13 The Scientific Study of Passive Thinking: Methods of Mind-Wandering Research

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13.1 Introduction

Chances are, at some point when you're reading this, your eyes will move across the page while your mind is elsewhere. This is likely true even if you really want to stay focused on what we have to say. People's ability to remain vigilant toward any one thing is remarkably flawed—the mind is rich with internal thoughts, concerns, simulation, and feelings that can pull our attention away. Of course, sometimes you can actively shift attention. If you get bored, you might look at your phone to check email or social media. This kind of attention shift is an active mental phenomenon as opposed to the more passive mental phenomenon of having one's attention drift away.

Mental life involves a dynamic coordination of these active and passive elements. You can *decide* whether to go to the store before or after work, *deliberate* on what to purchase, and *intentionally* buy the fruit instead of the chips (active phenomena), but you cannot easily manage your *desire* to eat chips or your *belief* that eating them will make you happy (passive phenomena). With regards to your attention span (assuming you are still with us), you may have decided to read this chapter, but that doesn't mean your desires to keep up with work or friends won't distract you.

Instead of reading carefully throughout, your mind will sometimes wander. It might wander to an upcoming test, a dinner out with friends last weekend, or a song you recently heard. Wherever it wanders, your mind will be wandering away from whatever we're saying. This isn't something you'll decide to do, but you will catch yourself doing it from time to time. For this reason, mind wandering falls on the *passive* side of the active/passive divide. This isn't a definition. Instead, it's an example that illustrates the phenomenon's passivity.

Special methods are often required to measure passive phenomena such as mind wandering or dreaming (Windt, 2015; Irving, 2018). In particular, the sciences of passive thinking often require self-reports or retrospective assessments of the content or character of one's mental states. However, philosophers and cognitive scientists have raised nontrivial epistemic concerns about self-report. It is therefore unclear whether we have an adequate methodology to study mind wandering empirically.

Our solution to this problem proceeds through a metaphysical account of mind wandering. We explain how mind wandering fits into the wider fabric of human agency, which makes sense of the causes and conditions of mind wandering. These can be leveraged into a (limited) defense of the self-report methods used to study mind wandering.

Our chapter has six parts. We first describe the central role of self-report in the rapid expansion of mind-wandering research over the last twenty years (section 13.2). Next, we argue that the passivity of mind wandering explains why self-report is necessary for its study (section 13.3), which may raise skeptical worries about the veracity of mind-wandering research (section 13.4). We then consider whether objective methods (section 13.5) or studies of intentional mind wandering (section 13.6) can obviate the need for self-report (spoiler: they can't). Finally, we propose a metaphysical solution to the epistemic problems of self-report (section 13.7).

13.2 Methodological Innovations

Two methodological innovations explain why mind wandering came to prominence in cognitive psychology. First was the discovery of the so-called default mode network—a set of brain regions associated with task-independent activity. Of equal importance was the revival of self-report methods to measure the wandering mind. In this section, we discuss why these two innovations are central to the history of mind-wandering research.

Twenty years ago, almost nobody in cognitive psychology or neuroscience talked about mind wandering (notable exceptions include Antrobus, 1968; Giambra, 1995; Wegner, 1997). Presently, each of the last five years has seen more than 100 articles published on mind wandering. One might assume that the reasons for this shift concern the importance of mind wandering itself. Mind wandering occupies a significant portion of our waking thoughts (Kane, Brown, et al., 2007; Seli, Beaty, et al., 2019). It is associated with a range of costs, including higher rates of car crashes (Yanko & Spalek, 2014; Gil-Jardiné et al., 2017), occupational accidents (Warm, Parasuraman, & Matthews, 2008), and general negative affect (Killingsworth & Gilbert, 2010).[1] It also has benefits for self-control (Gorgolewski et al., 2014), planning (Baird, Smallwood, & Schooler, 2011), and creativity (Preiss et al., 2016; Gable, Hopper, & Schooler, 2019; for a review, see Smallwood & Schooler, 2015). But the importance of mind wandering cannot explain its *increase* in prominence within the scientific community. After all, twenty years ago, mind wandering was just as pervasive in everyday life and had the same costs and benefits. Why, then, have the last two decades ushered in so much new research on mind wandering? Two methodological innovations deserve the lion's share of credit.

One innovation was the discovery of the so-called default mode network. In the early 2000s, researchers discovered a functionally connected set of brain regions that become considerably more active during moments of rest or inactivity than when subjects perform tasks (Raichle, 2015).[2] This helped to spur interest in studying what the brain is doing when it's not engaged in a task. In other words, what is the brain doing when it's "resting"? This marked an exciting departure from the norm in cognitive psychology and neuroscience, which was to study exclusively the cognitive processes that support task performance (Irving, 2018; Callard, Smallwood, & Margulies, 2011).

Over time, researchers realized that the default mode network subserves spontaneous internally directed cognition (Buckner, Andrews-Hanna, & Schacter, 2008) and that default mode activity increases when people's minds are wandering (Christoff, Gordon, et al., 2009). Initially, these results suggested that mind wandering might reflect a default state of human cognition: the unperturbed stream of thought. That suggestion turned out to be overly simplistic due to evidence that the default network can support goal-directed cognition (Spreng et al., 2010) and that other networks (notably the executive control network) are active during mind wandering (Fox et al., 2015; see Klein, 2012, for a philosophical discussion).[3] Still, the discovery of the default mode network helped mind wandering emerge as a research topic. It set the stage for observational experiments that were primarily concerned with studying what the brain does when one is not explicitly engaged in goal-directed thinking.

Mind-wandering science also benefited from a second methodological innovation: the development and refinement of self-report measures. Most studies of mind wandering in the lab and everyday life use a self-report method called retrospective thought sampling (Smallwood & Schooler, 2015). In these studies, participants are periodically interrupted as they perform tasks in the lab or go about their daily lives. They are then given a thought probe that asks questions about their immediately preceding experiences (figure 13.1). For example, one influential study asked subjects whether they agreed that "At the time of the beep [the thought probe], my mind had wandered to something other than what I was doing" (Kane, Brown, et al., 2007). Subjects who answered "yes" were classified as mind wandering. The study of mind wandering, then, leaned heavily on participants making retrospective judgments about their mental state just prior to being probed.[4]

Scientists have relied on these self-report methods to discover many characteristics of mind wandering, including (but not limited to) its frequency, costs, benefits, role in education, and its relationship to working memory, affect, episodic thinking, mindfulness, and the stream of thought (for reviews, see Smallwood & Schooler, 2015; Christoff, Irving, et al., 2016). Indeed, the vast majority of our knowledge of mind wandering is owed (at least in part) to self-report. In the next section, we explain why.

