exacerbated by the deployment of domain-general processes to ensure the continuity of self-generated cognition. This perspective is supported by recent work indicating that when in a negative mood, subclinical depression is marked by a tendency for the mind to wander to its past (Smallwood & O'Connor, 2011).

The process–occurrence framework, therefore, provides a rubric with which to separate the mind wandering associated with different psychopathological disorders. Certain conditions could be associated with a greater occurrence of mind wandering due to difficulties in the controlling of attention, such as ADHD. In others, mind wandering could arise because of problems in disengaging cognition from attempts to resolve personal problems, such as having a style of cognition characterized by rumination. According to the process–occurrence framework, in the former, this should be associated with more *frequent* mind-wandering episodes, while, in the latter, the episodes should on average last *longer*.

Process, Occurrence, and Why the Mind Wanders

> "Why" is the only question that bothers people enough to have an entire letter of the alphabet named after it. The alphabet does not go "A B C D What? When? How?" but it does go "V W X Why? Z."
>
> —Douglas Adams, *The Salmon of Doubt* (2002)

Perhaps the greatest value of the process–occurrence distinction is that it provides clarity on how to approach the most fundamental question that the phenomenon of mind wandering raises: *Why does the mind engage in thoughts and feelings unrelated to incoming perceptual information?* This final section of the review considers the current explanations for why mind wandering occurs before examining how future research can shed light on the processes of initiation of self-generated cognition.

Current Accounts of Why the Mind Wanders

Although the processes engaged in mind wandering are becoming reasonably well established, those that influence the occurrence of the experience remain less well understood, and the current concerns hypothesis, executive failure hypothesis, and meta-awareness hypothesis all make important predictions regarding why self-generated mental activity occurs. The current concerns hypothesis (Klinger, 1999; Klinger et al., 1973) suggests that mental content is motivated by the priorities the mind sets on the available stimuli. This view is consistent with studies that have manipulated mind wandering by varying the salience of internal states via priming self-memories or goals prior to task performance. Recent examples of such work have shown that priming self-memories raises the tendency for an individual to focus on future goals and that this enhanced focus on the future is in turn associated with a stronger bias to remember self-relevant information (Smallwood, Schooler, et al., 2011). Likewise, priming an individual's goals in the form of a to-do list leads to an increased focus on the future during mind wandering (Stawarczyk, Majerus, Maj, et al., 2011). Finally, recently it has been demonstrated that the mind-wandering state can enhance creativity via a processes of incubation (Baird et al., in press). Consistent with the notion that current concerns can motivate the occurrence of mind wandering, these data suggest self-generated thought is one way that the mind can seek novel solutions to problems.

Although the executive failure hypothesis fails to account for evidence of a role of working memory capacity in task-unrelated thought (Baird et al., 2011; Levinson et al., 2012) or the reduction in external distraction in individuals who mind-wander (Barron et al., 2011; Hu et al., 2012), it nonetheless offers insight into the processes that govern the process of switching between different mental contents. The executive failure view argues that a lapse in the dedicated processing of a given train of thought could create the mental space that allows the mind to shift to a different source. One question that must be addressed here is whether the process of attentional control influences the occurrence of mind wandering in a direct or an indirect manner. Plausibly, attentional control could influence mind wandering *directly* by inhibiting the events that act as the imperative stimulus that motivates the mind to wander. Alternatively, attentional control could influence mind wandering *indirectly* by ensuring continuity within a given train of thought, which would in turn prohibit the mind from shifting to an alternative topic.

Finally, the meta-awareness hypothesis argues that the ability to re-represent mental content allows the individual the chance to regulate the occurrence of mind wandering, in part because the experience is hard to recognize. Evidence supports the claim that participants often have difficulties in recognizing mind wandering spontaneously. For example, studies demonstrate that both intoxication and craving increase mind wandering without increasing recognition that mind wandering has occurred (Sayette, Reichle, & Schooler, 2009; Sayette, Schooler, & Reichle, 2010).

