Why Boredom is Interesting

Erin Corwin Westgate
Charlottesville, VA, USA

M.A., University of Virginia, 2016
B.A., Reed College, 2010

A Dissertation Presented to the Graduate Faculty
of the University of Virginia in Candidacy for the Degree of
Doctor of Philosophy

Department of Psychology

University of Virginia
May 2018

Abstract

What is boredom? According to the Meaning and Attentional Components (MAC) model investigated here, boredom signals a lack of meaningful attentional engagement and is the result of (a) an attentional component, composed of mismatches between cognitive demands and available mental resources and (b) a meaning component, composed of mismatches between activities and valued goals (or the absence of valued goals altogether). The MAC model generates a number of novel predictions, including that multiple types of boredom exist and motivate action according to their underlying attentional and meaning causes. Experimentally inducing meaning and attentional failure each separately lead to boredom (Study 1), and both over- and understimulation can lead to attentional failure that results in boredom (Study 2). Finally, different types of boredom lead to differing downstream consequences for people's subsequent preferences for interesting versus enjoyable activities (Study 3). Much like pain, boredom provides unpleasant but important feedback about our lives, telling us whether we *want* and are *able to* focus on what we are doing.

Why Boredom is Interesting

Erin Corwin Westgate

Charlottesville, VA, USA

A Dissertation Presented to the

Graduate Faculty of the University of Virginia

in Candidacy for the Degree of Doctor of Philosophy

April 11, 2018

Timothy D. Wilson (Chair)

Gerald Clore

Shigehiro Oishi

Kieran O'Connor

In memory of Elizabeth Theresa Westgate (1924-2017), who was anything but boring

Table of Contents

Note. Significant portions of this dissertation, including much of the introduction and all reported data (with the exception of Study 3), have been published in Westgate and Wilson (2018). The methods and results of Study 3, as well as the general discussion, have not been reported elsewhere.

A few years ago, frustrated officials at the Houston airport were stumped. They were fielding complaint after complaint from unhappy passengers, displeased about the long wait for their luggage to arrive at baggage claim. Nothing helped. Baggage claim was right next to the arrivals gate, wait times for luggage fell well within industry standards, and yet bored passengers continued to complain. They wanted the airport to do something – so, in exasperation, it did: it moved the baggage claim area *farther* away from the arrival gates. The move worked. Passengers didn't get their bags any faster, but they now spent most of that time marching happily through the airport to reach the far-off baggage claim area rather than simply waiting idly by the carousel. With that illusory sense of progress in hand, the passengers ceased to be bored, their complaints fell off and vanished, and airport officials were left in peace (Stone, 2012).

Boredom drives behavior, from cute tales of bored travelers to more serious societal issues, such as substance use (Lee, Neighbors, & Woods, 2007) and self-harm (Chapman & Dixon-Gordon, 2007). Surprisingly, though, boredom has received less attention in the psychological literature than it has from frustrated airport officials. In this dissertation, I 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 when they do. In doing so, the Meaning and Attentional Components (MAC) model accommodates and integrates previous work on boredom by clarifying the role of its underlying attentional and meaning components, including understimulation and meaningfulness (Westgate & Wilson, 2018).

Most previous accounts have focused overwhelmingly on *trait boredom*, or individual differences in a person's tendency to experience boredom more frequently, more intensely, or more easily compared to others. Similarly, 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, 1966; 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 boredom. My focus will thus be on *state boredom*, defined as "the aversive state of wanting, but being unable, to engage in a satisfying activity" (Eastwood et al., 2012, p. 483).

To preview, I will argue that boredom acts as an online affective indicator of unsuccessful attentional engagement in valued goal-congruent activity. Boredom informs us whether our current activity (internal or external) is something we *are able to* and *want* to be doing. It 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 I call the Meaning and Attentional Components (MAC) model, generates a number of novel predictions, including that existence of multiple types of boredom which motivate different responses according to their underlying attentional and meaning causes. The model offers additional insight into when boredom motivates people to seek interesting versus enjoyable activities, and suggests that people can be bored by both the external world and their own thoughts.

Theories of State Boredom

I begin with a short review of previous theories of state boredom, which I have grouped into three major families: (a) environmental theories, in which boredom is the result of environmental inputs (e.g., insufficient stimulation), (b) attentional theories, in which boredom results from attentional deficits; and (c) functional theories, in which boredom confers information about task value. Although each of these approaches offers valuable insight, none provides a comprehensive model of boredom.

