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Boring Thoughts and Bored Minds: The MAC Model of Boredom and Cognitive Engagement

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What is boredom? We review environmental, attentional, and functional theories and present a new model that describes boredom as an affective indicator of unsuccessful attentional engagement in valued goal-congruent activity. According to the Meaning and Attentional Components (MAC) model, boredom is the result of (a) an attentional component, namely mismatches between cognitive demands and available mental resources, and (b) a meaning component, namely mismatches between activities and valued goals (or the absence of valued goals altogether). We present empirical support for four novel predictions made by the model: (a) Deficits in attention and meaning each produce boredom independently of the other; (b) there are different profiles of boredom that result from specific deficits in attention and meaning; (c) boredom results from two types of attentional deficits, understimulation and overstimulation; and (d) the model explains not only when and why people become bored with external activities, but also when and why people become bored with their own thoughts. We discuss further implications of the model, such as when boredom motivates people to seek interesting versus enjoyable activities.

Keywords: attention, boredom, emotion, meaning, motivation

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> "If you are immune to boredom, there is literally nothing you cannot accomplish."
>
> —David Foster Wallace

At some point you will probably be bored by this paper. You may find your thoughts wandering, eyes skipping, attention utterly adrift—and for most of you, this sensation will be sinkingly familiar. Waiting in lines, trapped in meetings, stuck at stoplights: we all experience times when we simply cannot pay attention, where we want to do something—*anything*—other than what we're doing right now. Boredom can be as superficial as finding nothing worth doing on a lazy summer afternoon, or as deep as finding nothing worth doing at all. David Foster Wallace, in his novel *The Pale King* (Wallace, 2011), wrote of boredom, ominously, "Routine, repetition, tedium, monotony, ephemeracy, inconsequence, abstraction, disorder, boredom, angst, ennui—these are the true hero's enemies, and make no mistake, they are fearsome indeed. For they are real" (p. 231). Boredom is an immensely powerful motivator of people's actions, for both better and worse. It may inspire the most trivial and meaningful of acts, from doodling (Andrade, 2010; Maclay, Guttmann, & Mayer-Gross, 1938) and bursts of creativity (Baird et al., 2012; Harris, 2000; Schubert, 1977, 1978) to self-destructive drug use (Lee, Neighbors, & Woods, 2007), compulsive gambling (Mercer & Eastwood, 2010), and even self-harm (Barbalet, 1999; Chapman & Dixon-Gordon, 2007).

Surprisingly, for such a pervasive and potentially powerful emotion, boredom has not, until recently, received much attention in the psychological literature. In this paper, we review the current literature on state boredom, and propose a new model that makes novel predictions about what boredom is, why it is experienced, and how people react to it. In doing so, we present new empirical evidence for many of these predictions.

Most previous accounts have focused overwhelmingly on *trait boredom*, or individual differences in a person's tendency to experience boredom more frequently or intensely compared with others. Others have focused on chronic or existential boredom, which closely resembles depression and has long been the concern of philosophers and psychoanalytic thinkers (Frankl, 1962; Maddi, 1970; O'Connor, 1967; Schopenhauer, 1818). Although these are important topics, it is equally important to understand why everyone experiences boredom at times, what makes that state so aversive, and how people can avoid or reduce it. Our focus will thus be on *state boredom*, which has been defined as "the aversive state of wanting, but being unable, to engage in a satisfying activity"

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(Eastwood, Frischen, Fenske, & Smilek, 2012, p. 483). State boredom is thus a negative affective state that, in its simplest sense, signals a desire to do something different.

To preview, we will argue that boredom acts as an online affective indicator of unsuccessful attentional engagement in a valued goal-congruent activity. Boredom tells us whether our current activity (internal or external) is something we *are able to* focus on and *want* to be engaged in. Boredom thus has both attentional (i.e., *able* to) and meaning (i.e., *want* to) components. The experience of boredom motivates people to take steps toward restoring successful engagement in a meaningful activity. This approach, which we call the Meaning and Attentional Components (MAC) model, has the advantage of integrating prior approaches that have tended to focus separately on deficits in meaning or attention. It also has a larger scope than prior theories, in that it explains boredom while people are engaged in an external activity (similar to prior models) as well as boredom with one's own thoughts (unlike most prior models). Most importantly, the model generates a number of novel predictions, including that multiple types of boredom exist which motivate different responses depending on their underlying causes of meaning and attention. We present below empirical support for several of these predictions.

Theories of Boredom

We begin with a review of previous theories of state boredom, which we have grouped into three major families: (a) environmental theories, in which boredom is said to result from inadequate environmental inputs (e.g., insufficient stimulation); (b) attentional theories, in which boredom is said to result from attentional deficits; and (c) functional theories, in which boredom is said to confer information about the value of the task. Each of these approaches has made valuable contributions, though none provides a comprehensive model of boredom. Environmental theories, for instance, focus on the contextual determinants of boredom, whereas attentional theories focus on the psychological processes that underlie those effects. Likewise, functional theories focus on the adaptive role these processes play. By integrating these approaches into one comprehensive account, the MAC model is able to offer new perspectives on boredom that aren't apparent from the viewpoint of its individual components.

Environmental Theories of Boredom

The environmental factors that have been said to contribute to boredom include insufficient stimulation (Cox, 1980; Hebb, 1966; Kubose, 1972; London, Schubert, & Washburn, 1972; Mikulas & Vodanovich, 1993; O'Hanlon, 1981; Perkins & Hill, 1985; Posner, Russell, & Peterson, 2005; Thackray, Bailey, & Touchstone, 1977), non-optimal arousal (Berlyne, 1960; Hebb, 1966), and constrained choice (Chin, Markey, Bhargava, Kassam, & Loewenstein, 2017; Troutwine & O'Neal, 1981). What these factors have in common is that they primarily emphasize external environmental rather than internal psychological causes of boredom.

Insufficient stimulation. Classic theories of boredom focus on its roots in insufficient external stimulation in the environment. Examples include simple, repetitive tasks that require little to no thought or attention (Cox, 1980; Markey, Chin, Vanepps, & Loewenstein, 2014) and vigilance tasks that require constant attention but little variety (Hunter & Eastwood, 2016; Markey et al., 2014; Thackray et al., 1977). Posner et al. (2005) define boredom as low arousal caused by insufficient external stimulation, and van Tilburg and Igou (2017a) argue that low arousal is one of the key components that differentiates boredom from related emotions. Similarly, a lack of challenge is the primary cause of boredom in models of flow (Csikszentmihalyi, 2000), and optimal arousal theories of boredom implicitly assume that understimulation is the root cause of both low arousal and boredom (Hebb, 1966; Fiske & Maddi, 1961).

However, the evidence that boredom is characterized by low arousal is decidedly mixed. Although some studies have found boredom to be associated exclusively with low arousal (Mercer & Eastwood, 2010; Posner et al., 2005; Thackray et al., 1977; van Tilburg & Igou, 2017a), many more have found boredom to be associated with either high arousal (Abramson & Stinson, 1977; London & Monello, 1974; London et al., 1972; Ohsuga, Shimono, & Genno, 2001), or a mixture of both high- *and* low-arousal (Chin et al., 2017; Eastwood et al., 2012; Fahlman, Mercer-Lynn, Flora, & Eastwood, 2013; Goetz, Frenzel, Pekrun, & Hall, 2006; Goetz et al., 2014; Mercer-Lynn, Bar, & Eastwood, 2014; Merrifield & Danckert, 2014; Raffaelli, Mills, & Christoff, 2017). One of the shortfalls of theories that define boredom as a low-arousal state, then, is their inability to account for many studies that find that people who are bored are in a state of high arousal. This is consistent with research on the circumplex model of affect, which posits arousal and valence as independent emotional dimensions (Russell, 1980; Russell & Barrett, 1999). That is, high arousal can be either positive (e.g., excitement) or negative (e.g., frustration), depending on the eliciting circumstances. We report evidence consistent with a form of high-arousal boredom due to meaning deficits and overstimulation in Studies 2 and 3 of this paper, respectively.

Constraint. Troutwine and O'Neal (1981) suggested that it is not understimulation and low arousal that lead to boredom, but rather the existence of external constraints: People experience boredom when they feel "stuck" in a situation or unable to switch sources of stimulation. Such constraints impose reduced autonomy, which in turn reduces interest (Deci & Ryan, 1985; Harackiewicz, Abrahams, & Wageman, 1987; Lepper & Greene, 1978). For instance, officials at a Houston airport received many complaints from passengers about the amount of time they had to wait for their luggage to arrive at the baggage claim area. The passengers were in a highly constrained situation; there was nothing they could do to predict or control when their bags would arrive. Airport officials purportedly solved the problem not by speeding up the baggage handling process, but by moving the baggage claim area farther from the arrival gates. It took the same amount of time for the bags to arrive, but now passengers spent that time walking to the baggage claim area, presumably with a sense that they were freely making progress toward their goal of collecting their luggage (Stone, 2012). Objective constraints did not change (it took just as long to get their luggage after disembarking), but subjective perceptions did, which reduced the number of complaints, and, presumably, boredom (Fisher, 1993).

Likewise, in experience sampling studies, people report being more bored in highly constrained settings, such as at work or in school (Chin et al., 2017). Constraint is particularly pertinent in educational settings, where many students feel trapped by unvary-

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ing routines that they cannot escape (Daschmann, Goetz, & Stupnisky, 2011), and boredom in these settings is strongly associated with low motivation and poor outcomes (Goetz et al., 2014; Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010; Tze, Daniels, & Klassen, 2016). Pekrun (2006) argued that these precursors are, at heart, really about control; his control-value theory of achievement emotions argues that boredom is the joint result of (a) lack of control (or too much control) over an achievement task and (b) lack of perceived value in academic tasks.

Other studies, however, suggest that perceived constraint may only matter in unpleasant situations. In one, participants forced to listen to a monotonous recording experienced boredom, whereas participants forced to listen to an interesting recording did not (Troutwine & O'Neal, 1981). In other cases, people "trapped" in pleasant situations (e.g., at a tropical resort or on a pleasant date) do not become bored, despite the element of constraint. If it did, people who pay to attend a movie theater should surely be more bored than those who elect to watch the same film at home on Netflix, because visiting a movie theater involves more constraints (e.g., filmgoers cannot determine when the film begins, pause, rewind, or fast-forward through previews, nor control volume, etc.). Constraint may be an important element of boredom, but it is not the only determinant.

Attentional Theories of Boredom

In contrast to environmental theories of boredom, which focus on the contextual features of the situation, attentional theories focus on one of the cognitive processes underlying those effects: the regulation of attention (Eastwood et al., 2012; Fisher, 1993; Hamilton, 1981; Leary, Rogers, Canfeld, & Coe, 1986; Smith & Ellsworth, 1985). These theories attribute boredom to the profound failure of attentional systems to successfully orient, engage, and maintain focus on an activity.

Boredom as the failure of attention. Eastwood et al. (2012), in an influential article, argued that boredom occurs when (a) people are unable to successfully engage their attention in a satisfying activity, (b) they are aware of their lack of engagement, and (c) they attribute their lack of engagement to the activity. When these conditions are met people experience non-optimal arousal, executive function failure, difficulty concentrating, negative affect, perceived lack of agency, and slowed perceptions of time—in short, the classic hallmarks of boredom. Consistent with this view, studies have shown that when people find it difficult to pay attention to a monotonous task, and attribute that difficulty to the task, they report being bored (Damrad-Frye & Laird, 1989; Fisher, 1993; Fisher, 1998; Hunter & Eastwood, 2016).

Causes and consequences. The idea that attentional failure plays a pivotal role in the experience of boredom, and that the maintenance of attention depends on an optimal match between mental resources and cognitive demands, has received substantial support (Danckert & Merrifield, 2016; Eastwood et al., 2012; Fisher, 1993, 1998). However, these models have paid less attention to what leads to attentional failure in the first place or the downstream consequences of such a failure. For instance, attentional models often do not integrate their findings with other theoretical approaches to make clear predictions about when and why certain contextual features should elicit attentional failure and boredom. Nor do they distinguish between different kinds of attentional failure; we argue later that it is important to distinguish between understimulation (the case in which attentional demands exceed what a task requires) and overstimulation (the case in which attentional demands are insufficient for what a task requires). We will also suggest that it is important to distinguish between two types of attentional fit: The case in which attentional resources and task demands are both low and the case in which they are both high. These different forms of attentional matches and mismatches, we will argue, result in different types of boredom.

Lastly, attentional theories do not incorporate another important dimension of boredom: even when successfully engaged and attending to a task, people may feel bored if that task is not meaningful (van Tilburg & Igou, 2012). Attentional failure may determine whether a person *can* successfully engage in a task, but not whether a person *wants* to. Attentional regulation failure may thus be a sufficient—although not necessary—cause of boredom.