To understand how meta-awareness can regulate mind wandering, it will be necessary to understand why episodes of spontaneous self-generated thought come to an end. One possibility is that meta-awareness acts directly by detecting and terminating episodes of mind wandering that the individual does not wish to experience. In this view, meta-awareness involves a process that is distinct from those that control the occurrence or maintenance of the mind-wandering state, and this independence allows it the opportunity to regulate this element of consciousness. Alternatively, mind wandering could be hard to recognize because self-generated thought may engage metacognition and so prevent their deployment in the task of self-reporting mind wandering. In this view, mind-wandering episodes may come to an end for other reasons (e.g., because of failure to sustain internal thought, completion of the train of thought, or discontinuities in the external environment), and the temporary cessation of internal thought provides the individual the chance to redirect metacognitive resources to the task of self-report. In other words, because meta-awareness is produced when self-generated thought has already come to an end, it cannot play a causal role in terminating the state and should rather be seen as a process that allows metacognition to regulate subsequent cognition and/or behavior.

It may be possible to understand the role that meta-awareness awareness plays by exploring the psychological attributes of those mind-wandering episodes that are self-caught, relative to those that are caught by random sampling; the former might shed light on how individuals regulate their experiences, while the latter need not. Using this approach, Reichle, Reineberg, and Schooler (2010) demonstrated that prior to self-caught mind-wandering episodes, participants' reading times were longer than prior to episodes reported at probes. This observation led the authors to suggest that especially long reading times may reflect the recognition that the mind had wandered.

Are We Explaining Mind Wandering Yet?

Even though the hypotheses of current concerns, executive failure, and meta-awareness offer explanations for the conditions that favor mind wandering, they fall short of offering complete accounts for the spontaneous occurrence of a specific example of self-generated thought. In contemporary accounts of consciousness, the mechanism by which conscious thought emerges is described as the process of *ignition* (Dehaene & Changeux, 2011). Understanding this ignition process is ultimately necessary for explaining why a specific episode of self-generated thought emerged at *that* moment in time and why it had that specific content rather than the numerous alternative thoughts that an individual could conceivably have experienced.

One possibility is that memory systems and specifically the hippocampus provide the spark that ignites an internal train of thought (Buckner, 2010). This view is known as the *prospective consolidation hypothesis* and assumes that because the primary function of memory is to consolidate representations of what has already taken place, the same system is important when the mind seeks to make predictions regarding the future using imagination. Evidence in support of this proposition come from brain-imaging studies demonstrating that the hippocampus is active during both past and future thinking (Schacter, Addis, & Buckner, 2007), as well as from lesion studies indicating that lesions to the hippocampus not only interfere with memory but also impact upon prospection (Klein, Cosmides, Tooby, & Chance, 2002). More generally, this result might explain the somewhat puzzling finding that priming of self-memories results in greater future-related thought (Smallwood, Schooler, et al., 2011). One perplexing feature of these data is that stimulating self-memories did not lead to an increase in past-related thought. However, because the prospective consolidation hypothesis provides a mechanism through which memories can be transformed into future thoughts, this account could explain why participants engaged in greater future rather than past thought. At a more mechanistic level, studies in rats have documented that cells in the hippocampus, known as place cells, exhibit a temporal sequence of activity that encodes the spatial location necessary for maze navigation (Foster & Wilson, 2007). These sequences are replayed in reverse by the same cells when the task of maze navigation is completed, perhaps to consolidate the memory of the route. Finally, when the maze is correctly learned, the same cells fire in a prospective order as the rats prepare to navigate through the maze. While generalizing from such evidence must be done with caution, these findings raise the possibility that "a core function of the hippocampal system is to make predictions about upcoming events" (Buckner, 2010, p. 42), and so, stimulus-independent activity in the hippocampus could provide one source of ignition for a spontaneously generated train of thought.

Experimental Paradigms for Determining the Onset of Self-Generated Mental Events

To understand why mind wandering occurs, it is, therefore, necessary to identify the process of ignition for the experience, and

one way to do so is to examine the spontaneous events that systematically precede the experience. Identification of a behavioral or physiological indicator for the moment that mind wandering begins would provide objective information with which to test the different hypotheses on why the experience occurs and would also provide new empirical data upon which to develop further theory. Such an endeavor is likely to be complicated by the fact that systematic changes over time will be muddied: Without the capacity to identify the moment of onset, phase differences across episodes are likely to cause noise (see Figure 3B). A first step in this regard has been the employment of principal component analysis of the time course of response time data to a go/no-go task that is sensitive to absent-minded lapses (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997; Smallwood et al., 2004). This technique has revealed a pattern of slow oscillations occurring over approximately 20 s that is predictive of task performance (McVay & Kane, 2012; Smallwood, McSpadden, Luus, & Schooler, 2008), especially in individuals high in daydreaming (Smallwood, 2011a), and has also been shown to predict reports of task-unrelated thought (Smallwood, McSpadden, Luus, & Schooler, 2008; although see McVay & Kane, 2012).