Environmental Theories of Boredom

The environmental factors said to contribute to boredom include insufficient stimulation (Cox, 1980; Kubose, 1972; Hebb, 1966; London, Schubert, & Washburn, 1972; Mikulas & Vodanovich, 1993; O'Hanlon, 1981; Perkins & Hill, 1985; Posner et al., 2005; Thackray, Bailey, & Touchstone, 1977), non-optimal arousal (Berlyne, 1960; Hebb, 1966), and constrained choice (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 (Hebb, 1966; Fiske & Maddi, 1961; Mikulas & Vodanovich; Posner et al., 2005). 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 (Markey et al., 2014; Thackray et al., 1977).

However, despite the focus in environmental models on insufficient stimulation, boredom has been associated with several levels of arousal: low (Mercer & Eastwood, 2010; Posner et al., 2005; Thackray et al., 1977), high (Abramson & Stinson, 1977; London & Monello, 1980;

London, Schubert, & Washburn, 1972; Oshuga, Shimono, & Genno, 2001), and both high *and* low arousal (Eastwood et al., 2012; Fahlman, Mercer-Lynn, Flora, & Eastwood, 2013; Goetz, Frenzel, Hall, Nett, Pekrun, & Lipnevich, 2014; Mercer-Lynn, Bar, & Eastwood, 2014; Merrifield & Danckert, 2014). A shortcoming of approaches to boredom that define boredom as a low-arousal state is their inability to account for the empirical evidence that boredom is often associated with mixed- or high-arousal states, instead.

Constraint. Rather than understimulation and low arousal that lead to boredom, Troutwine and O'Neal (1981) argue that people experience boredom when they feel "stuck" in a situation or unable to switch sources of stimulation due to external constraints. Constraint imposes external control and reduces autonomy, which reduces interest (Deci & Ryan, 1985; Harackiewicz, Abrahams, & Wageman, 1987; Lepper & Greene, 1978) and is particularly pertinent in educational settings, where many students feel trapped by unvarying routines that they cannot escape (Daschmann, Goetz, & Stupinsky, 2011). Pekrun (2006) argued that these precursors are, at heart, really about control; his control-value model of achievement emotions argues that boredom is thus the joint result of (a) lack of control and (b) lack of perceived value in academic tasks. However, evidence suggests that perceived constraint may matter only in the situation itself is aversive. For instance, participants forced to listen to a monotonous recording experience boredom, whereas participants forced to listen to an interesting recording do not (Troutwine & O'Neal, 1981).

Attentional Theories of Boredom

In contrast to environmental theories of boredom, which focus on contextual features of the situation, attentional theories focus on one of its underlying mechanisms: the regulation of attention (Eastwood et al., 2012; Fisher, 1993; Hamilton, 1981; Leary, Rogers, Canfeld, & Coe, 1986). 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) argue 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. Thus, boredom is associated with nonoptimal arousal and failure of executive function. This resulting attentional failure manifests in difficulty concentrating, negative affect, perceived lack of agency, and slowed perceptions of time--in short, the classic hallmarks of boredom (Damrad-Frye & Laird, 1989; Fisher, 1993; Fisher, 1998). Attentional failure clearly plays a pivotal role in the experience of boredom. However, these models rarely identify the precursors or downstream effects of attentional failure, and fail to differentiate between attentional failure due to overstimulation versus attentional failures caused by understimulation. Neither do they explain 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.

Functional Theories of Boredom

Instead of focusing on contextual features of the environment, or the attentional mechanisms underlying them, a third family of theories focuses instead on the purpose and underlying function of boredom. Such theories draw on classic work on affect-as-information to explain the role that emotions play in conveying information relevant to one's current circumstances (Clore, Gasper, & Garvin, 2001). These functional approaches theorize that boredom acts as a distress signal that motivates behavioral or cognitive change. Although such theories agree that boredom provides information, they disagree about what information is being conveyed and, therefore, in what boredom is. Boredom may variously 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, 2015; Locke & Latham, 1990; Schmeitzky & Freund, 2013).

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, thereby missing out on other rewarding activities. Thus, understimulation is a signal that an activity no longer serves a useful function and is thus the immediate root cause of boredom: as stimulation drops, boredom kicks in and drives people to adopt new goals. 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. It doe not account, however, for boredom that results from *overstimulation* rather than understimulation (Eastwood et al., 2012; Fisher, 1987), or how new goals are adopted or pursued.