Functional Theories of Boredom

In contrast to environmental theories of boredom, which focus on eliciting contextual features, or attentional theories, which focus on one of the cognitive processes underlying those effects, functional theories focus on its underlying purpose. Drawing on classic work on affect-as-information (Clore, Gasper, & Garvin, 2001; Ortony, Clore, & Collins, 1988), functional theories emphasize the role that emotions play in conveying information relevant to one's current circumstances. These approaches theorize that boredom acts as a distress signal that motivates behavioral or cognitive change (Elpidorou, 2014, 2017). Although they agree that boredom provides information, they differ in what information is being conveyed and, therefore, in what causes boredom. Importantly, attention is not emphasized as one of these potential causes. Instead, boredom is said to signal whether an activity serves a useful goal (Bench & Lench, 2013; Fisher, 1993; Hill & Perkins, 1985), invokes an opportunity cost (Kurzban, Duckworth, Kable, & Myers, 2013), or is meaningful (Barbalet, 1999; Chater & Loewenstein, 2016; Locke & Latham, 1990; Schmeitzky & Freund, 2013; van Tilburg & Igou, 2017a).

Goals. Several theorists argue that boredom conveys information about whether the current activity serves a useful goal (Bench & Lench, 2013; Fisher, 1993). According to Bench and Lench (2013), boredom motivates people to switch goals by signaling that an activity no longer serves a useful purpose. Such goal-switching reduces opportunity costs by preventing people from persevering too long on tasks that are no longer beneficial and thereby missing out on other more rewarding activities. According to this account, understimulation is the signal that an activity is no longer serving a useful purpose and is thus the immediate root cause of boredom: as stimulation drops, boredom kicks in. Once triggered, this boredom drives people to adopt a new goal.

Bench and Lench's (2013) approach is one of the few that addresses the important question of the consequences of boredom, that is, how it motivates behavior change. Further, it makes predictions about what people will want to do when bored, suggesting that they will choose new goals indiscriminately (p. 462) or seek new goals that are mirror opposites of their previous goal (p. 465). For instance, people who became bored while watching a sad movie might subsequently prefer the goal of watching a funny

Table 1
Conflicting Predictions of Boredom Outcomes as a Function of Current Theories

Environmental and attentional theories	Functional theories	
	Low Meaning	**High Meaning**
Non-optimal Stimulation Demands ≠ Resources	(A) Boredom	(C) Enjoyment (***functional theories***) or boredom (***attentional theories***)
Optimal Stimulation Demands = Resources	(B) Boredom (***functional theories***) or enjoyment (***attentional theories***)	(D) Enjoyment

Note. Cells are lettered for ease of reference. The bolded terms indicate determinants of boredom.

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movie (or vice versa). However, whereas empirical evidence suggests that people choose new activities when bored, these choices appear neither indiscriminate nor the opposite of previous goals. Research shows, for example, that bored people often prefer exciting films to tranquil films (Bryant & Zillmann, 1984), meaningful activities to nonmeaningful activities (van Tilburg & Igou, 2012), and interesting foods (e.g., sweets and cherry tomatoes) to plain foods (e.g., crackers; Moynihan et al., 2015).

Opportunity costs. Similar to Bench and Lench (2013), Kurzban et al. (2013) argue that boredom's primary purpose is to avoid opportunity costs by providing an affective cost/benefit analysis of one's current activity. According to this approach, boredom is triggered when the cost of continuing the current task outweighs the benefit, particularly in comparison with currently available alternative tasks. Boredom thus stops people from doggedly pursuing unachievable goals and missing out on important opportunities. When one task becomes too "expensive," either because it is consuming too many resources or is not delivering enough benefit, the resulting boredom keeps a person from persisting at that task. The availability of attractive alternative tasks, in this view, should increase boredom, because it increases the opportunity cost of continuing with an unproductive one. Although this approach offers valuable insight into why boredom is functional, Kurzban and colleagues only tangentially touch on the role of attentional regulation and resource-demand mismatch. Their account implicitly assumes an optimal match between cognitive demand and resources. That is, the question is not whether the demands of a task outweigh available resources, but whether the resources spent are "worth it."

Meaning. A final group of functional theories suggest that boredom is a barometer of meaning. According to these theories, the crucial factor is not whether a task serves a goal, but whether people find *meaning* in the task. Boredom is a signal of a lack of meaning and motivates people to reengage in meaningful activities (Barbalet, 1999; Schmeitzky & Freund, 2013; van Tilburg & Igou, 2012).

There is considerable empirical support for the role of meaning in boredom. Unlike earlier environmental theories or more recent attentional theories, Barbalet (1999) argues that monotonous tasks are boring precisely because they tend to be relatively meaning- and purposeless. For instance, one study found that imputing meaning to a monotonous task increased productivity, presumably by reducing boredom (Locke & Latham, 1990). Another manipulated how meaningful a monotonous task was by varying the recipient of a small monetary award (Schmeitzky & Freund, 2013). In the low meaning condition, participants were told that they personally would receive a small sum of money at the end of the study. In the high meaning condition, participants were told that the same sum would be donated to a charity which would ultimately provide needy recipients with clean water. Participants in the high meaning condition reported that the experience (and the actual monotonous task itself) was more enjoyable and less boring than participants in the low meaning condition, even though they performed the same activity for the same amount of money.

van Tilburg and Igou (2012) define meaning as the expectation that an activity will satisfy a valued goal (van Tilburg & Igou, 2013) and suggest that a lack of meaning is the distinctive defining feature that distinguishes boredom from other emotions such as anger, frustration, and sadness. Boredom is thus a functional state that motivates people to reestablish meaning by seeking out new activities. Consistent with this view, experimentally induced state boredom increases prosocial intentions, nostalgia, and in-group favoritism (van Tilburg & Igou, 2011, 2017b; van Tilburg, Igou, & Sedikides, 2013) and leads to changes in political ideology (van Tilburg & Igou, 2016). Boredom may even motivate people to engage in maladaptive activities, if those activities offer the chance of restoring meaning to meaninglessness. For this reason, Barbalet (1999) speculates that boredom may underlie serious societal problems such as gambling and intergroup conflict, to the extent that people view these activities as meaningful alternatives to otherwise dull lives. Several types of maladaptive behavior have in fact been shown to be correlated with boredom, including problem gambling (Mercer & Eastwood, 2010), marijuana use (Lee et al., 2007), and alcohol use (Johnson & Cropsey, 2000; Orcutt, 1984).

Functional theories of boredom specify not just how and when boredom occurs, but why.[1] However, these theories do not directly account for boredom's well-documented attentional component: they explain why people feel bored when they do not *want* to be doing something, but they do not address the critical question of whether people *can* engage in the activity in the first place. This distinction is important because people routinely experience boredom during meaningful tasks when those tasks occur under challenging conditions or involve monotony and drudgery. In fact, functional and attentional theories offer competing predictions about whether people will experience boredom on such occasions. Consider the case in which people are attempting to perform a meaningful task but the demands of the task exceed their attentional resources. As shown in Cell C of Table 1, functional theories

[1] As noted, there are a variety of functional theories of boredom; as an illustrative example, we focus here on approaches that treat *meaning* as the primary informational function of boredom, because of the prevalence of this model in the literature.

Table 2
Profiles of Boredom (in Bolded Italics) and Their Predicted Outcome (in Italics) as a Function of Meaning and Attention

	Meaning component	
Attention component	**Low Meaning** Task is INCONGRUENT with valued goals	**High Meaning** Task is CONGRUENT with valued goals
Understimulation: Demand < Resources	(A) ***Meaningless + Attentional boredom*** *Seek interesting activity*	(E) ***Attentional boredom*** *Increase demand*
Low-level Engagement Low demand + Low resources	(B) ***Meaningless boredom*** *Seek enjoyable activity*	(F) ***Enjoyment*** ***(Low boredom)***
High-level Engagement High demand + High resources	(C) ***Meaningless boredom*** *Seek interesting activity*	(G) ***Interest*** ***(Low boredom)***
Overstimulation: Demand > Resources	(D) ***Meaningless + Attentional boredom*** *Seek enjoyable activity*	(H) ***Attentional boredom*** *Increase resources*

Note. Cells are lettered for ease of reference.

predict that people will not experience boredom, whereas attentional theories predict they will. Now consider the case in which people are performing a meaningless task with ample attentional resources. As seen in Cell B of Table 1, functional theories predict that people will experience boredom, whereas attentional theories predict they will not. Clearly a comprehensive approach to boredom is needed that resolves these competing predictions.

The Meaning and Attention Components (MAC) Model of Boredom

We propose that boredom is an affective indicator of unsuccessful attentional engagement in valued goal-congruent activity. That is, it is a functional emotion with both attentional ("can I focus?") and meaning ("do I want to?") components. Boredom, therefore, is experienced when people feel either *unable* or *unwilling* to cognitively engage with their current activity. Put differently, to avoid boredom, people must be able to focus on an activity and want to do so, and thus experience meaningful engagement.

The idea that people need to be both able and willing to perform an activity is hardly new; this assumption underpins many other psychological theories, including the Elaboration Likelihood Model of attitude change (Petty & Cacioppo, 1986), belief formation (Gilbert, 1991), and theories specifying the relationship between controlled and automatic processes (Strack & Deutsch, 2004; Wilson, Lindsey, & Schooler, 2000), among many others. We suggest that this distinction can be profitably applied to an understanding of boredom. Specifically, there are two crucial pieces of information boredom provides—first, whether there is successful cognitive engagement in the current task (*attentional* component) and second, whether the current task, regardless of engagement, is valuable and thus worth pursuing (*meaning* component). Whereas attention and meaning are interrelated in some ways (Barnard, Scott, Taylor, May, & Knightley, 2004; Treisman, 1964), we argue that they form two distinct proximal causes of boredom. We elaborate on these points in the following sections.

Attentional Component: Balancing Cognitive Demands and Mental Resources

The MAC model is depicted in Table 2. The rows represent the attentional component, namely whether people are *able* to maintain attention on the task, including orienting, alerting, and executive control (Posner & Petersen, 1990; Posner & Rothbart, 2007). Cognitive engagement is the result of successful attentional fit, which occurs when cognitive demands are balanced by available mental resources (Berlyne, 1960; Wickens, 1991; Wickens, 2002). A novel aspect of the model is that it posits two ways in which cognitive demands and mental resources can be balanced: low-level engagement (Row 2 in Table 2), where available resources and demands are both low (e.g., a tired person has just enough energy to watch TV or work on a Sudoku puzzle), and high-level engagement (Row 3 in Table 2), where available resources and demands are both high (e.g., an energized reviewer reading a well-written and fascinating manuscript; Frankenhaeuser & Gardell, 1976; Young & Stanton, 2002a; Young & Stanton, 2002b). For instance, Hancock and Caird (1993) found that optimal "mental workloads" occur when task demands match a given individual's cognitive capacity (Hancock & Caird, 1993).

Attentional failure results from the mismatch between cognitive demands and mental resources (Wickens, 1991; Wickens, 2002). Another novel feature of the model is that it also posits two ways in which attentional demands can be ill-matched with resources: understimulation or overstimulation.[2] The first row of Table 2 represents understimulation, which has been widely documented as a powerful predictor of boredom (Eastwood et al., 2012), and can occur either because demands are particularly low (e.g., a monotonous task; Cox, 1980; Markey et al., 2014) or because resources are particularly high (e.g., intelligence; London et al., 1972). For instance, whereas all people found it more boring to write the letters "cd" over and over for 30 min (vs. writing a story

[2] In a recent review, Raffaelli, Mills, & Christoff (2017) also raise this point, calling it the "mismatch hypothesis" (p. 3).

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for the same length of time), the people who found it the most boring were those who scored highest on a military intelligence test (London et al., 1972). This lack of challenge (i.e., instances where resources exceed demands) has been identified as a critical factor in boredom in both classic models of flow (Csikszentmihalyi, 2000), as well as more recent functional theories focusing primarily on boredom and meaning (van Tilburg & Igou, 2017a).

However, in contrast to such models, we argue that attentional failure can also take the form of *overstimulation*, whereby cognitive demands exceed mental resources (Wickens, 1991; Wickens, 2002; see the bottom row of Table 2). Overstimulation occurs either because demands are particularly high or resources are particularly low (e.g., an exhausted reviewer trying to read and understand a poorly written, dense manuscript).

There is empirical support for the hypothesis that overstimulation can cause boredom. One study found that while an easy version of a vigilance detection task increased boredom (as expected), so did a much more difficult version (Hitchcock, Dember, Warm, Moroney, & See, 1999). That both the hard and easy versions induced boredom, we argue, is likely because both versions resulted in attentional failure. In other words, just as the easy version was *too* easy (and thus understimulating), the harder version was too hard, as evidenced by much lower performance in that condition. Additional evidence comes from research in work and academic domains. Students consistently feel most bored (and least interested) during classes that are too difficult and in which they do not expect to do well (Tanaka & Murayama, 2014; Wigfield & Eccles, 2000). Fisher (1987) likewise identified two distinct patterns of workplace boredom: one associated with underload and another with overload. She argued that overstimulation can give rise to boredom when a task is too demanding and exceeds a person's capacity for meaningful understanding (Fisher, 1993). And, as we will see shortly, one reason people find thinking to be boring is because it is difficult to sit alone and concentrate on one's thoughts, and reducing that cognitive demand makes it less boring (Westgate, Wilson, & Gilbert, 2017).