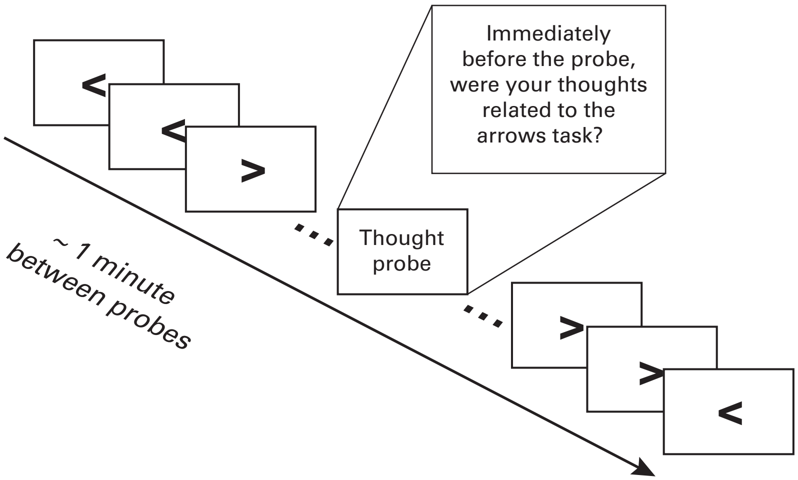

Figure 13.1
Retrospective thought sampling in a laboratory study (example). Subjects are interrupted by a thought probe on average once a minute. They are then asked whether their immediately preceding thoughts are related to the laboratory tasks. If not, their thoughts are classified as mind wandering.
Source: Reproduced with permission from Irving and Glasser (2020).

13.3 Self-Report and Passive Phenomena

Self-report is central to mind-wandering research. In this section, we explain why this is due to the passivity of mind wandering. Specifically, we build on an argument from Irving (2018). Irving notes that cognitive psychologists typically study a cognitive process by giving subjects a voluntary task that activates that process. But because mind wandering is passive, no voluntary task initiates mind wandering. So, psychologists need a task-free method to study mind wandering, and presently the best task-free method is self-report.

Here is our expanded version of Irving's argument:

1. If a cognitive process or state ϕ cannot[5] be voluntarily initiated and does not reliably subserve the performance of a task, then the psychological study of ϕ requires self-report.
2. Mind wandering cannot be voluntarily initiated.
3. Mind wandering does not reliably subserve the performance of a task.
4. Therefore, the psychological study of mind wandering requires self-report.

The remainder of this section offers support for these premises.

13.3.1 Processes and Reports (Premise 1)

Cognitive psychology often relies on experimental tasks in part to avoid the need for self-report. Let's say that a cognitive psychologist wants to study a cognitive process or state ϕ. She will typically design an experimental task the performance of which requires some behavioral response τ, where τ is known to activate ϕ. Our experimenter then has no need to ask subjects to self-report on whether they use process ϕ in the experiment, since we already know that anyone who performs τ activates process ϕ. We call this approach "task-based psychology" (for an example, see our discussion of the go/no-go paradigm in the next paragraph).

Tasks can activate a psychological process or state in two ways, depending on how directly one can control the process or state. First, some tasks exploit the fact that subjects can voluntarily initiate a psychological process or state. We'll say that an agent can voluntarily initiate ϕ if and only if she can bring about the occurrence of ϕ immediately by deciding, choosing, or willing to make ϕ obtain (see Adams, 1985, p. 8; cf. van Inwagen, 1989, p. 410). One example of the use of voluntary initiation is how psychologists use a go/no-go task to study inhibitory processes (Lappin & Eriksen, 1966; Logan, 2015). Subjects respond quickly to targets (e.g., "go" signs) and withhold their response when they receive a stop signal (e.g., "stop" signs). Because the task is timed, subjects typically begin to respond as soon as they see a stimulus, even if it is a stop signal. In stop trials, they then have to inhibit their response. Psychologists use go/no-go tasks to study the psychological process of inhibiting an ongoing action. Subjects can voluntarily initiate this sort of inhibition. So, anyone who completes the go/no-go task will voluntarily activate the process in question.

Psychologists cannot use this direct method to study passive states and processes such as beliefs, desires, or dreaming. Agents cannot voluntarily initiate passive processes or directly be in some passive state because they can neither come to be in these states nor bring about the occurrence of these processes immediately. At most, agents can indirectly be in some passive state or bring about the occurrence of a passive process ϕ by performing *another* action that they know is likely to bring it about that ϕ. Suppose you don't now desire to eat a tomato, for example. You cannot simply decide or choose to have that desire in a way that immediately and directly causes you to want a tomato. You can do things that make the desire more likely, such as looking at pictures of caprese salads. But this amounts to only indirectly controlling your desires.

Task-based psychologists can sometimes use indirect methods to study passive states and processes. Sometimes, a passive state or process ϕ will subserve the voluntary performance of a task τ. If so, psychologists can ask subjects to voluntarily perform τ in order to activate ϕ indirectly. Consider, for example, how psychologists use spatial cueing paradigms (Posner, 1980) to study the effects of participant's beliefs on visual attention. Beliefs are passive, insofar as one cannot directly choose or decide to believe something (van Fraassen, 1984). But spatial cueing tasks manipulate subjects' beliefs about the location of a target stimulus. Participants are assigned to one of three conditions. In one condition, a peripheral cue is presented indicating the location of the target stimulus (the congruent condition). In another condition, the peripheral cue is presented in a location that differs from the target stimulus (the incongruent condition). In the control condition, no peripheral cue is presented. Fixation occurs much more quickly in congruent conditions relative to incongruent conditions (Israel, Jolicoeur, & Cohen, 2018). This suggests that participants with true beliefs about the target location outperform subjects with false beliefs.

Belief, though passive, can be studied within the standard task-based experimental paradigm because we understand something about how belief produces action. Part of what it is to be a belief is to play a certain *causal* role in the production of action and a *normative* role in the explanation of action (Stalnaker, 1984, pp. 4–5, 82). Paradigmatically, the desire G, coupled with the belief that A-ing is a means to realize G, will cause one to begin A-ing (Audi, 1979). When we know about someone's actions and desires, we can therefore use this schema to infer someone's beliefs. For example, visual fixation is an action (or a component of an action) that subjects use to complete an experimental task. So, we can reliably infer that subjects form beliefs about the best location for visual fixation. Crucially, we can make this inference even though belief is passive because we know how beliefs tend to subserve action.

We argue that there are two conditions under which psychologists can use task-based methods to study a cognitive process or state ϕ: (1) when subjects can voluntarily initiate ϕ, and (2) when ϕ reliably subserves the performance of a task that one can voluntarily initiate. If neither of those conditions obtain, psychologists must use the methods of task-free psychology: self-report.

13.3.2 Tasks and Mind Wandering (Premises 2 and 3)

Premise 2 in our argument says that one cannot voluntarily initiate mind wandering. This is intuitive. People cannot make their minds wander at the drop of a hat, and they often catch their minds wandering (just as you can catch yourself dozing off). People can put themselves in a position that makes mind wandering likely, such as reading a boring book. But at the end of the day, you must let mind wandering come to you.

Premise 3 says that mind wandering does not reliably subserve the voluntary performance of a task. Unlike belief, researchers cannot ask subjects to perform tasks that require mind wandering because there are no such tasks. Our argument for this premise differs, depending on how you define mind wandering (cf. Irving, 2018, for similar arguments).

Most psychologists define mind wandering as task-unrelated thought. In a laboratory, this means that our wandering thoughts are (by definition) unrelated to the task assigned by the experimenter. But if thoughts subserve an experimental task, then they are related to that task. By definition, any thoughts that subserve the experimental task are not mind wandering—at least according to the standard operationalization (Smallwood & Schooler, 2015).