Building on this work, Franklin et al. (2011) demonstrated that it was possible to predict mind-wandering reports at thought probes using an algorithm that initiated experience-sampling probes based on changes in reading speed. This algorithm initiated an experience-sampling probe whenever response time was short and failed to lengthen after the participant read a longer than average word. Algorithm-initiated probes were able to catch individuals' mind wandering more often than randomly administered probes, and the frequency with which these probes occurred was predictive of subsequent reading comprehension.

In addition to response time, several other potential markers for self-generated thought exist. Both galvanic skin response and heart rate are high during the off-task state (Smallwood et al., 2004, 2007), while baseline levels of pupil diameter are greater during periods when attention is focused on self-generated material (Smallwood, Brown, Baird, Mrazek, et al., 2012; Smallwood, Brown, et al., 2011). Likewise, eye-tracking data have indicated that reading times are longer when the mind wanders (Reichle et al., 2010) and the frequency of eye blinking increases (Smilek et al., 2010). Given this variety of covert markers (both behavioral and psychophysiological), future studies could profit from seeking temporal convergence across several different measures that best predict the experience of mind wandering. Plausibly, this combination of different covert measures of cognitive function, with additional techniques such as fMRI or EEG, could then be used to define more refined neural markers, which could in turn shed light on the cognitive processes that take place during the shift from task-related to task-unrelated thought. These techniques are already being used in examining unconstrained mental processes during the resting state (for a review, see Kelly et al., 2012), and the extension of these techniques to understanding conscious states may help identify the processes that ignite the mind-wandering state.

An alternative way to examine the precursors of mind wandering would be to explore whether task events can act as triggers and directly or indirectly cause the mind to wander (Cheyne, Solman, Carriere, & Smilek, 2009). Work using the same go/no-go task as discussed above has examined how the sequence of targets and nontargets can predict subsequent performance on these tasks. These studies have revealed a systematic window of time, in the range of 4 to 5 s, in which subsequent performance is impaired following the presentation of rare task events that challenge the attention of the individual. These consequences are especially pronounced if the initial events are responded to in a suboptimal manner (Cheyne, Carriere, Solman, & Smilek, 2011). In these studies, the extent to which these behavioral phenomena relate to conscious thoughts per se is unclear, and if they do, it is unclear whether the content of these thoughts are task related (e.g., worries about the task) or truly self-generated experiences (e.g., daydreams about the upcoming weekend). Nonetheless, this method could be extended to identify or constrain time windows within which a mind-wandering episode began and so help hone in on the precedent for an off-task thought.

Conclusion

This article has demonstrated that the distinction between process and occurrence affords an integrated framework that (a) provides conceptual leverage on different theoretical views on self-generated mental activity, (b) reconciles the relationship between the cognitive state and both domain-general processes and concurrent task error, and (c) provides important hypotheses for applied research in education and psychopathology. This review has established that the processes that ensure the continuity of the experience of an internal train of thought are similar to those that can be engaged in standard task-relevant paradigms, and as a result, these processes are becoming reasonably well understood. By contrast, our understanding of why mind wandering occurs is less well specified, in part because we are unable to identify the moment of ignition for the state. As the spontaneous occurrence of the mind-wandering state is one of the most informative aspects of the phenomenon for our understanding of the mind and brain (Christoff, 2012), identifying the onset of self-generated mental activity must be a primary focus for future research into the mind-wandering state.

More generally, the process–occurrence framework makes it clear why self-generated mental activity can be so puzzling for cognitive science: The process of imagination has undisputable value; however, the cost–benefit ratio for such thought is heavily influenced by context. For example, although the future thoughts that occupy our time on the commute to work are appropriate and perhaps welcome, the same experience is inappropriate when operating heavy machinery or when taking an exam at school. Therefore, in its most general sense, the distinction between process and occurrence underscores that the value or cost associated with self-generated cognition can only be fully understood by taking into account the context within which the experience unfolds (Smallwood, 2010). Although laboratory conditions focusing on attentional constraint capture certain features of our daily life that demand control, experimental constraint cannot adequately capture elements of everyday life in which attention is free to wander (Kingstone, Smilek, & Eastwood, 2008). While the mental capacity to spontaneously consider information that is not present in the perceptual moment is undoubtedly beneficial, doing so at an inopportune moment is best avoided.

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