Nonetheless, the idea that boredom can result from overstimulation may seem counterintuitive, in part because overstimulation can also result in a different emotion: frustration. Frustration results from "being displeased about an undesirable event" (Clore, Ortony, Dienes, & Fujita, 1993, p. 76), and occurs particularly as the result of blocked goal pursuit (Anderson & Bushman, 2002; Dollard, Doob, Miller, Mowrer, & Sears, 1939; Scherer, 2001). To the extent that overstimulation involves failing to achieve a desired outcome (e.g., the exhausted reviewer finding it difficult to finish the review and move on to something more enjoyable), frustration will co-occur with boredom. But frustration and boredom have distinct causes and do not always overlap. People's goals can be blocked for reasons outside of their control (e.g., a flight delay) and that have nothing to do with their cognitive resources or processes (Clore et al., 1993). Under these circumstances they will feel frustrated but not bored. But if their goal is blocked because the cognitive demands entailed overwhelm their limited resources, they should feel both bored and frustrated.

Put differently, a task should give rise to boredom to the extent that people feel they do not have the appropriate cognitive resources to stay focused on what they are doing, but frustration to the extent that such failure to focus blocks a desired outcome. Thus, whereas boredom is about the process, frustration is about the outcome of that process. Frustration should thus have a linear relationship with task difficulty; as difficulty increases, people are less likely to successfully complete a task and frustration should increase accordingly. Boredom, on the other hand, should have a curvilinear relationship with difficulty: When a task is too easy or too hard, people will feel understimulated or overstimulated, respectively, have trouble paying attention, and experience boredom. When the task is "just right," matching people's available cognitive resources, people should not be bored. We report data consistent with this hypothesis in Studies 3 and 4.

Meaning Component: Matching Current Activities With Valued Goals

The columns of Table 2 represent the meaning component of the model, namely whether the person *wants* to do the activity. Activities feel meaningful—and people *want* to engage in them—when they are congruent with currently activated goals that are both valued and task salient (Heintzelman & King, 2013; Steger, 2012). Activities vary in the degree to which they serve such goals: some activities may only partially fulfill current goals; other activities may barely correspond to such goals at all. The greater the congruency, according to the MAC model, the greater the sense of meaning, and thus the lower the likelihood of boredom. The left column represents instances in which people perceive the current activity as incongruent with valued goals, resulting in low meaning. The right column represents instances in which people perceive the current activity as *congruent* with valued goals, resulting in high meaning.

But which goals matter? Currently activated concrete goals, like emotions, are rooted deeply in the moment (Clore et al., 2001) and reflect currently accessible thoughts, not long-term abstractions. They concern outcomes that are highly valued, imminently attainable, under threat, or require action in the present or near future (Klinger, Barta, & Maxeiner, 1980, referred to these as "current concerns"). A goal that is unimportant in a larger sense, such as the outcome of a particular basketball game, may thus trump long-term goals, such as being admitted to law school—for a fan watching her favorite team protect a slim lead in the final minutes of the game. It is these currently accessible goals that determine whether an activity feels meaningful or boring. Working on law school applications may be deeply meaningful in a long-term sense, but may not *feel* meaningful if the potential applicant is thinking instead of her hopes for her college basketball team. That said, goals that hold particular importance to the individual and reflect deeply held values naturally evoke deeper feelings of meaningfulness. Such goals, when salient, may be particularly conducive to lending weight and meaning to otherwise boring tasks.

Activities thus feel most meaningful when the currently accessible goal is highly valued and the current activity is highly congruent with that goal. Activities feel meaningless when they do not serve a current goal, or that underlying goal has no value. Such activities are likely to be boring, even if the prerequisites for attention have been met. Thus, the meaning component complements the attentional component as an independent cause of boredom. We present evidence for this hypothesis in Studies 1 and 2.

Bringing Attention and Meaning Together

Like other theories that handle similarly distinct but conceptually related constructs, such as the expectancy-value theory of motivation (Wigfield & Eccles, 2000) and the Elaboration Likelihood Model of attitude change (Petty & Cacioppo, 1986), the MAC model holds that attention and meaning deficits are profitably treated as independent determinants of boredom. We acknowledge that at extreme levels one type of deficit can trigger the other: It is difficult for people to pay attention to a task that they find completely meaningless, and difficult for them to find meaning in a task when they do not have the resources to pay attention to it (Barnard et al., 2004; Treisman, 1964). However, we will present evidence from several studies (e.g., Study 1) showing that attention and meaning (a) are not highly correlated, (b) independently predict boredom, and (c) do not interact. This does not mean that the two constructs will never influence each other, of course; and we discuss this issue further in the section on future directions. As we will see, however, the evidence to date suggests that attention and meaning function largely independently in the context of boredom.

Multiple Profiles of Boredom

One of the most important implications of the MAC model is that people's experiences of boredom vary depending on how it was triggered, that is, on the specific deficits in attention and meaning displayed in Table 2 (Barrett, 2014; Chin et al., 2017; Eastwood et al., 2012; Fahlman et al., 2013; Goetz et al., 2006; Goetz et al., 2014; Mercer-Lynn et al., 2014; Merrifield & Danckert, 2014). That is, specific deficits in attention and meaning result in distinct profiles of boredom, while at the same time retaining the core informational and contextual features that define boredom as such (i.e., the structure of the MAC model described above). By positing different forms of boredom in this way, we follow a psychological constructionist approach to emotion (e.g., Conceptual Act Theory, Barrett, 2006, 2014; OCC model of emotion, Clore & Ortony, 2013; Ortony et al., 1988; Schachter & Singer, 1962), in which emotions are viewed as an emergent construct that result from people's analysis of their internal cues and the situations in which they occur. From this perspective boredom does not exist as a discrete entity, module, or mechanism in the brain, but is a "situated affective reaction" resulting from inferences people draw from their internal cues (e.g., inattention, arousal, behavior) and the context in which these cues occur (e.g., failing to cognitively engage in a valued goal-congruent activity; Clore & Ortony, 2013, p. 341). As a result, and consistent with the literature on emotion more generally, we believe that self-report measures are the best way to assess boredom (Barrett, 2004; Diener, 2000; Nisbett & Wilson, 1977; Robinson & Clore, 2002). That said, investigating neural or physiological markers of boredom may be a fruitful area for future research, a point that we return to later.

It also follows from this constructionist approach that the various causes of boredom may be characterized by distinct features such as increased arousal or frustration, resulting in distinct boredom profiles. Our typology, therefore, takes into account both meaning and attention as antecedents of boredom and focuses on the affective consequences of each (see Table 2). We present evidence in Study 2 for different profiles of boredom that correspond to their causal antecedents. In Study 3 we provide a detailed example of two such profiles, one in which boredom is accompanied by frustration and one in which it is not.

Others have also argued that there are different profiles, or types, of boredom, usually in an attempt to reconcile patterns of high and low arousal in boredom (Goetz et al., 2014; Schmeitzky & Freund, 2013). According to Berlyne (1960), for example, when people exert effort to pay attention in an unstimulating environment, autonomic arousal *increases*, and it is this increased arousal that leads to boredom. Schmeitzky and Freund (2013) distinguished theoretically between *high arousal boredom,* associated with feelings of agitation and frustration, which occurs when a specific activity lacks meaning, and *low arousal boredom*, which resembles apathy and occurs when *all activities* lack meaning. Our model builds on these approaches by providing the following taxonomy of different profiles of boredom.

Attentional boredom. Attentional boredom occurs when people are unable to successfully engage their attention in an otherwise satisfying activity (Eastwood et al., 2012). As discussed earlier, the MAC Model holds that a lack of attentional fit can occur either because mental resources exceed cognitive demands (i.e., understimulation; see Row 1 of Table 2) or because cognitive demands outweigh available mental resources (i.e., overstimulation; see Row 4 of Table 2). Attentional boredom can occur even when people are engaged in a meaningful task, to the extent that there is an attentional mismatch (see Cells E and H of Table 2). For instance, in one study, participants listened to an otherwise engaging and interesting article; however when mildly distracted by noise from an adjoining room, their impaired attention resulted in boredom (Damrad-Frye & Laird, 1989). Attentional boredom thus corresponds most closely to the environmental and attentional theories of boredom reviewed earlier. We present evidence in Study 2 for a profile of attentional boredom produced by understimulation.

Attentional boredom may motivate people to reestablish successful attention by regulating available resources and cognitive demands to optimize attentional fit. When people are understimulated (Cell E in Table 2), they are likely to want to increase cognitive demands, whereas when people are overstimulated (Cell H in Table 2), they are likely to want to decrease cognitive demands. Adding or removing distractions (e.g., music) from an environment would be one such strategy. The literature on divided attention, for instance, suggests that when the demands of one task are insufficient to use all of the available mental resources, those leftover resources are allocated to a secondary task (Kahneman, 1973; Norman & Bobrow, 1975; Wickens, 2002, 2008). If regulating cognitive demand or mental resources is not possible, people may abandon their current activity, in hope of selecting a new activity that is better calibrated to their current available resources. This may be one reason why activity type was the best predictor of boredom in Chin et al. (2017), and why people were most bored at work and in school, where there is limited freedom to switch activities.

Meaningless boredom. Meaningless boredom, which occurs when an activity is incongruent with valued goals (see Column 1 in Table 2), corresponds most closely to functional theories of boredom that focus on a lack of meaning or goals as the cause of boredom. For instance, participants in one study reported that copying references from a Wikipedia article about concrete was not only boring, but served no purpose and made them want to do

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something more meaningful (van Tilburg & Igou, 2012). Meaningless boredom may primarily motivate a *change of activity*, with the aim of bringing activity into alignment with valued goals. We present evidence for this profile of boredom in Study 2. It may be exacerbated when people are unable to locate or engage in meaningful alternatives, such as when their current activity is subject to external constraints (Troutwine & O'Neal, 1981), or when currently salient goals lack sufficient value (Schmeitzky & Freund, 2013). An implication of this view is that people in positions of power may be less likely to experience meaningless boredom, because of the greater level of control they exert over their own lives and corresponding freedom to freely switch activities. Indeed, a recent experience sampling study found not only that the wealthy are less likely to experience boredom on a day-to-day basis, but that differences in their use of time accounted for 9% of that boredom gap (Chin et al., 2017). Another implication of this view is that meaningless boredom may be more difficult to resolve when goals chronically lack meaning or cannot be identified, as in instances of depression.

Mixed states: Attentional + meaningless boredom. A mixed state of meaningless and attentional boredom occurs when both attention and meaning deficits are both present (see Cells A and D in Table 2). Cell A represents the case in which people have more than enough resources to complete a meaningless task (e.g., circle all the 6s on several pages of digits at a slow rate), whereas Cell D represents the case in which people have insufficient resources to complete a meaningless task (e.g., circle all the prime numbers and those divisible by 7 on several pages of digits at a very fast rate). Many experimental inductions of boredom have likely resulted in mixed states, by giving participants tasks that lack meaning and are also understimulating (e.g., watching a monotonous video on repeat).

Bored Minds

Previous work has focused on boredom as an affective evaluation of external events—feelings, in other words, about what's happening in the world. We argue that boredom can also be an affective evaluation of what's inside one's own head. In other words, thinking itself can be boring or interesting. Below we review existing work on thought and boredom, and then discuss how the MAC model of boredom applies to thought.

Mind wandering. Mind wandering, which occurs when a person trying to engage in a task finds that his or her mind has wandered away to unrelated topics (also called task-unrelated thought), is very common during repetitive or boring activities (Smallwood & Schooler, 2006; Smallwood, O'Connor, Sudbery, & Obonsawin, 2007). Mind wandering is thought to exacerbate boredom through at least two mechanisms: (a) by highlighting the discrepancy between what one *is* doing and the desirable but unobtainable alternatives one *could* be doing (Bench & Lench, 2013; Eastwood et al., 2012; Neu, 1998; Smallwood & Schooler, 2006) and (b) by drawing attention to one's own failure to regulate attention (Eastwood et al., 2012). For instance, in one study, people who were instructed to let their minds wander to an enjoyable scenario while performing a monotonous task subsequently were *more* bored than participants who let their minds wander to negative scenarios (Critcher & Gilovich, 2010). Presumably, the enjoyable scenario (while pleasant to think about) triggered comparison with the *un*enjoyable present.

Other researchers suggest that mind wandering is simply a symptom of boredom. People may prefer to seek out alternative external activities, but when that is not possible, internal sources of stimulation (such as mind wandering) may serve instead (Bench & Lench, 2013; Singer, 1975; Smith, 1981). However, by definition, mind wandering consists of instances of divided attention, where people are attempting to do one thing but their thoughts are focused on something else. Until recently there has been little research on thinking as an activity in its own right, that is, cases in which people's goal is to engage in interesting or enjoyable thinking and not to focus on the external world.

Intentional thinking. Intentional thinking—as opposed to spontaneous or unintentional thinking—is the deliberate initiation and maintenance of a stream of thought. Recent studies have shown, for example, that people sometimes deliberately attempt to divert attention from a boring task by focusing on their thoughts while performing that task (Seli, Cheyne, Xu, Purdon, & Smilek, 2015; Seli, Risko, & Smilek, 2016). These studies have not, however, measured how successful people are at avoiding boredom with intentional thinking (that is, they have not included measures of people's affect). Nor, until recently, have researchers examined how much people enjoy their own thoughts in the absence of any external activity, when the goal is simply to have a pleasant experience.