Others define mind wandering in terms of its dynamics rather than its relationship to an ongoing task (Irving, 2016; Christoff, Irving, et al., 2016; Sripada, 2018). Dynamic views focus on how mind wandering unfolds over time, meandering from one topic to another. Such views contrast mind wandering with goal-directed thinking, which remains focused on the agent's task. Irving (2016) appeals to guidance to explain the dynamic difference between mind wandering and directed thinking. During goal-directed thinking, for example, the agent guides her attention to remain on task-relevant stimuli. During mind wandering, in contrast, the agent's attention is unguided and thus free to meander from topic to topic.

We can now explain why no task can reliably recruit mind wandering. Part of what it means to perform a task is to guide your attention to thoughts that are relevant to that task. So, any thoughts that subserve an agent's task will be thoughts toward which she guides her attention. Therefore, those thoughts will not constitute mind wandering.

We now have an argument that explains why mind-wandering research relies on self-report. Agents cannot voluntarily initiate mind wandering, and nor can mind wandering reliably subserve the performance of a task. The methods of task-based psychology are therefore ill suited to study the wandering mind. Mind-wandering researchers must instead rely on task-free methods—namely, self-report.

13.4 Skepticism about Self-Report

Self-report is central to the science of mind wandering. At bottom, mind-wandering research fundamentally requires that we ask people to reflect on what's going on in their minds. You might think this is a serious cause for concern. Empirical evidence suggests that people are notoriously unreliable when they make judgments about their own minds. The situation is particularly bad when we use survey responses as data points. Survey responses are subject to framing effects (Sinnott-Armstrong, 2008), social desirability biases (Robins & John, 1997), and simple misunderstanding of the questions being asked (Cullen, 2010). Moreover, people are bad at remembering their responses to surveys, raising the question of whether responding to surveys activates reliable, reasons-responsive processes. Hall, Johansson, and Strandberg (2012) showed this when they reversed people's responses to a moral and political opinion survey and got people to defend their reversed positions!

Surveys about experience are notoriously unreliable. Fortunately, such surveys differ from thought sampling methodology in important ways. Thought probes do not interrogate *why* you are mind wandering, just *whether* you are. So, while people exhibit unreliability in making process assessments ("Why are you in a particular mental state?"), mind-wandering research requires state assessment ("Are you in this particular mental state?"). Furthermore, thought sampling questions do not ask about obscure technical concepts such as knowledge or freedom. Rather, they ask about a pervasive and familiar experience: whether your mind was wandering. Finally, thought-sampling methods ask about your immediately preceding experiences, rather than asking you to report on what your experiences are like in general. Such methods may therefore avoid the distorting effects of memory (Windt, 2016).

We have empirical reasons, though, to trust self-reports of mind wandering. Mind-wandering research shows surprising consistency across subjects in self-reports of mind wandering (see Kane, Smeekens, et al., in preparation). For instance, there is emerging evidence of convergent validity between self-reports and third-party assessments of mind wandering (Mills, Rafaelli, et al., 2018). Self-reports of mind wandering consistently correlate with various indirect measures of mind wandering. Some of these are behavioral, such as performance errors (McVay & Kane, 2009), comprehension failures (Schooler, Reichle, & Halpern, 2004), eye movements (Uzzaman & Joordens, 2011), and changes in response variability (Seli, Smallwood, et al., 2015). Other measures are physiological, including evoked response potentials (Smallwood, Beach, et al., 2008), pupil dilation (Franklin, Mrazek, et al., 2013), eye blink rate (Smilek, Carriere, & Cheyne, 2010), and changes in brain activity (Christoff, Gordon, et al., 2009).

Of course, none of this is decisive. Global skeptical arguments about even the simplest experiential reports (Schwitzgebel, 2008) are notoriously hard to defuse (see Sosa, 1994). Furthermore, there are critics of self-report within the science of mind wandering (see Weinstein, 2018). One issue concerns the distorting effects of thought probes. Studies that present probes too often may disrupt the natural flow of thought in at least four ways. First, probes may reorient attention to task demands and reduce mind wandering (Seli, Carriere, Levene, et al., 2013; although see Robison, Miller, & Unsworth, 2019). Second, hyper-probing can lead to increased meta-awareness of one's thoughts, which itself alters the occurrence of mind wandering (Zedelius, Broadway, & Schooler, 2015). Third, this increased meta-awareness is a problem in itself: it inflates assessments of the degree to which mind wandering is accompanied by meta-awareness. Finally, laboratory tasks are often structurally dissimilar from real-world tasks, meaning that rates of mind wandering in the lab are difficult to translate into predictions of rates of mind wandering in the real world (see Murray et al., 2020).

Another methodological problem concerns how we define mind wandering. The vast majority of self-report studies operationally define mind wandering as task-unrelated thought (Mills, Rafaelli, et al., 2018). Indeed, many task-unrelated thoughts overlap with mind wandering. If your mind wanders from topic to topic as your eyes scan this page, for example, your thoughts are unrelated to the task of reading. Yet, the standard view has come under fire from multiple fronts. Task-unrelated thought is a broad and heterogeneous category (Irving, 2016; Christoff, Irving, et al., 2016). While your eyes mindlessly scan the page, for example, you might diligently do mental math for your statistics class. Or you might obsessively ruminate on a fight you just had with your friend. Such focused thinking seems to contrast with the meandering characteristic of mind wandering. Furthermore, it's not clear how the standard view handles cases of mind wandering in the absence of a task. Your mind can wander while you are resting on the beach, but then you don't have a task to wander away from (Seli, Kane, et al., 2018; Irving, 2016).

Cognitive scientists have recently proposed alternatives to the standard definition of mind wandering, but it is still an open question how amenable those new theories are to self-report. The dynamic view says that mind wandering is relatively unconstrained thought, which freely meanders from topic to topic (Irving, 2016; Christoff, Irving, et al., 2016; Sripada, 2018; see section 13.2). Yet, the empirical study of the dynamic stream of thought is still in its infancy, and ongoing work tells a nuanced story. One study found that reports of freely moving and task-unrelated thought are orthogonal in daily life and that the former independently predicts affect (Mills, Rafaelli, et al., 2018). Another found that unique electrophysiological signatures are differentially associated with freely moving, directed, and task-unrelated thought (Kam et al., 2021). However, yet another study failed to find predicted relationships between freely moving thought and various clinical pathologies (OCD, depression, and anxiety), as well as finding a negative correlation between freely moving thought and creative idea generation (Smith et al., unpublished manuscript). Additional studies also suggest that measures of thought dynamics are redundant with measures of task unrelatedness (O'Neill et al., 2020). This might suggest that the probes used to assess freely moving thought do not yet measure constructs that are readily interpretable.

Others argue that mind wandering is a heterogeneous construct with multiple overlapping attributes that no single instance of mind wandering fully exemplifies (Seli, Kane, et al., 2018). This argument depends on the (contentious) claim that no single definition of mind wandering picks out an extensionally adequate concept. On this basis, some have begun to propose alternative subjective measures of mind wandering that reflect the inherent heterogeneity of the construct (Murray et al., 2020).