Such studies of "thinking for pleasure" have found that being alone with one's thoughts is not particularly enjoyable (Wilson et al., 2014). Participants who spent 6–15 min alone trying to entertain themselves with their thoughts, in the absence of any external stimulation, reported that the experience was only somewhat entertaining, somewhat enjoyable, and also somewhat boring. When given the opportunity, 67% of the men and 25% of the women in one study chose to self-administer an electric shock during a 15-min thinking period, presumably because they were bored.

MAC model applied to thinking. We argue that what makes a thought boring should be the same as what makes anything boring: deficits in attention and meaning. In short, thinking should be boring when people are not *able* or do not *want* to do it. However, the peculiarities of internal thought make certain causal factors particularly salient.

Attentional difficulties in thinking. Whether a person is *able* to maintain attention on their thoughts (i.e., the attentional component) may be particularly important for thinking, because the cognitive demands placed by conscious deliberative thought are considerable and difficult to reduce. And, as we have seen, people enjoy cognitively demanding tasks only when they have sufficient resources. Thus, we predict that people will only enjoy intentional thinking when they have sufficient mental resources to initiate, monitor, and control the contents of their own thoughts. Without those resources, they will experience the same attentional difficulties and boredom that result when the demands of an external activity exceed available mental resources (i.e., Cells D and H in Table 2).

Intentional thinking is particularly problematic because the most direct methods of resolving attentional failure due to overstimulation (i.e., by down-regulating cognitive demands or upregulating mental resources) are difficult to accomplish. Reducing the cognitive demands placed by intentional thinking may be possible

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only via indirect strategies that make aspects of intentional thought (such as initiation or maintenance) easier. Such strategies, such as keeping a list of potential thought topics on hand, may be helpful, although they do not seem to occur to people spontaneously. However, there is evidence that these strategies are effective at reducing cognitive demand and increasing enjoyment when people are encouraged to use them (Westgate et al., 2017). In one set of studies, participants generated a list of topics they would enjoy thinking about and then were asked to think about those topics for 4 to 6 minutes. Participants enjoyed their thoughts more if they were given a simple "thinking aid"—a reminder of the topics they had listed (either on a computer screen or index cards, depending on the study). Participants who were not given the thinking aid, and had to rely on their memories, found it more difficult to concentrate on their thoughts, which in turn predicted lower enjoyment of the thinking period. In short, by reducing the cognitive demands involved in initiating and maintaining their train of thought, thinking became less boring. This suggests that part of the challenge of intentional thought is that it is inherently taxing and that there are specific strategies people can learn to make it easier and more enjoyable.

Alternatively, instead of reducing the cognitive demands of intentional thought, people could simply increase their mental resources to match the task. However, mental resources are difficult to increase deliberately. Practice may be one way to increase such resources, as well as short-term strategies targeted at physiological factors (e.g., sufficient sleep, caffeine). However, such strategies generally require planning and/or long-term change; they may not be easy to implement on the spot when they are most needed.

Meaning difficulties in thinking. Even if people are capable of successfully maintaining attention on their thoughts, they might not *want* to. Accordingly, thinking should be boring if it is incongruent with currently activated and valued goals. Thoughts may feel "meaningless" (and thus boring) either because (a) thought content is not related to current goals, (b) those current goals are not sufficiently valued, or (c) thinking itself is not seen as an activity capable of contributing to valued goals. We have found, for instance, that participants report that planning their day is a more important goal to them than trying to enjoy their thoughts (Alahmadi et al., 2017). If people do not value trying to enjoy their own thoughts, and wish to be doing something else, it is unsurprising if they then find thinking boring. Accordingly, thinking could be made more enjoyable by motivating people to try to do it. Supporting this hypothesis, when people are given the specific goal of entertaining themselves with their thoughts (vs. thinking about whatever they want) they report considerably less boredom and greater enjoyment (Alahmadi et al., 2017).

To summarize, the MAC model suggests that thinking will be boring when people are unable to successfully maintain their attention on thoughts that are congruent with currently activated valued goals. We present evidence for this hypothesis in Studies 1 and 4. In this respect, thinking resembles most other activities, and is subject to the same attentional and meaning requirements. On the other hand, intentional thinking poses unique challenges. It is particularly taxing and many of the strategies typically used in resolving boredom (e.g., increasing cognitive demand, switching activities) are either unavailable or difficult to implement. Effective strategies to make thinking more enjoyable may require time and practice to use productively, and do not seem to occur to people spontaneously.

Novel Predictions

To summarize, the MAC model leads to several novel predictions:

> *Hypothesis 1: Different determinants of boredom.* The most basic prediction of the MAC Model is that deficits in attention and meaning will each produce boredom independently of the other. As noted, this prediction is contrary to all prevailing theories of boredom, which have focused primarily on one or the other of these variables. We present evidence for this hypothesis in Studies 1 and 2.

> *Hypothesis 2: Different profiles of boredom.* Not only are there different determinants of boredom, but these determinants (i.e., attention and meaning) result in characteristic boredom profiles. We present evidence for this hypothesis in Studies 2 and 3.

> *Hypothesis 3: Two types of attention deficit.* Attention deficits can come in two forms: understimulation and overstimulation, resulting in distinct boredom profiles. We present evidence for this hypothesis in Studies 3 and 4.

> *Hypothesis 4: Bored minds.* The model can explain not only when and why people become bored with external activities, but also when and why people become bored with their own thoughts. We present evidence for this hypothesis in Studies 1 and 4.

Empirical Evidence

Here we report four studies that found support for several of the key predictions made by the MAC Model. Studies 1 and 2 tested the most basic assumption of the model, namely that attention and meaning deficits both produce boredom and do so independently. Study 2 provides evidence that attention and meaning deficits result in different profiles of boredom (Hypothesis 2). Studies 3 and 4 tested the hypothesis that boredom occurs both when people feel understimulated (Row 1 in Table 2) and when they feel overstimulated (Row 4 in Table 2), resulting in different emotional profiles (Hypothesis 3). In addition, Studies 1 and 4 provide evidence that the model extends to "just thinking" (Hypothesis 4).[3]

Study 1: A Meta-Analysis of Correlational Evidence for the MAC Model

Perhaps the most basic postulate of the MAC model is that both attention and meaning deficits contribute to boredom and can be considered independent predictors. We found evidence for this

[3] Study 1 is an internal meta analysis of published and unpublished data. Studies 2 and 3 have not been published elsewhere. Study 4 is a re-analysis of data reported by Westgate et al. (2017) for different purposes. We report here the primary outcome variables of interest for each study. Additional details about all studies, including dependent measures not relevant to the present hypotheses, can be found here: https://osf.io/nvh5w/. The complete datasets are available from the first author.

postulate in 14 studies that included measures of attention, meaning, and boredom. We conducted regression analyses in each study and then aggregated the results via an internal meta-analysis. These studies employed correlational designs; we present experimental evidence in Study 2.

Study selection. We included in the meta-analysis all studies we have conducted that measured the core constructs of interest, namely attention, meaning, and boredom. We focused on those items that were identical across all studies, which yielded a single item for each variable. By doing so, we are able to directly compare the unstandardized regression coefficients in our analyses across all 14 studies (Becker & Wu, 2007). We excluded three studies that had alternative measures of attention (including Study 3 in this paper) and three studies that lacked a measure of meaning. All other studies we have conducted on this topic, including several pilot studies, are reported here. Some of these studies piloted boredom inductions or experimental manipulations, such as a letter detection study in which participants were randomly assigned to follow a simple or complex rule. In some cases these manipulations did not yield significant results; the results do not change if these conditions are dropped. In addition, some of the studies were conducted online with undergraduates or mTurk workers, and in these studies a high percentage of participants dropped out after being assigned to condition but before completing the tasks. The results do not change when we include only laboratory studies in which attrition was not an issue. In other words, we adopted the conservative approach of including all participants in all conditions of all studies in the analyses reported here, for a total combined sample of 1,355 undergraduate and mTurk participants. The details of each study are provided in the supplementary materials and summarized in Table S1.

Method. In each of the 14 studies, participants completed a task designed to produce boredom and then answered questions about their experience. Boredom tasks varied across studies. Some used a thinking paradigm in which participants were asked to entertain themselves with their thoughts either alone in an unadorned room or in everyday life for 2–6 min (Westgate et al., 2017 Study 5; Westgate et al., 2017 Footnote 5; Wilson, Westgate, Buttrick, & Gilbert, 2017). In others participants completed a 5–10 min simulated air traffic control task (adapted from Markey et al., 2014) in which they identified whether two lines on a circular plot would eventually collide (Westgate et al., 2017, Study 2; Westgate, 2016a, 2016b, 2016c, 2016d, 2016e, 2016f, 2017a, 2017b, 2017c). In the remaining studies participants crossed out letters on a page according to a simple or complex rule for 3–6 min (Westgate, 2017d), or engaged in either planning or their usual everyday activities during “down times” in their day when they had nothing else to do (Wilson et al., 2017). In all studies, following the task, participants rated how boring the experience was, how difficult it had been to concentrate on their thoughts (a measure of attention), and how personally meaningful the experience was (a measure of meaning), all on 9-point Likert scales that ranged from 1 = *not at all* [boring, difficult, meaningful], 5 = *somewhat* [boring, difficult, meaningful], and 9 = *extremely* [boring, difficult, meaningful].

Results and discussion. Our main hypothesis was that attention and meaning would predict boredom, even when controlling for the presence of the other. To test this we conducted multiple regressions in each study, predicting boredom as a function of self-reported attention, self-reported meaning, and their interaction, after centering the predictors around the scale midpoints (5 = *somewhat difficult to concentrate/somewhat personally meaningful*). We then entered the resulting unstandardized regression coefficients and their standard errors into a random effects meta-analysis to arrive at a meta-analytic estimate of the unstandardized regression coefficients (Viechtbauer, 2010; see Table 3). As predicted, the greater the reported attentional difficulties (i.e., difficulty in concentrating), the greater the reported boredom, $b = .34$, 95% CI [.28, .40], $z = 11.72$, $p < .00000000001$. Also as predicted, the less meaningful participants reported the experience to be, the greater the reported boredom, $b = -.35$, 95% CI

Table 3
Study 1: Meta-Analysis of 14 Studies Reporting Unstandardized Regression Coefficients of Attention, Meaning, and Their Interaction in a Regression Predicting Boredom

Study	*N*	Attention	Meaning	Attention × Meaning	Correlation *r*
Westgate et al., 2017, Study 5	110	.34 [.18, .50]	−.29 [−.43, −.14]	−.03 [−.09, .04]	−.33 [−.50, −.17]
Westgate et al., 2017, Footnote	164	.33 [.21, .46]	−.30 [−.43, −.17]	.00 [−.06, .05]	−.36 [−.49, −.23]
Westgate, 2016a	71	.11 [−.23, .45]	−.16 [−.40, .08]	−.03 [−.12, .06]	−.05 [−.29, .18]
Westgate, 2016b	33	−.64 [−2.00, .71]	−.77 [−1.48, −.07]	−.18 [−.55, .19]	−.04 [−.39, .30]
Westgate, 2016c	171	.47 [.31, .62]	−.43 [−.56, −.30]	.09 [.04, .13]	−.09 [−.23, .06]
Westgate, 2016d	207	.42 [.26, .59]	−.52 [−.67, −.37]	.06 [.01, .11]	−.13 [−.27, .00]
Westgate, 2016e	53	.03 [−1.25, 1.30]	−.12 [−.51, .28]	−.10 [−.43, .24]	−.10 [−.37, .17]
Wilson et al., 2017	161	.36 [.24, .47]	−.35 [−.49, −.21]	−.01 [−.07, .06]	−.15 [−.30, −.01]
Westgate & Wilson, 2018, Study 2	228	.25 [.07, .43]	−.32 [−.44, −0.20]	−.01 [−.07, .04]	−.08 [−.21, .05]
Westgate, 2016f	14	.77 [−.82, 2.35]	−.09 [−.63, .45]	.17 [−.27, .61]	−.01 [−.56, .53]
Westgate, 2017a	61	.17 [−.38, .71]	−.30 [−.59, −.01]	−.05 [−.21, .10]	.18 [−.06, .43]
Westgate, 2017b	32	−.39 [−1.06, .28]	−.36 [−.90, .17]	−.10 [−.30, .09]	−.01 [−.36, .34]
Westgate, 2017c	39	.14 [−.58, .87]	−.30 [−.84, .24]	−.02 [−.26, .22]	−.06 [−.37, .25]
Westgate, 2017d	21	−.17 [−1.24, .89]	−.97 [−1.82, −.12]	−.13 [−.45, .19]	−.07 [−.51, .36]
Overall		**.34 [.28, .40]**	**−.35 [−.41, −.28]**	**.00 [−.03, .04]**	**−.12 [−.21, −.04]**

Note. Studies are listed in chronological order by date conducted. Overall meta-analytic estimates weighted by inverse variance are given at the bottom and bolded. Sample sizes reflect the number of participants for which we had complete data; participants missing data for any one of the three variables of interest (meaning, attention, or boredom) are not included in this sample. Columns for Attention, Meaning, and Attention × Meaning report the unstandardized regression coefficients and their 95% CIs when attention, meaning, and their interaction are entered in a linear regression model predicting boredom. Correlation *r* reports the zero-order correlation between attention and meaning in that sample.

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[−.41, −.28], $z = -10.86$, $p < .00000000001$. Finally, as predicted, the interaction between attention and meaning was not significant, $b = .005$, 95% CI [−.03, .04], $z = .28$, $p = .78$. The results were consistent across all 14 studies; as shown in Figures S1–S3 (see supplemental materials) the test of heterogeneity of effects was nonsignificant. The independent main effects of attention and meaning are portrayed visually in Figure 1 using fixed effects estimates derived from a multilevel model of the pooled raw data (Bainter & Curran, 2015; Curran & Hussong, 2009).

To test for moderators we added the following variables in a mixed-effects meta-analysis: sample population (undergraduates or mTurkers), study location (in the lab, online, or in the field), and boredom task (thinking, air traffic, letter detection, planning, or normal everyday activities). There were few significant effects of the moderators. The most consistent differences were between mTurk and undergraduate samples, such that the two mTurk samples exhibited significantly stronger main effects of both attention, $z = 2.25$, $p = .02$, and meaning, $z = -2.14$, $p = .03$, as well as their interaction, $z = 2.29$, $p = .02$. There were no significant effects of study location (zs < 1.38, ps $> .17$) or task (zs < 1.81, ps $> .07$).

One potential explanation of the results is that attention and meaning were too strongly correlated to distinguish between them due to multicollinearity. To find out, we computed the zero-order correlations between attention, meaning, and boredom in each study and then combined them with an internal meta-analysis. Paralleling the results from the regression analyses, both attention, $r = .37$, 95% CI [.31, .43], $z = 12.02$, $p < .00001$, and meaning, $r = -.38$, 95% CI [−.45, −.31], $z = -10.55$, $p < .00001$, were significantly correlated with boredom at the zero-order level. However, attention and meaning were only weakly correlated with each other across the 14 studies, $r = -.12$, 95% CI [−.21, −.04], $z = -2.96$, $p = .003$, suggesting that multicollinearity was not an issue.

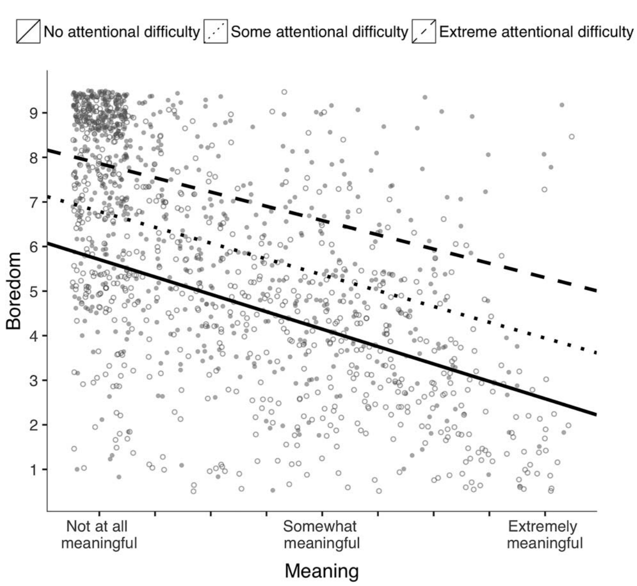

Figure 1. Study 1: The correlational effects of self-reported attention and meaning on boredom pooled across 14 studies.

In sum, Study 1 found support for the importance of both attention and meaning deficits in boredom across multiple domains, settings, and populations. Whereas attention and meaning, separately, have been previously linked to boredom (Eastwood et al., 2012; van Tilburg & Igou, 2017a), no previous study has examined how they jointly combine to predict boredom.[4] Many attentional theories of boredom argue that, as the "final mediating mechanism," any effect of meaning on boredom will be mediated via attention (Eastwood et al., 2012, p. 487). Likewise, many functional theories argue that the effects of attention on boredom should be mediated via meaninglessness (Barbalet, 1999; van Tilburg & Igou, 2012). Instead, we found very little evidence that attention was fully mediating the effects of meaning (or vice versa; see supplemental materials for details). Rather, as predicted by the MAC model, deficits in attention and meaning predicted boredom independently and were only weakly correlated.

A limitation of the results of Study 1, however, is that they are based on correlational analyses, and thus cannot rule out the possibility of reverse causality (i.e., that boredom produced deficits in attention or meaning) or the role of third variables. To address this limitation we employed an experimental design in Study 2, manipulating deficits in attention and meaning while participants performed a boring task. We also expanded the dependent measures to test whether, as predicted, attentional and meaning deficits produce different profiles of boredom (Hypothesis 2).

Study 2: Experimental Evidence for the MAC Model

Study 2 employed a 2 (Attention: low vs. high) × 2 (Meaning: low vs. high) design, corresponding to the top two rows of Table 2. We predicted that, similar to the results of Study 1, there would be significant main effects of both attention and meaning on reported boredom, such that low attention and low meaning would independently increase boredom. We further predicted that boredom resulting from attentional deficits would take a different form than boredom resulting from meaning deficits (Hypothesis 2).

Participants. Participants were 228 undergraduate psychology students (132 women, 84 men, 10 declined to answer) between the ages of 18 and 27 ($M = 18.77$, $SD = 1.22$). Fifty-nine percent identified as White/Caucasian, 21.7% as Asian, 5.8% as Hispanic 4.9% as Black/African American, 4.4% as Other, and 4.4% declined to answer. Following guidelines by Simmons, Nelson, and Simonsohn (2013), we aimed for a sample size of 50 participants per cell; we oversampled slightly to ensure that we met our minimum target sample. We had partial data for two participants, and 10 participants were unable to complete the study due to computer malfunctions, leaving a final sample of 216 participants. Participants were recruited from the Department of Psychology participant pool and compensated with course credit.

[4] An exception is a study by van Tilburg and Igou (2017a) in which participants rated attention, perceived meaning, and boredom (as well as 10 other emotions) after viewing an 8-min video documentary of Milgram's obedience study. Consistent with our results, they found, using multidimensional scaling, that boredom was more negatively related to both meaning and attention, relative to other emotions. However, they did not control for the main effects of attention and meaning or examine the potential interaction between meaning and attention.

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Method. Participants completed the study by themselves in an unadorned room in a single 30-min laboratory session, after storing all of their personal belongings (e.g., cellphones, watches, and backpacks). All instructions and dependent measures were delivered on a computer via a Qualtrics program. Participants first indicated their mood and the number of hours they slept the night before. They then completed a simulated air traffic control task (adapted from Markey et al., 2014), in which they viewed a series of circular plots with two lines. They pressed one key if they judged that the lines would eventually cross (collide) and another key if they judged that they would not.

We manipulated attentional fit by varying the difficulty of the task, such that it was understimulating (Row 1 of Table 2) or optimally stimulating at a low level of engagement (Row 2 of Table 2). We conducted extensive pilot testing of the manipulation to ensure that the final versions of the task were, on average, understimulating or optimally stimulating, respectively, for our undergraduate sample (these pilot studies are reported as part of Study 1 of this paper). In the understimulation condition, participants completed an extremely easy version of the task in which the lines collided on only a small number of trials (3%) and these cases were extremely easy to identify (e.g., colliding lines directly opposed each other). In the low-level engagement condition, participants completed a more challenging and thus optimally stimulating version of the same task, in which the lines collided more frequently (47% of trials) and were more difficult to identify (e.g., colliding lines were only a few degrees off from parallel). Although more challenging, the task in this condition was still relatively simple and did not require a major investment of cognitive resources (that is, it was designed to capture Row 2 of Table 2, low-level engagement, rather than Row 3 of Table 2, high-level engagement). We expected this manipulation to lead to low attention in the easy condition (due to attentional misfit) and high attention in the more challenging condition (due to optimal attentional fit), respectively.

We manipulated meaning by varying how much value participants perceived the task to have. In the high meaning condition, participants were told that the task would consist of approximately 600 trials and that researchers would make a contribution to a charity of their choice if they performed at or above chance (e.g., 50% accuracy). Participants were then allowed to pick one of seven charities that would receive the funds and wrote 3–5 sentences explaining the reason for their choice. Participants in the low meaning condition were told that the task would consist of approximately 600 trials with no mention of a donation to charity.

The air traffic control task lasted 10 min, with no time limit per trial. Afterward, participants rated how boring, interesting, and enjoyable the air traffic control task was on 9-point Likert scales that ranged from 1 = *not at all* [boring, interesting, enjoyable], 5 = *somewhat* [boring, interesting, enjoyable], and 9 = *extremely* [boring, interesting, enjoyable]. To test whether the charity manipulation was effective, we asked participants how personally meaningful the task was, how much they felt they were accomplishing a worthwhile goal, and how much their performance was contributing to an important cause (all on 9-point Likert scales that ranged from 1 = *not at all*, 5 = *somewhat*, and 9 = *very much).* To test whether the attention manipulation was effective, we asked participants how difficult it was to concentrate, whether their attention was successfully focused, whether they forced themselves to pay attention, and the extent to which they experienced mind-wandering during the thinking period (all on 9-point Likert scales that ranged from 1 = *not at all*, 5 = *somewhat*, and 9 = *very much*).

Participants then completed a number of additional measures, including the Multidimensional State Boredom Scale (MSBS; Fahlman, Mercer-Lynn, Flora, & Eastwood, 2013).[5] The MSBS consists of five subscales measuring Inattention (e.g., "It was difficult to focus my attention," four items, $\alpha = .90$), Disengagement (e.g., "I wished I was doing something more exciting," nine items, $\alpha = .88$), Agitated Affect (e.g., "I felt agitated," five items, $\alpha = .91$), Dysphoric Affect (e.g., "I felt down," four items, $\alpha = .85$) and Time Perception (e.g., "Time was dragging on," five items, $\alpha = .96$), all on 7-point Likert scales ranging from 1 = *Strongly Disagree*, 4 = *Neutral*, 7 = *Strongly Agree*. We modified the question stems on the MSBS to refer to the experiences participants just had on the air traffic control task rather than to what they were experiencing at the moment.

Results and discussion. Manipulation checks indicated that the attention and meaning manipulations were successful; for example, participants in the high meaning condition scored higher on the index of personal meaningfulness (three items, $\alpha = .87$) than participants in the low meaning condition, $F(1, 214) = 58.69$, $p < .001$, $d = 1.04$, and participants in the low attention condition reported more attentional difficulties (four items, $\alpha = .80$) than participants in the optimal attention condition, $F(1, 214) = 15.77$, $p < .001$, $d = .54$. The manipulations had little or no effect on the other manipulation check; for example, the attention manipulation had no effect on reported meaning (see supplementary materials for details).

Did manipulating attention and meaning affect boredom? To find out, we created a boredom index by averaging participants' ratings of how boring, interesting (reversed score), and enjoyable (reversed scored) the air traffic control task was ($\alpha = .89$; similar results are obtained if, as in Study 1, we examined the boredom question alone). As predicted, participants were more bored in the understimulated condition ($M = 7.77$, $SD = 1.46$) than the low-level engagement condition ($M = 7.27$, $SD = 1.57$), as reflected by a significant main effect of the attention manipulation, $F(1, 214) = 5.94$, $p = .016$. (see Figure 2 and Table 4). Also as predicted, participants were more bored in the low meaning condition ($M = 7.77$, $SD = 1.34$) than the high meaning condition ($M = 7.26$, $SD = 1.67$), as reflected by a significant main effect of the meaning manipulation, $F(1, 214) = 6.29$, $p = .013$. The interaction between attention and meaning was not significant, $F(1, 214) = .79$, $p = .37$.

We hypothesized that the attention and meaning manipulations would affect boredom in different ways. Specifically, we anticipated that manipulating attention would primarily influence attentional processes, namely the extent to which participants maintained attention on the task. On the other hand, we anticipated that manipulating meaning would increase feelings of disengagement (e.g., lack of "caring" about the task) and lead to higher arousal. We tested these hypotheses by examining the effects of the atten-

[5] The additional dependent measures, described in the supplemental materials, were exploratory and not relevant to the primary hypothesis of interest.

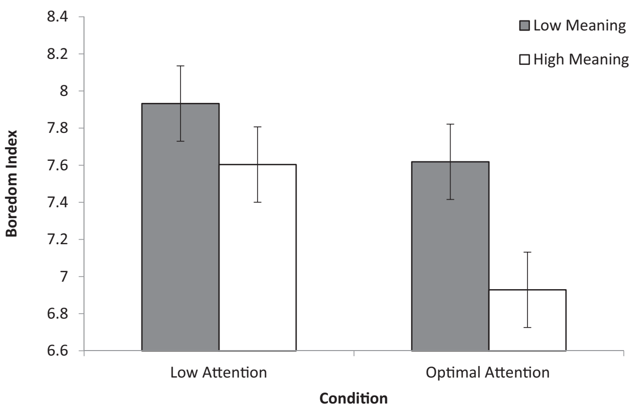

Figure 2. Study 2: The effects of manipulating attention and meaning on boredom.

tion and meaning manipulations on the subscales of the Multidimensional State Boredom Scale (see Table 4). As expected, the attention manipulation (but not the meaning manipulation) significantly predicted the Inattention subscale, such that participants were more inattentive during the easy version of the task. In contrast, the meaning manipulation (but not the attention manipulation) significantly predicted the Disengagement, Dysphoric Affect, Agitated Affect, and Time Perception subscales, such that participants were more disengaged, more dysphoric, more agitated, and perceived time to be passing slower when the task was meaningless.