Our review suggests that psychologists and philosophers have both worried about our current self-report measures of mind wandering. But the solutions to these problems almost exclusively involve the refinement of self-reports. You may wonder: Can we do better?

13.5 Intentional Mind Wandering

We find ourselves in a pickle. On the one hand, we argue that the scientific study of mind wandering requires self-report. On the other hand, there are several reasons to be skeptical of self-report methods. You may therefore ask whether we can break out of the cycle of self-report.

Our master argument in section 13.2 suggests that mind-wandering research must rely on self-report. Recall that our argument is as follows:

1. If a cognitive process or state ϕ cannot be voluntarily initiated and does not reliably subserve the performance of a task, then the psychological study of ϕ requires self-report.
2. Mind wandering cannot be voluntarily initiated.
3. Mind wandering does not reliably subserve the performance of a task.
4. Therefore, the psychological study of mind wandering requires self-report.

If you think mind-wandering research can break the cycle—that is, can do without self-report—then there must be something wrong with this argument. In the next two sections, we consider two objections to our argument. The first targets Premises 2 and 3, arguing that so-called intentional mind wandering can either be voluntarily initiated or subserve a task. The second targets Premise 1, on the grounds that objective measures allow us to study mind wandering without tasks or self-report. We turn first to the objection from intentional mind wandering.

Premises 2 and 3 state that no voluntary task can activate mind wandering, either directly or indirectly. You might resist this claim based on empirical evidence for intentional mind wandering. People frequently report intentional mind wandering—that is, letting their minds wander on purpose—both in the laboratory (Seli, Risko, Smilek, & Schacter, 2016) and in everyday life (Kane, Brown, et al., 2007). Empirical research suggests that everyday thinking recognizes the possibility of intentional mind wandering (Irving et al., 2020). Furthermore, intentional and unintentional mind wandering are differentially associated with independent state- and trait-level variables (Seli, Risko, & Smilek, 2016).

The possibility of intentional mind wandering might seem intuitive. While you're reading this chapter, for example, you might defiantly turn your head away from the page and let your thoughts drift from topic to topic. You might then argue that intentional mind wandering is a voluntary task that activates mind wandering. If so, then task-based methods may be able to measure mind wandering after all (contra Premises 2 and 3).

Our response to this objection depends on how you define mind wandering. Consider the task-unrelated thought theory of mind wandering. On this view, intentional mind wandering would consist in you intending to have task-unrelated thoughts. However, in intending to have such thoughts, you acquire a task: letting your mind wander. So, your thoughts are task related—not mind wandering. Intentions generate tasks. So, it's impossible to intend to think task-unrelated thoughts (see Murray & Krasich, 2020).

Of course, alternative characterizations of mind wandering might have the conceptual tools to explain intentional mind wandering. Some have suggested that intentional mind wandering might reflect maintaining variable streams of thought through meta-control (Irving, under revision). This is similar to contemplative techniques used by surrealist painters (Green, 2010) and meditators (Lutz et al., 2008).

Unfortunately, this interesting proposal is limited because the ability to maintain a wandering stream of thoughts requires a specialized process—meta-control—and employing it likely requires specialized training. Meta-controlled mind wandering may therefore differ in important ways from mind wandering in the absence of meta-control. However, there is no way to assess this without the use of self-report. Again, we find that self-report is indispensable for the scientific study of mind wandering.

Our discussion thus far shows the limits of methods that require direct voluntary control over mind wandering. If mind wandering is task-unrelated thought, such methods are conceptually incoherent. If mind wandering is unguided thought, such methods cannot tell us about mind wandering in general unless we use self-report. But perhaps we will have more luck with methods that exploit indirect voluntary control over mind wandering.

It is possible to control mind wandering indirectly: you can perform some *other* voluntary task τ because you know that τ reliably leads to mind wandering. Suppose that after a long day of studying, you want to let your mind wander to clear your head. You might do this by taking a shower or washing the dishes, which are the kinds of boring tasks that reliably lead to mind wandering (Mason et al., 2007; Smallwood, Fitzgerald, et al., 2009). You might assume that indirect voluntary control provides a route to the task-based study of mind wandering. Rather than ask subjects whether their mind was wandering, for example, you might simply give them the kind of boring task that reliably leads to mind wandering.

Baird, Smallwood, Mrazek, and colleagues' (2012) influential study of mind wandering and creativity employs this kind of indirect method. They tested whether mind wandering can lead to creative insights. This idea is intuitive: when you're stuck on a problem, for example, you might make progress by letting your mind wander in the shower. Baird, Smallwood, Mrazek, and colleagues (2012) tested this idea by having subjects solve a creative problem, take a break, and then return to the same problem. During the break, subjects in the experimental condition performed an easy task known to induce mind wandering. Subjects in one control condition performed a difficult task known to reduce mind wandering. Baird, Smallwood, Mrazek, and colleagues found that subjects who performed the easy task were more creative after the break than those who performed the difficult task. So, they concluded that mind wandering facilitates creativity.

But Baird, Smallwood, Mrazek, and colleagues' indirect method makes it difficult to interpret their results (Irving, 2018). It is possible that easy tasks facilitate creativity more than difficult tasks *because* they lead to higher rates of mind wandering. But it is also possible that the effect of task difficulty on creativity bypasses mind wandering entirely. Easy tasks might lead to relaxation, whereas difficult tasks might lead to frustration. And this difference in affective state might be what drives creativity. This is not a problem that indirect task-based methods can solve. Baird, Smallwood, Mrazek, and colleagues' subjects do not voluntarily initiate mind wandering or perform a task that mind wandering subserves. Rather, they perform a task τ that has two likely effects: mind wandering and creativity. Indirect methods alone cannot determine whether the effect on creativity is due to τ or mediated by mind wandering. To test for this mediation, we would need to ask subjects whether their minds are wandering during the break, and see whether those self-reported rates of mind wandering predict creativity—that is, we would need to rely on self-report.

Our discussion in this section shows that mind-wandering researchers cannot use intentional mind wandering to make do without self-report. A careful study of intentional mind wandering might lead to the development of direct and indirect methods to study the wandering mind. But those methods at best complement self-report; they are not a replacement.

13.6 Establishing Objective Measures

We cannot exploit intentional mind wandering to ground a task-based science of the wandering mind. Premise 1 of our master argument states, roughly, that self-report is the best (perhaps the only) alternative to task-based methods. If so, it follows that mind-wandering research must rely on self-report. You might object that there is a third alternative to task-based methods and self-report. Tasks and reports are useful because they reliably indicate that a process such as mind wandering is active. If we can devise alternative indicators for mind wandering, then we can do without tasks or reports. This hope animates the search for objective measures of mind wandering.

Seemingly toward this search, researchers have found various objective markers that correlate with reports of mind wandering, such as motor response times, task accuracy, and eye movements. One hope is that those objective markers can obviate the need for self-report. Rather than ask subjects whether their mind was wandering, the dream is simply to determine this answer by looking at behavior.

After a careful review of objective methods, we argue that we cannot replace self-report for two reasons. First, current findings are mixed and likely impacted by idiosyncrasies of ongoing task demands and strategies. As such, an indisputable set of mind wandering–specific behaviors has yet to be established. Second, self-report is still used to establish objective methods. Thus, objective methods actually extend, rather than replace, self-reports in the study of mind wandering.

13.6.1 Response Times and Performance Accuracy

Many laboratory studies of mind wandering have integrated thought probes into the Sustained Attention to Response Task (SART; Robertson et al., 1997), which is a task historically used to study vigilance. The SART requires participants to respond to nearly all stimuli and withhold responses to infrequent targets. Errors of commission and faster responses times (RT) are generally taken as evidence of vigilance lapses—that is, it is supposed that participants perform the task more quickly because they rely on their prepotent responses to stimuli rather than making on-the-fly adjustments, and errors of commission are thought to occur due to the associated attenuated response inhibition.

In many studies, self-reported mind wandering during the SART is also correlated with worse task performance and faster RT (e.g., McVay & Kane, 2011; Kane & McVay, 2012; Thomson, Besner, & Smilek, 2015). These findings seem consistent with frameworks of mind wandering that characterize it in terms of executive control failures (McVay & Kane, 2010) or lapses in vigilance (Spruyt et al., 2019). The link with faster RT is particularly intriguing as a potential real-time, thought-probe, independent index of mind wandering: with faster RT, the more likely it is that a participant's mind is currently wandering.

Unfortunately, this framework is too simple and, at times, inaccurate. Indeed, a few studies have found that self-reported mind wandering was associated with significantly *slower* RT (Baird, Smallwood, Lutz, et al., 2014; Bastian & Sackur, 2013). Factors contributing to these discrepancies are unclear but may include a variety of interrelated factors pertaining to differences in thought content, progression, and meta-awareness of mind wandering (Bastian & Sackur, 2013). Another possibility is that RT variability, rather than speed, is actually a better indicator of mind wandering (Bastian & Sackur, 2013; Seli, Cheyne, & Smilek, 2013; Thomson et al., 2014), but others have failed to find this effect (e.g., McVay & Kane, 2011). Therefore, the collective evidence does not eliminate the link between mind wandering and RT in the SART, but it does call into question RT as a reliable indicator of mind wandering across experimental conditions. In other words, the link between RT and mind wandering seems highly influenced by specific task parameters, which challenges the utility of using it as a single reliable behavioral index of mind wandering.

A tempting hypothesis, then, is that changes in RT relative to task performance could improve predictions of mind wandering. Supportive evidence of this has shown that as an iterated task progressed, the frequency of reported mind wandering increased, the observed differences in associated RT become more robust, and accuracy decreased (e.g., Krimsky et al., 2017).

Even this framework, however, is not without its challenges, especially because people can perform simple tasks accurately enough even while mind wandering, such as mind wandering while driving home from work. For example, Brosowsky and colleagues (forthcoming) measured rates of mind wandering during an implicit learning task. They found that as participants learned the task, RTs became faster and depth of mind wandering increased. Performance, however, improved throughout the task (consistent with the task becoming learned). Thus, some tasks are such that as they become automatized, mind wandering does not interfere with their performance. RTs and performance are uninformative indicators of mind wandering in these situations.

Furthermore, people exhibit signs of strategic mind wandering, especially in predictable or familiar task environments (Seli, Carriere, Wammes, et al., 2018). Seli and colleagues had participants watch a clock hand that moved in discrete steps, completing one revolution every twenty seconds. The instructions were simple: press the space bar on the keyboard whenever the clock hand reached the "12" (upright) position. Using thought probes to measure the occurrence of mind wandering, they found that mind wandering was significantly more likely to occur when the clock hand was in the second or third quadrant ("3"–"9") than the first or fourth quadrants. People began mind wandering when they knew they didn't need to pay attention, and they returned to the task when they knew they should. Accordingly, there was no relationship between the rates of reported mind wandering and task accuracy.

Collectively, findings from Seli, Smilek, et al. (2018) suggest that people can continue monitoring the task and remain aware of the task environment even when they report mind wandering. Again, we see that the link between mind wandering and potential behavioral indices is highly influenced by specific task parameters and might not be a reliable indicator of mind wandering across contexts.

13.6.2 Gaze Behaviors

A growing body of research has investigated eye movements as a potential behavioral index of mind wandering. Motivating this approach, eye movements are closely linked to the visual processing priorities of the visual system (e.g., Just & Carpenter, 1976; Kowler et al., 1995). This is in part due to the structural and functional limitations of the visual system in virtue of the anatomy of the eye, the organization of neurons in the primary visual cortex, and strict capacity limits on attention and working memory. People tend to look wherever they are attending (rare exceptions include covert shifts of attention) in such a way that best serves ongoing task goals.

During mind wandering, however, the visual system becomes, to some degree, perceptually decoupled from sensory inputs (Schooler et al., 2011; Smallwood, 2013). Neuroscientific measures support this idea. For instance, electroencephalography studies have shown that self-reported mind wandering is associated with attenuated P1 event-related potential (ERP) component amplitude (Baird, Smallwood, Lutz, et al., 2014; Kam et al., 2011; Smallwood, Beach, et al., 2008)—the ERP component associated with low-level visual processing (Hillyard et al., 1973). Mind wandering is also associated with attenuated cognitive processing of external stimuli, as indicated by an attenuated P3 ERP component amplitude (Barron et al., 2011). Considered together, these findings indicate a reduction in the cortical processing of external visual information associated with self-reported mind wandering.

Changes in visual processing during mind wandering, then, should result in corresponding changes in gaze behaviors. Accordingly, research has identified a number of changes in gaze behaviors associated with mind wandering, although results have been relatively mixed. To illustrate, as one of the first studies to investigate mind wandering–related gaze behaviors, Reichle, Reineberg, and Schooler (2010) showed that the eyes tended to fixate on words for a longer duration of time before reports of mind wandering compared to reports of attentive reading. These longer fixations were not related to word length or frequency as they typically are during attentive reading (Juhasz & Rayner, 2006; Rayner & Duffy, 1986; Reichle, Rayner, & Pollatsek, 2003). This finding suggests that the observed longer fixations durations before reports of mind wandering reflected perceptual decoupling, corroborating the self-reports.

Reichle and colleagues (2010) suggests that longer fixation durations might be a promising objective measure of mind wandering, especially because this relationship has been replicated in other work using reading tasks (e.g., Faber, Bixler, & D'Mello, 2018; Foulsham, Farley, & Kingstone, 2013; Frank et al., 2015; Steindorf & Rummel, 2020; although see Smilek, Carriere, & Cheyne, 2010; Uzzaman & Joordens, 2011) as well as scene-viewing tasks (Krasich et al., 2018; Zhang, Anderson, & Miller, 2020). The challenge, though, is that many contemporary frameworks of eye movements consider longer fixation durations a marker of *increased* visual processing (e.g., Choi et al., 2017; Coco, Nuthmann, & Dimigen, 2020; Henderson, Choi, Luke, & Schmidt, 2018; Luke et al., 2018), which is supported by neuroscientific evidence in reading (Henderson, Choi, Luke, & Desai, 2015) and scene viewing (Henderson & Choi, 2015). Therefore, it would seem as though the relationship between mind wandering and fixation duration—and perhaps gaze control in general—might also prove to be idiosyncratic.