Did these different patterns of responses explain the effects of the manipulations on boredom? Mediation analyses calculated with bootstrapping procedures using 10,000 samples (Hayes, 2013) suggested that they did. As shown in Table 5, the Inattention subscale of the MSBS was a significant mediator of the effect of the attention manipulation on boredom, whereas the Disengagement, Agitated Affect, Dysphoric Affect, and Time Perception subscales were not. As also seen in Table 5, the Disengagement, Dysphoric Affect, Agitated Affect, and Time Perception subscales of the MSBS were significant mediators of the effect of the meaning manipulation on boredom, whereas the Inattention subscale was not. Thus, consistent with Hypothesis 2, manipulating attention and meaning not only independently increased boredom, but did so via separate mechanisms with different downstream consequences. Attentional deficits increased boredom through a lack of attention to the task, whereas low meaning increased boredom through disengagement in the task. In addition, meaningless (but not attentional) boredom was characterized by increased agitation and arousal.

Taken together, Studies 1 and 2 provide support for three hypotheses made by the MAC model: that both attentional and meaning deficits produce boredom (Hypothesis 1), that they result in different profiles of boredom (Hypothesis 2), and that the model explains not only why people become bored when engaged in various tasks but also why they become bored when trying to think in the absence of any external stimulation (Hypothesis 4). These results, we note, are unique to the MAC Model and inconsistent with previous theories of boredom. For example, the results suggest that a task will be perceived as boring if it lacks meaning, even if people are otherwise successfully maintaining attention—inconsistent with attentional theories (see the two right-hand bars in Figure 2). They further suggest that a task will be perceived as boring if it is understimulating, even if it is viewed as high in

Table 4
Study 2: Manipulating Attention and Meaning: Effects on Boredom

Measure	*df*	η_p^2	*F*	*p*
Boredom index				
Attention	1	.027	5.94	.016*
Meaning	1	.029	6.29	.013*
Attention × Meaning	1	.004	.79	.374
Inattention (MSBS subscale)				
Attention	1	.063	14.32	<.001***
Meaning	1	.010	2.05	.154
Attention × Meaning	1	<.001	.08	.779
Disengagement (MSBS subscale)				
Attention	1	<.001	.06	.801
Meaning	1	.071	16.17	<.001***
Attention × Meaning	1	<.001	.02	.876
Agitated affect (MSBS subscale)				
Attention	1	<.001	.01	.945
Meaning	1	.046	10.28	.002**
Attention × Meaning	1	.012	2.50	.116
Dysphoric affect (MSBS subscale)				
Attention	1	.004	.93	.336
Meaning	1	.021	4.60	.033*
Attention × Meaning	1	.004	.81	.368
Time perception (MSBS subscale)				
Attention	1	.009	2.04	.155
Meaning	1	.025	5.48	.020*
Attention × Meaning	1	.001	.21	.650

Note. $N = 217$. ANOVA results for the effect of the experimental manipulations of attention (i.e., understimulation versus optimal stimulation), meaning (i.e., charity versus no charity donation), and their interaction (Attention × Meaning) on overall boredom and on each of the Multidimensional State Boredom Scale (MSBS) sub-scales.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5
Study 2: Mediators of the Effects of Attention and Meaning on Boredom

Mediator	*a*	*b*	*ab*	95% CI
Attention condition				
Inattention	**−.36*** **	**.54*** **	**−.19**	**−.32, −.10**
Disengagement	.02	.87***	.02	−.11, .15
Agitated affect	.01	.43***	.002	−.08, .06
Dysphoric affect	.09	.35***	.03	−.03, .11
Time perception	−.14	.61***	−.09	−.22, .03
Meaning condition				
Inattention	−.14	.54***	−.07	−.19, .03
Disengagement	**−.30*** **	**.86*** **	**−.26**	**−.42, −.13**
Agitated affect	**−.31*** **	**.41*** **	**−.13**	**−.24, −.05**
Dysphoric affect	**−.20* **	**.32*** **	**−.07**	**−.15, −.01**
Time perception	**−.24* **	**.61*** **	**−.14**	**−.28, −.02**

Note. Condition is coded as −1 = Low, 1 = Optimal for Attention and −1 = Low, 1 = High for Meaning. *a* = the beta weight of condition regressed on the mediator; *b* = the beta weight of the mediator regressed on boredom, controlling for condition; *ab* = the indirect effect. The results that are bolded represent significant mediation, because the 95% confidence intervals do not include zero.
* $p < .05$. *** $p < .001$.

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meaning—inconsistent with functional theories (see the two left-hand bars in Figure 2). Perhaps most importantly, Study 2 demonstrated that boredom is experienced in different ways under these different conditions (see Table 5).

One of the most counterintuitive predictions of the MAC Model is that people will become bored not only when they are understimulated (see the top row of Table 2), but also when they are overstimulated, such that they do not have sufficient cognitive resources to perform a task (see the bottom row of Table 2). Study 2 found support for boredom resulting from understimulation; Studies 3 and 4 tested whether boredom results from overstimulation as well, and whether this state is distinct from emotions such as frustration (Hypothesis 3).

Study 3: Correlational Evidence for a Curvilinear Relationship With Cognitive Demand

As argued earlier, a task should give rise to boredom to the extent that people feel they do not have the cognitive resources to complete it, but frustration to the extent that their failure to complete it blocks a desired outcome (Hypothesis 3). This means that there should be a curvilinear relationship between the cognitive demands of a task and boredom: When the cognitive demands are too low, people should feel understimulated and bored as a result (as occurred in the understimulation condition of Study 2). When cognitive demands are "just right," people should feel engaged and not bored (as occurred in the low-level engagement condition of Study 2). When cognitive demands are too high, however, such that people feel overstimulated, boredom should return to high levels.

In contrast to this curvilinear relationship, we predict that frustration will be linearly related to cognitive demands, because the more demanding the task, the more difficult it will be for people to accomplish their goal of completing it. Note that according to this prediction, boredom and frustration will be similarly high when people feel overstimulated, but differ when people feel understimulated. In the latter case people will feel bored (because they have more resources than needed to complete the task) but not frustrated (because they can accomplish the goal of completing the task). Study 3 tested these hypotheses using a correlational design.

Participants. Participants were 130 undergraduate psychology students (57% female), predominantly Caucasian (64%), between the ages of 18 and 28 ($M = 19.02$, $SD = 1.29$). One participant was unable to complete the study because of a computer malfunction, leaving a final sample of 129 participants. Participants were recruited from the Department of Psychology participant pool and compensated with course credit.

Method. As in Study 2, participants completed the study by themselves on a computer in an unadorned room after storing their personal belongings. Participants first indicated their mood and the number of hours they slept the night before. They then completed a 231-trial Stroop task (Stroop, 1935), followed by a moderately challenging variant of the air traffic control task used in Study 2.[6] All participants received the high meaning condition of Study 2, whereby they were told that the researchers would make a contribution to a charity of their choice for completing the task successfully. The task itself lasted 5 min, with no time limit per trial. Afterward, participants rated how boring, interesting, enjoyable, personally meaningful, and frustrating the task was on 9-point Likert scales that ranged from 1 = *not at all* [boring, interesting, enjoyable, meaningful, frustrating], 5 = *somewhat* [boring, interesting, enjoyable, meaningful, frustrating], and 9 = *extremely* [boring, interesting, enjoyable, meaningful, frustrating], and completed a number of additional measures, including how difficult the task was on a 9-point Likert scale ranging from 1 = *too easy*, 5 = *just right*, and 9 = *too hard.*

Results and discussion. Were people bored when the task was too hard, as well as when it was too easy; that is, was there a curvilinear relationship between how difficult people perceived the air traffic control task to be and boredom? We entered self-reported difficulty as both a linear and quadratic predictor of boredom during the air traffic control task. As expected, there was not a significant linear effect of difficulty on boredom, $b = .07$ (.11), $t(125) = .60$, $p = .55$, Cohen's $d = .11$, but there was a quadratic effect, $b = .14$ (.05), $t(124) = 2.98$, $p = .003$, Cohen's $d = .54$, such that people reported more boredom both when they said the task was too hard as well as when it was too easy (see Figure 3 and Table 6). As expected, we found that the relationship between difficulty and boredom was negative below the optimal midpoint, $b = -.43$, $p = .001$, but positive above it, $b = .31$, $p = .002$. In other words, the farther people were from optimal difficulty, the more boredom they experienced.

Could people's ratings of boredom simply be a proxy for frustration? To find out, we performed the same analyses, this time predicting self-reported frustration instead of boredom. As expected, there was a linear effect of difficulty on frustration, $b = .73$ (.09), $t(125) = 7.81$, $p < .001$, Cohen's $d = 1.40$, such that increased difficulty was associated with greater frustration, but no quadratic effect, $b = .01$ (.04), $t(124) = .31$, $p = .76$, Cohen's $d = .06$. Furthermore, when controlling for frustration in the boredom model, the quadratic effect of difficulty on boredom persisted, $b = .14$ (.05), $t(123) = 2.95$, $p = .004$, Cohen's $d = .53$, and when controlling for boredom in the frustration model, the linear effect of difficulty on frustration persisted, $b = .72$ (.09), $t(124) = 7.75$, $p < .001$, Cohen's $d = 1.39$. In other words, as predicted, when people are overstimulated in an outcome-dependent context, they experience both frustration and boredom, but when they are understimulated they experience boredom but not frustration. Consistent with this view the two emotions were not strongly correlated, $r = .12$, $p = .19$.

In sum, Study 3 found evidence for a curvilinear relationship between boredom and cognitive demand, even after controlling for self-reported frustration, supporting Hypothesis 3. This is in contrast to attentional models that define boredom in terms of understimulation (Eastwood et al., 2012; van Tilburg & Igou, 2017a), which would predict a linear relationship between difficulty and boredom. Because these results are correlational, however, a causal test of whether excessive difficulty leads to poor attention

[6] The purpose of the Stroop task was to manipulate people's perceptions of how many cognitive resources they had to perform the air traffic control task. Half of the participants were told that their Stroop performance indicated that they did not have many resources available, whereas half were told that their Stroop performance indicated that they had adequate resources available. As it happened, this manipulation had no effect on any manipulation check or dependent variable, thus we collapsed across conditions for the remaining analyses. Results remain the same with and without controlling for the failed manipulation. Details of the manipulation and all other measures can be found in supplemental materials.

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Figure 3. Study 3: The relationship between self-reported difficulty and boredom (on the left) versus frustration (on the right). See the online article for the color version of this figure.

and boredom requires directly manipulating cognitive demand. We did so in several studies reported by Westgate et al. (2017) to answer another question: whether we could make thinking more enjoyable. Participants were asked to enjoy their thoughts while sitting in an unadorned room by themselves. Importantly for present purposes, participants reported that it was somewhat difficult to concentrate on their thoughts, suggesting that they were in the bottom row of Table 2: the demand of the task exceeded their cognitive resources. Participants in another condition received a “thinking aid” that made it easier for them to concentrate, suggesting that they were in the third row of Table 2 (they had sufficient resources to perform a demanding task). Because one of the dependent measures was how bored participants said they were, these studies provide a direct experimental test of Hypothesis 3, that participants would be bored when a demanding task was overstimulating but less bored when it was not.

Study 4: Manipulating Cognitive Demands (Reanalysis of Westgate et al., 2017)

Participants. Participants in the six studies were, respectively, 40 undergraduate psychology students (69% female, M = 18.56 (.91) years; pilot test), 142 undergraduate psychology students (58% female, M = 19.06 (.97) years; Study 2), 351 Amazon mTurk workers (63% female, M = 34.80 (12.28) years; Study 3), 466 Amazon mTurk workers (63% female, M = 34.57 (12.05) years; Study 4), 113 undergraduate psychology students (59% female, M = 18.69 (.99) years; Study 5), and 164 undergraduate psychology students (74% female, M = 18.49 (.78) years; study reported in Footnote 5), for a total sample of 1,276 participants.

Method. We present a summary of the procedures here; details can be found in Westgate et al. (2017). In all studies, participants, either in the lab or at home online, were asked to entertain themselves with their thoughts for 4–6 min while by themselves. They were first asked to generate eight topics they would enjoy thinking about, such as a specific memory (e.g., their first kiss) or an enjoyable fantasy. They were then instructed to think about those topics during the 4–6 min thinking period. In the control condition (randomly assigned), the list of topics participants had generated was not available to them during the thinking period. In the topic reminder condition, participants could consult their list of topics; the topics were either presented on the computer screen or were on index cards that participants had filled out and kept with them during the thinking period. All participants then completed measures about their thinking experience, including how boring it was, how difficult it had been to concentrate, and how much their minds had wandered. In two of the studies, participants also reported how personally meaningful the experience was.

Results and discussion. Did making the thinking task easier make it less boring? We performed an internal meta-analysis of all studies, including a pilot and a study reported by Westgate et al. in a footnote. The overall effect of the topic reminder on boredom was highly significant, $z = -3.46$, $p = .0005$ (Viechtbauer, 2010), such that people who could review their thought topics during the thinking period were significantly less bored than people who could not. The overall meta-analytic effect size was small, but robust, Cohen’s $d = -.20$ (95% CI [−.09, −.31]).

We hypothesized that the reason participants were less bored in the topic reminder condition was because the reminders made a difficult task less demanding. To test this hypothesis, we conducted a meta-analysis of the indirect effect of two mediators related to attention: difficulty concentrating and mind-wandering. Indirect effects and their standard errors were calculated for each study using bootstrapping procedures with 10,000 samples (Hayes, 2013). As expected, there was a significant meta-analytic indirect effect of both difficulty concentrating, $ab = -.45$ (95% CI [−.58, −.33]), $z = -7.06$, $p < .0001$, and mind-wandering,

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Table 6
Study 3: Model Comparison of Relationship Between Subjective Difficulty and Boredom, Versus Frustration

Model	*b*	*SE*	*t*	*p*	R^2	*AIC*
Outcome: Boredom						
Model 1					.003	187.31
Difficulty	.07	.11	.60	.55		
Model 2					.01	187.91
Difficulty	−.02	.13	−.18	.86		
Frustration	.12	.11	1.17	.243		
Model 3					.07	180.54
Difficulty	−1.39	.50	−2.78	.006**		
Difficulty^2	.14	.05	2.98	.003**		
Model 4					.08	181.24
Difficulty	−1.46	.51	−2.90	.004**		
Difficulty^2	.14	.05	2.95	.004**		
Frustration	.12	.10	1.13	.262		
Outcome: Frustration						
Model 1					.33	144.62
Difficulty	.73	.09	7.81	<.001***		
Model 2					.34	145.22
Difficulty	.72	.09	7.75	<.001***		
Boredom	.09	.08	1.17	.24		
Model 3					.33	146.52
Difficulty	.60	.44	1.36	.18		
Difficulty^2	.01	.04	.31	.76		
Model 4					.34	147.22
Difficulty	.72	.45	1.59	.12		
Difficulty^2	.00	.04	.01	.99		
Boredom	.09	.08	1.13	.26		

Note. $N = 126$. Model comparison where Model 1 = linear effect of difficulty, Model 2 = linear effect of difficulty controlling for potential covariate, Model 3 = quadratic effect of difficulty, Model 4 = quadratic effect of difficulty controlling for potential covariate. Unstandardized regression coefficients (*b*) and their error terms (*SE*) are reported along with significance tests (*t*, *p*) for each variable in the model. Overall percentage of variance accounted for by the model $(R)^2$ and model fit (*AIC*) are reported on the far right; lower AIC indicates better model fit.
** $p < .01$. *** $p < .001$.

$ab = -.38$ (95% CI [−.52, −.24]), $z = -5.40$, $p < .0001$, such that people who received topic reminders found it easier to concentrate and mind-wandered less, which in turn led to lower levels of boredom (see Figure 4). That is, as predicted, the topic reminders made a somewhat demanding task easier to perform, and lowered boredom as a result.[7]

Functional models that posit that boredom is fundamentally about meaning (rather than attention) might argue that the topic reminders made the thinking period more meaningful and thus less boring. We tested this hypothesis in the two studies that included meaning as a dependent measure (Study 5 and the footnoted study). As expected, the more meaningful participants found the thinking period to be, the less bored they were, $r = -.45$ [−.55, −.36], $z = -9.33$, $p < .0001$. (This correlation is included in the meta-analysis presented in Study 1.) But also as expected, meaning did not mediate the effects of the task reminder manipulation on boredom, $ab = -.17$ (95% CI [−.37, .03]), $z = -1.67$, $p = .09$. In other words, meaning was an independent predictor of boredom (consistent with Hypothesis 1), but a manipulation designed to make the task less cognitively demanding reduced boredom by influencing attention, not meaning (also consistent with Hypothesis 1).

Taken together, Studies 3 and 4 provide evidence that overstimulation (i.e., when cognitive demands exceed cognitive resources) leads to attentional deficits which produce boredom (Hypothesis 3). These results are inconsistent with models that define boredom solely in terms of understimulation (Eastwood et al., 2012) or a lack of challenge (van Tilburg & Igou, 2013, 2017a), and support the prediction of the MAC model that boredom results from attentional *mismatches*, which occur when a task is too easy (understimulation) or too hard (overstimulation).

Additional Hypotheses and Future Directions

The studies just reviewed provide considerable support for some of the basic tenets of the MAC Model, namely that (a) attentional and meaning deficits independently produce boredom (Hypothesis 1), (b) they do so in ways that result in different profiles of boredom (Hypothesis 2), (c) both overstimulation and understimulation can create attentional deficits and subsequent boredom (Hypothesis 3), and (d) the model applies to internal thought as well as engagement in external activities (Hypothesis 4). Clearly, however, there is more to be done to test further implications of the model. Here we discuss predictions about how people will allevi-

[7] Additional details, including descriptive statistics, may be found in supplemental materials.

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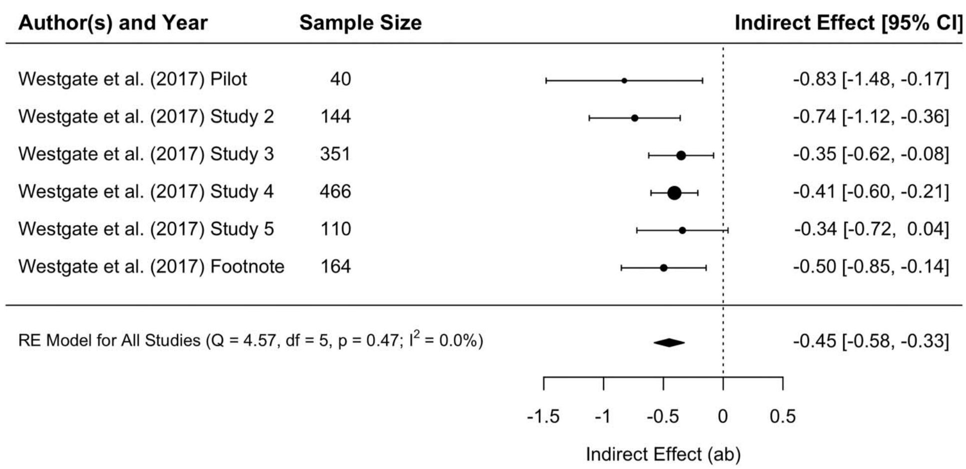

Figure 4. Study 4: The indirect effect of "difficulty concentrating" mediates the effect of the reduced difficulty manipulation on boredom in Westgate et al. (2017).

ate boredom, the downstream consequences of boredom, and the relationship between state and trait boredom.

Alleviating Boredom

Boredom is a highly aversive state; when given the choice, people will choose even very negative stimuli (e.g., electric shock) over being bored (Bench & Lench, 2017; Havermans, Vancleef, Kalamatianos, & Nederkoorn, 2015; Nederkoorn, Vancleef, Wilkenhöner, Claes, & Havermans, 2016; Wilson et al., 2014). In one study, for example, when participants watched an 85-s clip of a tennis game on repeat for an hour, they shocked themselves an average of 22 times (93% shocked themselves at least once; Havermans et al., 2015). One of the primary desires of a bored person, then, is to *stop* feeling bored. Existing theories say little, however, about the specific steps people will take to alleviate boredom.

According to the MAC model, the state of boredom provides people with information about their current attentional and meaning states which they then use to form judgments and make decisions (Clore et al., 2001). In other words, boredom can signal different things, as illustrated in Table 2, which leads to different strategies to reduce it: either by bringing activities into alignment with valued goals or calibrating cognitive demands to available mental resources. More specifically, this results in four primary routes to alleviating boredom: switching activities, regulating goal value, regulating cognitive demand, and regulating mental resources.

Switching activities. If boredom's primary function is to provide information about the current activity, then, in many cases, people will react to feeling bored by *doing something else* (van Tilburg & Igou, 2012). Although environmental theories treat switching activities as the default response to boredom, we suggest that switching activities is most effective during *meaningless boredom*, when an activity conflicts with valued goals. In that situation, regulating resources or demands in the hopes of reestablishing attention on a meaningless task seems unlikely, because people are not inclined to invest effort in reestablishing attention on things they do not care about (Wigfield & Eccles, 2000). As such, boredom represented in the left hand (Low Meaning) column of Table 2 is likely to spur a switch in activity. When this is not possible, due to external constraints (e.g., solitary confinement, work, school), boredom may become particularly severe (Chin et al., 2017; Troutwine & O'Neal, 1981).

Regulating goal value. Often switching activities is not possible (e.g., because of external constraining factors) or is undesirable. An alternative is to change or reconstrue the underlying goals themselves. Bench and Lench (2013) argued that the need to switch goals is the entire *raison d'etre* for boredom, and that the negative affect, attention to novelty, and preference for risk associated with boredom help foster new goal pursuits. Unfortunately, switching goals is difficult to do deliberately; people generally cannot simply decide to care about new goals on demand (Custers & Aarts, 2010; Dijksterhuis & Aarts, 2010). Alternatively, reconstruing the goal in a way that adds value may be more feasible and also decrease boredom. Reframing an otherwise mundane activity as a puzzle is a well-known strategy that utilizes this principle (Sansone, Weir, Harpster, & Morgan, 1992). Similarly, research on effort justification shows that when people freely choose to work toward a goal, and that work turns out to be tedious or unpleasant, they come to view the goal as especially attractive (and thus worth the effort; Aronson & Mills, 1959; Pallak & Pittman, 1972).

Regulating cognitive demands. Sometimes an activity is meaningful, but either too hard or too easy (i.e., Cells E and H in Table 2). In these cases, resolving attentional failure takes priority, by regulating the demands of the task or one's cognitive resources. When people are understimulated (Cell E), for example, they can increase cognitive load by making tasks more complex (e.g., varying routine) or seeking sources of additional stimulation (e.g., doodling, mind wandering; Norman & Bobrow, 1975; Wickens, 2002). When people are overstimulated (Cell H) they can decrease cognitive load by simplifying a task (e.g., breaking it down into smaller chunks) or removing sources of distraction (e.g., turning off background music). People may also attempt to regulate cognitive demands when experiencing a mix of meaningless and attentional boredom (i.e., Cells A and D in Table 2). When

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experiencing mixed boredom states, we predict that people will generally prioritize remedying the meaning failure first, most often by switching activities, or switching or reconstruing underlying goals. If, however, such attempts are unsuccessful, they may attempt to regulate cognitive demands in hopes of restoring attention.

Regulating mental resources. An alternative to regulating task demands is to regulate available mental resources. This strategy may be particularly likely when demanding tasks are difficult to simplify, as in Cell H of Table 2. In such cases people can attempt to increase their mental resources via short-term physiological means (e.g., sleep; Lim & Dinges, 2008; coffee; Smith, Clark, & Gallagher, 1999; prescription stimulants; Turner et al., 2003) or long-term cognitive means (e.g., practice; Petersen et al., 1998). For instance, the malleable attentional resources theory posits that people actually perform better on more challenging tasks, because attentional systems respond to increased demand with increased resource allocation, within limits (Young & Stanton, 2002b). When people are understimulated, as in Cell E of Table 2, they might even try to reduce their mental resources (e.g., through alcohol consumption). Many studies show that people are more likely to drink at work if their workload is understimulating and boring (Herold & Conlon, 1981; Hingson, Mangione, & Barrett, 1981; Walsh, Rudd, Biener, & Mangione, 1993).

When strategies fail. Why, given the many strategies outlined above, do people get stuck in a bored state? One answer is that people may either be unaware of or unable to engage in strategies that would reduce their boredom. For instance, although playing a game on one's cell phone might effectively reduce boredom, it may be inappropriate (e.g., at faculty meetings) or impossible (e.g., no cell signal) in particular situations or under certain constraints (Troutwine & O'Neal, 1981). Similarly, when people are alone with their thoughts, they appear to be both unaware of (Alahmadi et al., 2017) and unable to (Westgate et al., 2017) use strategies that would make their thoughts less boring and more enjoyable. For instance, people do not spontaneously seem to adopt the goal of thinking interesting or enjoyable thoughts unless prompted to, in part because they underestimate how enjoyable and meaningful such thoughts could be (Alahmadi et al., 2017). Likewise, even when people are given the goal of thinking enjoyable thoughts and prompted to generate such topics in advance, implementing successful strategies for intentional thinking may simply be too cognitively taxing for people to do successfully without assistance (Westgate et al., 2017). In sum, people may not always be aware of the best strategy to reduce boredom in a given instance, and even when aware, may not be in a position to deploy it.

The Interest Versus Enjoyment Pathway

Switching activities is an effective strategy for correcting both meaning and attention deficits in boredom. However, relatively little is known about *what* people switch to. Most studies looking at this question have offered only dichotomous choices (e.g., electric shocks, food)—one option which participants may accept or reject. The few studies that have offered a broader choice of alternatives have found that bored people prefer exciting, interesting, and meaningful alternatives (Bryant & Zillmann, 1984; Moynihan et al., 2015; van Tilburg & Igou, 2012, 2016, 2017b). However, these results do not explain why or when people prefer certain alternatives over others. We suggest that the choice of alternative activity depends on what people *want* to feel, which in turn depends on boredom's underlying cause.