To test this idea, Faber, Krasich, and colleagues (2020) asked participants to complete a battery of computer-based cognitive tasks while their eye movements were measured. These tasks included the SART, listening to an audiobook (while looking at a central fixation), reading a narrative story, comprehending an illustrated text, viewing visual scenes, watching a recorded academic lecturer, and watching a narrative film. As such, the tasks varied across the spatial extent of the visual stimuli as well as the visual and semantic processing demands. Accordingly, these tasks should demand very different gaze patterns during attentive viewing, and the purpose of the study was to examine whether the relationship between mind wandering and eye movements would also vary by task.

The findings showed just this contextual variance. Specifically, in tasks that required extensive sampling of the visual field (i.e., scene viewing, comprehending an illustrated text, and narrative reading), fewer fixations were made prior to self-reported mind wandering compared to reported attentive viewing. Depending on the task, these fixations were also longer and more spatially dispersed. Conversely, in tasks that required more centrally focused gaze (i.e., the SART, listening to an audiobook while looking at a central fixation, and watching a recorded academic lecture), mind wandering was associated with shorter and more dispersed fixations as well as larger saccades. These findings support the idea that the relationship between mind wandering and gaze behavior varies according to the idiosyncrasies of the task.

These findings pose a challenge for initiatives attempting to use gaze patterns as a behavioral index of mind wandering. It is probably no surprise, then, that predictive modeling methods (such as those described in Yarkoni & Westfall, 2017) have yet to identify a common set of gaze parameters that can be used across *all* tasks. Still, modeling eye movements to predict mind wandering *within* a task has some potential. Essentially, this approach considers a variety of changes in eye movements associated with reports of mind wandering in concert.

For instance, Faber, Bixler, and colleagues (2018) developed a gaze behavior–based, machine-learned model of mind wandering utilizing reading data from 132 undergraduate students across two universities (data set from Kopp, D'Mello, & Mills, 2015). Specifically, this "mind-wandering detector" trained a supervised classification model of gaze behaviors associated with self-caught mind wandering (participants pressed a key on the keyboard when they caught themselves mind wandering).[6] The model included sixty-two global (content-independent) gaze features, such as the number, duration, and dispersion of fixations; the number of saccades (ballistic eye movements between fixations); and the number of blinks.

The model was validated using a leave-one-reader-out cross-validation method that trained the model on data from $n - 1$ participants and tested the model on data from the remaining participant until all 132 served as a "test" participant. The model (sequential minimization optimization) showed a weighted precision of 72.2 percent and a weighted recall of 67.4 percent. Stated simply, this mind-wandering detector could accurately (though not perfectly) predict self-reported mind wandering from gaze behaviors. Others have used similar approaches to predict the likelihood of ongoing mind wandering offline (e.g., Bixler & D'Mello, 2016; Brishtel et al., 2020) and in real time (Mills, Gregg, et al., 2020) during reading.

Outside of the context of reading, Hutt and colleagues (2019) adopted an offline-to-online classification-verification approach to predict the likelihood of ongoing mind wandering within an artificial intelligence tutoring system (ITS). These authors first gathered data from 135 high school students who completed the ITS and responded to pseudo-randomly distributed thought probes (probe-caught mind wandering) as to whether they were on- or off-task at a given moment. The authors then used Bayesian networks to classify gaze behaviors associated with mind wandering (from a set of fifty-seven global gaze parameters, eighty content-specific parameters, and eight features related to the human–computer interactions) and a leave-several-students-out cross-validation scheme (67 percent of students were used in the training set and 33 percent were assigned to the test set) for fifteen iterations. Findings showed accuracies (mind wandering $F_1=0.59$) were better than chance ($F_1=0.24$), and this model could generalize to data collected from a controlled laboratory study.

Live mind-wandering detection was then tested on a new sample of thirty-nine high school students. Students completed the same ITS while mind-wandering probabilities were generated. Two types of thought probes were distributed throughout the learning session: (1) a probe that was triggered by the mind-wandering detector used to assess hits and false alarms, and (2) pseudo-random probes used to identify missed mind-wandering episodes. Findings showed that mind-wandering detection ($F_1=0.40$) was above chance ($F_1=0.24$). Collective evidence from Hutt and colleagues (2019) again indicates that accurate (though still imperfect) real-time mind-wandering detection can be achieved by training classification algorithms on a collection of gaze behaviors linked to self-reported mind wandering.

13.6.3 Limitations of Objective Methods

Classifying eye movements to detect ongoing mind wandering seems to promise an objective measure of mind wandering: online machine learning classifiers may allow us to detect ongoing mind wandering without disrupting the subject's task performance or spontaneous stream of thoughts. This would ease worries about how self-reports disrupt the thoughts they are designed to measure.

Yet, even these mind-wandering detectors do not remove the need for self-report. First, we argued that objective measures of mind wandering are not always available and that they require unique classification for each task context. Moreover, this so-called objective method for identifying mind wandering still has a subjective core. Machine learning classifiers are initially trained on data about self-reported mind wandering. Researchers then validate a classifier on the basis of how well it detects said self-reported mind wandering. Self-report is therefore still the epistemic foundation of objective measures of mind wandering (Irving, 2018).

Classifiers inherit many of the other challenges of self-report methods as well. For instance, even supposing that the classifiers perfectly detect self-reported mind wandering (which they don't), they will be trained to detect the experimenter-imposed operational definition of mind wandering, which is most frequently task-unrelated thought. But we've already seen that various researchers have criticized this definition (section 13.3). Therefore, we can develop a more nuanced classifier—that detects the dynamics of thought, for example—only *after* we develop more nuanced self-report measures of mind wandering.

Our more fundamental point is that wholehearted skepticism about self-report is not an option for mind wandering research. In section 13.3, we noted that philosophers and cognitive scientists have both questioned whether self-report can *ever* be a reliable method. We think the success of mind-wandering science generates a powerful response to this brand of skepticism. However, if skepticism still tempts you, objective methods should provide you no relief, since those methods are only as good as the self-reports that they are designed to track.

13.7 Functional Justification of Self-Report

We've shown that mind-wandering science cannot break out of the cycle of self-report, but that does not mean we must trust self-report blindly. Instead, we have empirical and philosophical reasons to be confident in self-reports about mind wandering. We have already reviewed some of the empirical reasons for confidence (section 13.4). Self-reports of mind wandering are remarkably consistent in their contents and their ability to pick out behavior, neural activation, and third-party reports. If self-reports were spurious, we should predict that this consistency would not arise.

We will now provide a philosophical argument for the reliability of self-reports. Recall earlier our discussion of how the functional role of belief plays an important role in supporting inferences about it in experimental contexts. We believe that understanding the functional role of mind wandering will be similarly helpful in vindicating some of the self-report methods used to measure mind wandering. Our argument has the following structure. We have independent reason to believe two leading (and compatible) theories about the function of mind wandering (related to plural goal pursuit and exploration). We note that each of those theories makes predictions about the contexts in which mind wandering should be most prevalent. Self-reports confirm those predictions. The fact that our best theories and self-report methods converge is reason to trust both theory and method.