What do bored people wish to feel instead? Boredom is often contrasted with the emotions of both interest (Csikszentmihalyi & LeFevre, 1989; Hunter & Csikszentmihalyi, 2003; Silvia, 2005) and enjoyment (Nett, Goetz, & Hall, 2011). Therefore, when people are bored and wish not to be, we predict that they will seek activities that lead them to feel either *interest* or *enjoyment,* and that successfully resolved boredom will typically result in one of these affective states.

Interest and enjoyment are related, although they differ in important ways (Berlyne, 1971; Cupchik & Gebotys, 1990; Silvia, 2005, 2006). Notably, something may be interesting without being enjoyable (e.g., watching a film about the Holocaust), or enjoyable without being interesting (e.g., watching a favorite sports team handily defeat a mediocre competitor). People readily distinguish between enjoyable and interesting stimuli in a variety of contexts, including artwork, anagrams, music, paintings, photographs, and polygons (Berlyne, Robbins, & Thompson, 1974; Crozier, 1974; Cupchik & Gebotys, 1990; Libby, Lacey, & Lacey, 1973; Reeve, 1989; Russell & George, 1990; Silvia, 2005). More importantly, interest and enjoyment appear to have different causes (Silvia, 2006). Complexity, for instance, increases interest and decreases enjoyment (Aitken, 1974; Berlyne et al., 1974; Boykin, 1977; Brown & Farha, 1966; Crozier, 1974; Day, 1967; Day, 1968; Eisenman, 1966; Evans & Day, 1971; Normore, 1974; Reeve, 1989; Russell, 1994; Russell & Gray, 1991; Silvia, 2005). Likewise, certainty increases enjoyment, but decreases interest (Crozier, 1974; Iran-Nejad, 1987). Similarly, novelty decreases enjoyment (Van den Bergh & Vrana, 1998; Zajonc, 1968) but increases interest (Berlyne, 1974; Reeve, 1989).

Silvia (2006) defines interest as the affective state that results from a joint appraisal of novelty-complexity and coping potential (i.e., whether one is able to make sense of a situation). In other words, interest is about those things that are "not understood but are understandable" (Silvia, 2006, p. 58). In contrast, people enjoy familiar things that have been rewarding in the past (Silvia, 2008), especially if they are simple and positive (Turner & Silvia, 2006). An implication of this view is that interest requires more cognitive work than does enjoyment, so that people can make sense of complex, novel, uncertain situations. For instance, in one study participants asked to read an abstract difficult-to-understand piece of modern poetry (e.g., "such daring against men with a throat so big separated by a hundred years full of misfortune: the bloody flux") unsurprisingly found the poem incomprehensible—and boring (Silvia, 2005). However, when people were first informed beforehand that the poem was about killer sharks, they were able to make sense of the poem—and it became interesting. Likewise, when asked to select the most interesting polygon from a set, people who understood complex art selected more complex shapes (Silvia, 2005). Interest, then, relies on preexisting cognitive frameworks and requires mental resources to make sense of situations and stimuli. In contrast, enjoyment, particularly of familiar stimuli, requires less processing. Pursuing interest is thus "riskier," in that it demands an investment of cognitive resources that may not always pay off affectively.

Whether bored people seek out interest versus enjoyment should thus be influenced by their subjective perceptions of available

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mental resources. When boredom is the result of understimulation, as in Cell A of Table 2, people should prefer interesting over enjoyable activities. They have ample cognitive resources to invest in an activity (e.g., watching a documentary about the Civil Rights movement) that could have both affective and cognitive payoffs. Studies of boredom that have offered a choice of alternatives have almost universally induced boredom through understimulation, and have found, as we would predict, that such boredom results in a preference for interesting alternatives, such as "exciting" foods (Moynihan et al., 2015).

When boredom is the result of overstimulation, as in Cell D of Table 2, we predict that people will prefer enjoyable over interesting activities. In this case people have invested resources trying (unsuccessfully) to complete a task, which should lead them to prefer to do something effortless and enjoyable (e.g., watching a sitcom) more than something effortful and interesting (e.g., the documentary).[8]

These predictions about the interest versus enjoyment pathway have important implications for people's susceptibility to boredom over time. If people are routinely overstimulated, and thus chronically seek out enjoyable over interesting activities, they may become more susceptible to boredom in the future. This is because switching to an enjoyable activity (e.g., a game of Candy Crush) rather than an interesting activity (e.g., a documentary about the Civil Rights movement), alleviates boredom but does nothing to foster new interests and goals that might prevent boredom from happening again in the future. In this sense, enjoyable alternatives resemble junk food, which offer short-term satisfaction at the cost of long-term well-being. Interesting activities, in contrast, involve cognitive work through deep processing and elaboration of new and existing schemas and knowledge (Silvia, 2006, 2008), which build a framework for avoiding boredom in the future.

State Versus Trait Boredom

The present work focuses specifically on state boredom. Individual differences in boredom are well-documented, and person-based theories investigate the interaction between individual (e.g., boredom proneness and boredom susceptibility) and situational causes of boredom (Gerritsen, Toplak, Sciaraffa, & Eastwood, 2014; Hunter & Eastwood, 2016; Mercer-Lynn et al., 2014). The ways and extent to which trait boredom interacts with the current model remain unexplored. For instance, in discussing the interest versus enjoyment pathway, we theorized that choosing to engage in enjoyable (vs. interesting) alternatives may, over time, lead to greater susceptibility to boredom and, eventually, stable individual differences in how often and how easily a person experiences boredom. Known correlates of individual differences in trait boredom may also be explained theoretically by the MAC model; for instance people high in boredom proneness are also likely to struggle with self-regulation, perhaps because poor self-regulation makes them particularly sensitive to the affective fallout of attentional failure. Conversely, people low in trait boredom may experience boredom less frequently or less intensely because they are more efficient at resolving such instances of meaning and/or attention failure. Intriguingly, recent experience sampling work suggests that trait boredom, rather than being a stable individual difference, may actually better reflect variation in people's choices of activities (Chin et al., 2017). When those differences in activity are accounted for, the tendency for some people to experience boredom more than others diminishes substantially.

Likewise it would be interesting to explore individual differences in the attention and meaning components of the MAC Model. Most people have experienced instances where, for example, colleagues found a conference talk fascinating, while they were bored to tears. How is it possible for different people to have such different responses to the same situation? For one, emotions depend on construals, and the same objective situation may be construed quite differently by two people experiencing it. Our colleague may know more about the topic, or simply have gotten more sleep the night before, and such situational or individual differences may moderate the effects of attention and meaning discussed above. For instance, having greater mental resources on hand may lead to fewer attentional difficulties (and thus more interest and less boredom) when trying to focus on the talk. Such moderation should take place at the level of mechanism (i.e., meaning and attention deficits) rather than with their downstream consequences (i.e., types of boredom). Take intelligence, a person-related individual difference known to correlate with boredom (London et al., 1972). Rather than asking how highly intelligent people would experience attentional versus meaningless boredom, we would instead ask whether intelligence increases available mental resources or influences the meaning people find in a task. In addition, people likely differ in their categorization and perception of boredom itself, including at the cultural level (Barrett, 2009). Such situational, individual, and cultural differences, and their interplay with the attentional and meaning components described here, are worthy of further investigation.

Following the Time Course: Shifts in Boredom Type Over Time

So far we have described discrete types of boredom, characterized by deficits in attention and/or meaning. How do these states evolve over time? Surprisingly, there has been little work on this question, despite distortions in time perception being a well-documented feature of boredom (Danckert & Allman, 2005). What work exists suggests that boredom does vary over time (Czikmantori, Hennecke, & Brandstätter, 2017; Haager, Kuhbandner, & Pekrun, 2016). Baumeister, Vohs, DeWall, and Zhang (2007) argue that emotions in general provide a taste of the pleasure or pain a person will experience in the future. That is, the role of emotions, rather than to punish or reward completed actions, is to entice people toward— or warn them off—from impending behaviors. As such, when encountering an activity that either precludes successful attentional engagement or is incongruent with valued goals, people may feel a flicker of boredom that acts as a pilot light. If a person is able reengage attention or meaning, such boredom may fade, perhaps even before being consciously noted. Conversely, chronic boredom may occur when goals chronically lack value, thus resisting resolution and permanently trapping people in the left column of Table 2 (i.e., "Low Meaning").

Importantly, just as boredom intensifies and wanes across a single emotional experience, the underlying attention and

[8] Importantly, it is the *perception* of resources, rather than objective resources, that determines whether a person seeks an enjoyable versus interesting activity (Job, Dweck, & Walton, 2010).

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meaning components likewise fluctuate. Thus, boredom may differ not only in intensity across the time course, but also in type. Goetz et al. (2014), for instance, identified five distinct types of boredom increasing in arousal and negative valence, ranging from *indifferent* boredom (low arousal, mildly positive) to *reactant* boredom (high arousal, intensively negative). These types may reflect progressive stages of boredom, with boredom increasing in arousal and negativity over time. Likewise, in our model, if deficits in attention eventually give rise to deficits in meaning, attentional boredom is likely to transition to a mixed state over time, and vice versa. In addition, to the extent that people are actively attempting to regulate attention and meaning, they may create (or resolve) such deficits. Consider attentional boredom: If people are unsuccessful in regulating attentional fit, they might try to resolve it indirectly, for instance by switching goals. In that case, they would find themselves engaged in the same activity, but with different goals than they started with. If these new goals are no longer congruent with the existing activity, they would now be experiencing meaning as well as attention deficits. In this way, *attentional* boredom could transition to *mixed* or even *meaningless boredom*. Thus, although the type of boredom experienced at any given moment depends on the immediate proximal state of its underlying meaning and attention components, as those components change over time, so too should boredom.

Physiological and neural markers may be particularly helpful in unobtrusively charting the course of boredom as it unfolds. Although self-report is the best—and most direct—method of assessing online subjective emotional experience (Diener, 2000; Robinson & Clore, 2002), indirect measures may contribute to understanding how the causal processes underlying boredom fluctuate over time. For instance, neural markers of attention and mind-wandering (including fMRI and EEG) might help delineate how attention goes astray and impacts self-reported boredom (Raffaelli et al., 2017). In one study, for example, brain scans of participants during monotonous (and boring) tasks showed greater activation of the default mode network but lower activation of areas associated with executive control, whereas scans of participants watching an interesting film showed correlated activity in both areas (Danckert & Merrifield, 2016).

Similarly, a long-standing debate in the literature is whether boredom is, in fact, solely a low arousal emotion. The MAC model predicts it is not (at least, not necessarily), and as shown in Studies 2 and 3 of this paper, we find data consistent with this prediction on self-report measures. However, physiological measures of arousal (e.g., heart rate and heart rate variability, blood pressure, skin conductance) would help clarify when—and under what conditions—boredom occurs in a low versus high arousal state. Previous work, for instance, suggests that increased boredom due to attentional difficulties during a vigilance task may be associated with increases in heart-rate variability (but not with heart rate, blood pressure, oral temperature, skin conductance, or body movement; Thackray et al., 1977). In contrast, Merrifield and Danckert (2014) found increases in heart rate and cortisol when inducing boredom via an understimulating video (relative to a sad or neutral video), accompanied by decreases in skin conductance. Additional studies on the time course of boredom, using multidimensional measures of how it changes over time, would add significantly to the literature.

Summary

In the preceding sections we reviewed existing theories of boredom and proposed a new model that unifies and expands upon previous work. We also reported empirical support for four critical predictions made by the model, namely that attention and meaning are independent causes of boredom, that they result in multiple profiles of boredom, that both under- and overstimulation can lead to boredom via attentional failure, and that the model applies to internal thought as well as external activities. Additional empirical testing is needed for the further implications of the model, such as that underlying causes determine how boredom is best resolved, that such choices can lead to an interest-enjoyment pathway that reinforces the likelihood of boredom, and that the MAC model interacts with individual and socioecological variables (including time) to create variations within and across people.

According to the MAC model, boredom is an affective indicator of unsuccessful attentional engagement in valued goal-congruent activity. It is not, as Kierkegaard claimed and perhaps many people feel, "the root of all evil" (Kierkegaard, 1843, p. 286). Like physical pain, boredom is a symptom that things are not quite right; when understood and heeded appropriately, boredom is both healthy and necessary (Eccleston, & Crombez, 1999; Elpidorou, 2014, 2017). It is a canary in the coal mine of everyday existence, signaling whether we *want* and are *able* to cognitively engage with our current activity—and impelling us to action when we do not or cannot. How we respond to boredom matters: blindly stifling every flicker of boredom with enjoyable but empty distractions precludes deeper engagement with the messages boredom sends us about meaning, values, and goals. Empty maladaptive responses, such as self-inflicted electric shocks in the lab, compulsive social media use, or full-scale gambling and drug use, may work to temporarily alleviate boredom, but at what cost? In the words of critical theorist Walter Benjamin, "Boredom is the dream bird that hatches the egg of experience. A rustling of the leaves drives it away" (Benjamin, 1968, p. 91).

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