Let us start by reviewing two theories about the function of mind wandering.

13.7.1 Plural Goal Pursuit

The mind's tendency to wander is both salient and puzzling. Studies indicate that we spend a lot of time mind wandering (Seli, Beaty, et al., 2019). Perhaps this is obvious from your ordinary experience. But take a step back, and this statistic is shocking. When the world is a dynamic, unpredictable, and dangerous place, why would any creature spend half their lives being inattentive? What function could mind wandering have that explains its prominence in our lives?

The first theory is that mind wandering enables scattered agents like us to plan our futures. Human beings have hierarchically structured sets of goals, commitments, and projects that they aim to complete over timescales of days, weeks, months, and even years. This requires balancing many different demands that these place on our time. For example, one must balance the demands of being a teacher, being a parent, being a friend, and so on. Navigating social space requires living up to the different goals and expectations associated with the various roles one occupies.

In addition to having many goals, people have relatively limited capacities. Some of these limitations are physical. The particularities of embodiment preclude us from moving in two opposite directions simultaneously. However, some of these limitations are psychological. Foveal vision does not extend much beyond about 5° of arc. Working memory has severe capacity limits (Logie, 2011), items stored in working memory decay rapidly (Baddeley & Hitch, 1974; Oberauer & Kliegel, 2006), and self-control exhibits depletion effects over short timescales (Dang, 2018). These limits present obstacles to plural goal pursuit.

In order to do a lot with a little, people scatter their agency over time (see Murray, 2020). Non-scattered agents act sequentially, and they can only start a new activity upon completing or abandoning their current activity. Scattered agents, on the other hand, are capable of being engaged simultaneously in various projects without explicitly acting on any particular project then and there. In this way, scattered agents act in such a way that their actions have distinct (non-overlapping) temporal parts (see Sorensen, 1985). While scattering action is an efficient solution to the problem of plural goal pursuit under conditions of computational limitation, scattered agency raises unique engineering problems. People must now balance focus on their present activities with keeping an eye on acting in the future.

Balancing consists in dynamically altering the allocation of psychological resources to pursue multiple goals fluidly at the same time. At any point in time, there will be multiple, jointly incompatible ways of allocating one's psychological resources to pursuing distinct tasks. For example, do you focus on answering emails, editing a manuscript, or diving into some grading? You can't do all three at once, and you've got to do them all eventually. The marginal utility of focusing on any task diminishes over time. This creates pressure to switch to other tasks, the phenomenological correlate of which might be the experience of effort (Shenhav et al., 2017). However, the possibility of switching to a disengaged plural pursuit state can be beneficial, where people think about various goals without thinking too hard about any particular goal. This is especially true when current task performance is unlikely to improve with increased or sustained focus. Mind wandering's first function is arguably to enable this disengaged plural pursuit state.[7] On this view, mind wandering drifts between various contents, though it is predominantly drawn to one's goals and concerns (cf. Klinger, 2013; Irving, 2016). Mind wandering, then, reflects a way of managing limited mental resources for scattered agency.

13.7.2 The Function of Exploration

Mind wandering's second function may be to help us navigate the explore–exploit trade-off (Sripada, 2018; Irving, 2019). Imagine that you are beginning to write an essay. Before you put pen to paper, you are faced with a choice. Should you pursue one of the ideas that you have already come up with, or should you explore a new idea? Explorers take a risk: you might waste precious time. But you might strike gold. This decision is an example of a fundamental trade-off between two aims of a cognitive agent: to explore for new ideas, or to exploit the ideas we already have in order to get things done.

Humans arguably have different modes of thought that are tailored to the demands of exploitation and exploration (Sripada, 2018). Exploitative modes of thinking remain focused on our goals or personal concerns for extended periods of time and shield out distractions. You engage in exploitative thought, for example, when you successfully guide your attention to this chapter for long enough to get through a few pages. Exploitative thinking is necessary for limited agents like us. At any time, you can only focus on a tiny subset of all the relevant information. To make this subset count, you must be able to focus on what you think is relevant (e.g., this chapter) and ignore almost limitless things that might distract you.

Exploitation is an incomplete strategy, however, because you can be wrong about what is in fact relevant to you. Imagine that you dutifully guide your attention to this chapter, and nothing but, for a whole day. We the authors would be thrilled! But we recognize that you might miss out. Perhaps you would forget about other commitments that you have made. Or you might simply fail to expand the sphere of what you are reading and thinking about. By constantly guiding your attention to what you *think* is relevant, you risk being caught in a cognitive bubble, where you never notice the information that would lead you to expand your own point of view.

Exploratory modes of thought such as mind wandering may help us burst cognitive bubbles. When your mind drifts between topics, you may think of ideas that seem strange, useless, or irrelevant. This is not a bug of mind wandering but rather a feature, since seemingly useless information can turn out to be crucial. Seemingly irrelevant ideas may be just what you need to expand your point of view. Mind wandering, then, may be an inbuilt mode of cognitive exploration that helps us take risks and search for new ideas. Most of the time, this exploration may prove useless. But sometimes it will strike gold.

13.7.3 Triangulation of Function and Method

We have sketched two theories about the functions of mind wandering. First, mind wandering supports plural goal pursuit. Second, mind wandering supports cognitive exploration. Despite their differences, these theories generate common a priori predictions about the circumstances likely to elicit mind wandering.

Mind wandering should occur when we are bored or under-stimulated. Both of our functional theories contrast mind wandering with more focused forms of thinking, which occur when we are pursuing a single important goal (e.g., writing an exam or running from a tiger). We should therefore expect mind wandering to occur when people are bored, as boredom reflects a perceived lack of important information to extract from the task environment. Relatedly, we should expect strategic mind wandering in familiar and predictable task environments. Such environments are structured in ways where task performance does not benefit from sustained focus on the task (Kane, Gross, et al., 2017). When engaged in boring or predictable tasks, we can free our cognitive resources to focus on the type of plural goal pursuit and/or exploration characteristic of mind wandering (Geana et al., 2016).

Results from self-report studies are consistent with our a priori predictions about the circumstances likely to elicit mind wandering. For example, mind wandering is more frequent when people are bored or under-stimulated, or when they are doing something either too easy or too difficult (Eastwood et al., 2012). People report that mind wandering is more pleasant when they are doing something unengaging, which suggests that mind wandering relieves boredom (Mooneyham & Schooler, 2013). The conditions that we expect to elicit mind wandering turn out to be the conditions where we observe a lot of mind wandering.

The fact that our best functional theories and self-report methods converge is reason to trust both theory and method. Consider an analogy. Imagine that we have two very different methods to estimate a quantity, such as the density of gold. Can we trust that our methods are accurate? Well, suppose we find that each method is internally consistent: they yield the same measurements at different times and for different samples of gold. Suppose further that the methods are consistent with each other: both estimate the density at 19.32 cm^3. Unless we have reason to think otherwise, the best explanation of this internal and external consistency is that (1) the density of gold is 19.32 cm^3, and (2) both methods can accurately estimate this density. The fact that diverse methods triangulate onto a single answer gives us reason to trust both methods.

We think a similar form of triangulation gives us reason to trust self-report methods in mind-wandering science. Self-report methods are internally consistent, at least about the result that variables such as boredom elevate mind wandering. Self-report methods are also consistent with independently plausible theories about the function of mind wandering. Put colloquially, one reason to believe self-reports about mind wandering is that they make sense.

Put more precisely, philosophical argumentation and self-report are both reliable methods for forming beliefs about mind wandering. These methods triangulate onto common claims about mind wandering—for example that boring tasks elevate mind wandering. Unless we have reason to think otherwise, the best explanation for this triangulation is (1) that mind wandering occurs more frequently in boring and undemanding tasks and (2) that philosophical argumentation and self-report are both accurate.

We have focused on predictions about boredom. But triangulation has much broader application in the science of mind wandering. We can generate more consensus predictions from our best theories of the function of mind wandering. We can then see whether self-report methods yield results that make sense, given these predictions. If they do, this gives us defeasible reason to trust that self-reports about mind wandering are accurate. Mind-wandering science may be unable to do without self-report. But our trust in self-report can be based in theory rather than blindness.

13.8 Conclusion

Mind-wandering science cannot do without self-report. At best, objective measures complement but do not replace self-report methods. This is not a defect of mind-wandering research but rather a reflection of the kind of cognitive state that mind wandering is: a passive manifestation of agency. We suspect that there are many other passive manifestations of agency that are inaccessible to purely task-based methodologies. As such, research on mind wandering provides valuable lessons on how to refine self-report methodologies and use them in conjunction with more standard methods in cognitive psychology and neuroscience.

Skeptics about the reliability of self-report may take this as reason to doubt mind-wandering science. Our response to the skeptic appeals to the metaphysics of mind wandering to partially vindicate self-report methods. This response highlights how theoretical models play an important role in verifying the accuracy of experimental methods. When the outputs of these methods (data) converge with the predictions of the model, this is crucial evidence for the validity of empirical methods. Convergence, then, also provides evidence in favor of the model. The justificatory pathway between theory and data runs both ways. This runs contrary to a tendency in cognitive psychology to separate theory and data, with data being considered the only source of evidence. Theories, on this view, might make predictions that guide the acquisition of data, but theories themselves are not considered sources of evidence. Our argument depends on this being wrong. Instead, the theoretical content of and argument for a model play important roles both in verifying each of these methods and in the model itself. This is consistent with a model-based view of scientific methodology that began to flourish as a reaction against the logical positivism of the twentieth century (see Kuhn, 1962; Feyerabend, 1969; Tal, 2011).

While this is a longer story than we have space here to tell, we want to highlight the fact that, on our view, *philosophical theorizing* plays an important role in generating evidence insofar as such theorizing can produce models. Our argument is one example of this. The functional characterizations of mind wandering offered above are drawn from philosophical reflections on mind wandering, attention, and action. This suggests that philosophers have a more active role to play in empirical inquiry than simply double-checking the inferences that cognitive scientists make.

Notes

1. The Killingsworth and Gilbert (2010) study enjoys some prominence in the mind-wandering literature for being one of the first large-scale experience sampling studies of mind wandering published in a prestigious venue. The paper is cited mainly for two findings: (1) the results that 30–50 percent of waking thoughts are mind wandering, and (2) the association between mind wandering and negative affect. However, both results have been challenged recently. Some studies have shown that the frequency of mind wandering varies as a function of the response options provided to indicate mind wandering. Based on how self-reports are interpreted, mind wandering can constitute anywhere from 18 to 60 percent of waking thoughts (Seli, Beaty, et al., 2019). Moreover, the association with negative affect fails to distinguish between different kinds of mind wandering (intentional/unintentional) and does not consider relevant trait-level moderators (e.g., mindfulness; see Wang et al., 2017). Reanalysis of the Killingsworth and Gilbert (2010) data shows that accounting for interest in the content of off-task thoughts reveals a positive association between mind wandering and positive affect (Franklin, Broadway, et al., 2013). This shows that the results of the Killingsworth and Gilbert (2010) study should be viewed within the context of recent developments and criticisms.

2. Shulman and colleagues (1997) provided the initial characterization of the default mode network by contrasting activations in control states from activations in task states in positron emission tomography studies. Follow-up studies confirmed the identity of the network (Binder et al., 1999; Mazoyer et al., 2001).

3. Nonhuman animals, including marmosets and macaques, also have a network that is organized similarly to the default network (for a review, see Buckner & DiNicola, 2019). This may also point to a dissociation between mind wandering and the

default network if there are independent reasons to deny that nonhuman animals mind wander.

4. There are many different kinds of self-report used throughout the behavioral sciences. We are interested in the kind of self-report described here—namely, making a judgment about one's mental states on the basis of retrospective assessments. All subsequent reference to self-report picks out this subset of self-report measures.

5. The modal scope includes nomological possibility. In section 13.4, we explain why creatures like us in worlds like this cannot voluntarily initiate certain activities. Perhaps there are worlds and creatures that differ on these grounds. We think it is the job of theologians and poets (rather than this chapter) to consider these possibilities.

6. Faber, Bixler, and D'Mello (2018) actually tested a few different classification algorithms. The best model was a sequential minimization optimization algorithm, which is an implementation of a support vector machine classifier.

7. The term "disengaged" serves to distinguish mind wandering from multitasking, the latter of which is an engaged or committed form of plural goal pursuit. Roughly, in multitasking, someone explicitly commits to focusing on several tasks simultaneously. In mind wandering, several tasks can at any one time be at the forefront of one's mind, but there is no explicit commitment to keep any single task (or set of tasks) in focus.

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Neuroscience and Philosophy

Edited by: Felipe De Brigard, Walter Sinnott-Armstrong

Citation:

Neuroscience and Philosophy
Edited by: Felipe De Brigard, Walter Sinnott-Armstrong
DOI: 10.7551/mitpress/12611.001.0001
ISBN (electronic): 9780262367332
Publisher: The MIT Press
Published: 2022

The open access edition of this book was made possible by generous funding and support from MIT Press Direct to Open

The MIT Press

The MIT Press would like to thank the anonymous peer reviewers who provided comments on drafts of this book. The generous work of academic experts is essential for establishing the authority and quality of our publications. We acknowledge with gratitude the contributions of these otherwise uncredited readers.

This book was set in Stone Serif by Westchester Publishing Services. .

Library of Congress Cataloging-in-Publication Data

Names: Brigard, Felipe de, editor. | Sinnott-Armstrong, Walter, 1955– editor.
Title: Neuroscience and philosophy / edited by Felipe De Brigard and
Walter Sinnott-Armstrong.
Description: Cambridge, Massachusetts : The MIT Press, [2022] |
Includes bibliographical references and index.
Identifiers: LCCN 2021000758 | ISBN 9780262045438 (paperback)
Subjects: LCSH: Cognitive neuroscience—Philosophy.
Classification: LCC QP360.5 .N4973 2022 | DDC 612.8/233—dc23
LC record available at https://lccn.loc.gov/2021000758