Opportunity costs. Similarly, Kurzban et al. (2013) argue that boredom’s primary purpose is to avoid opportunity costs by providing an affective cost/benefit analysis of current activity. 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. Although this approach offers valuable insight into why boredom is useful, Kurzban and

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

	Functional Theories	
Environmental and Attentional Theories	**Low Meaning**	**High Meaning**
Non-Optimal Stimulation Demands ≠ Resources	A ***Boredom***	C ***Enjoyment (Functional) or Boredom (Attention)***
Optimal Stimulation Demands = Resources	B ***Boredom (Functional) or Enjoyment (Attention)***	D ***Enjoyment***

Note. *Cells are lettered for ease of reference.*

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; the question is not whether the demand outweighs available resources, but whether the resources spent are “worth it.”

Meaning. A final group of theories emphasizes the pivotal role of boredom as a barometer of meaning. According to these theories, the crucial factor is not whether the task serves a goal, but whether the task (or goal) in question is *meaningful*. Boredom, in short, signals a lack of meaning, and motivates people to re-engage in meaningful activities (Barbalet, 1999; Locke & Latham, 1990; Schmeitzky & Freund, 2013; van Tilburg & Igou, 2012). According to van Tilburg and Igou (2012, 2017), a lack of meaning (and challenge) are the distinctive defining features that distinguish boredom from other emotions, including anger, frustration, and sadness. When bored, people attempt to re-establish meaning by seeking out new activities.

Functional theories of boredom specify not just how and when boredom occurs, but why. However, these theories do not directly account for boredom's well-documented attentional component: they explain why people feel bored when they don't *want* to be doing something, but they do not address the critical question of whether people *can* do the activity in the first place. This distinction is important because people routinely experience boredom during otherwise meaningful tasks when those tasks occur under challenging conditions or involve monotony and drudgery. In fact, functional and attentional theories offer competing predictions for whether people will experience boredom on such occasions (see Table 1). Understanding how these meaning and attentional components work in tandem is thus essential in conceptualizing a complete model of boredom.

To summarize, current theories of boredom offer many valuable insights into how and why boredom occurs, but none of them capture all of the components of boredom in a single theoretical model. The MAC model unifies the attentional and meaning components established above, resulting in a model with distinct implications and predictions for what boredom is and how it is resolved. Rather than reinventing the wheel, the MAC model integrates existing theoretical "wheels" into a new vehicle that is able to go places that none were able to travel on their own.

The Meaning and Attentional Components (MAC) Model of Boredom

I 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 continue with their current activity. Put differently, in order to avoid boredom, people must have the ability to focus on an activity and the desire to do so.

The idea that both motivation and ability are required to perform an activity is hardly new; even flight attendants routinely ask passengers seated in exit rows of the aircraft whether they are “willing and able” to assist in the event of an emergency (F.A.A. Exit Seating, 2017). This “exit row” assumption – that people must have both the capacity to act and the desire to do so - underpins many other psychological theories, including the Elaboration Likelihood Model of attitude change (Petty & Cacioppo, 1986), belief formation (Gilbert, 1991), interpersonal theory of suicide (Van Orden, Witte, Cukrowicz, Braithwaite, Selby, & Joiner Jr., 2010), and theories specifying the relationship between controlled and automatic processes (Strack & Deutsch, 2004; Wilson, Lindsey, & Schooler, 2000), among many others. I 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 engagement in the current task (*attentional* component) and second, whether the current task, regardless of engagement, is meaningful (*meaning* component). The ways in which these two components combine to produce boredom, versus enjoyment or interest, are depicted in Table 2.

Critically, I argue that, much like other theories that handle related but conceptually distinct constructs (expectancy-value theory, Wigfield & Eccles, 2000; ELM, Petty & Cacioppo, 1986), attention and meaning can be treated as independent components of boredom. At extremes it is certainly possible, perhaps even likely, that attention and meaning may interact. However, I will present preliminary evidence later that across more than a thousand participants in over a dozen studies, attention and meaning are not highly correlated, independently predict boredom, and do not interact. Thus, the evidence to date suggests that rather than being tightly intertwined, attention and meaning function largely independently in the context of boredom. Below, I elaborate on the attention and meaning components of boredom, and their own determinants.

Attentional Component: Balancing Cognitive Demands and Mental Resources

The rows in Table 2 represent the attentional component, namely whether people are *able* to maintain attention on the task. Successful attention – or cognitive engagement - occurs as a result of attentional fit, or the extent to which the demands of the task match people's cognitive resources. Successful attentional engagement typically occurs when cognitive demands are balanced by available mental resources (Wickens, 1991). A crucial but often overlooked distinction is that there are also two scenarios in which cognitive demands and mental resources are balanced: low-level engagement (Row 2 in Table 2), where available resources are low and demands are low (e.g., a tired person has just enough energy to watch television or work on a sudoku puzzle), and high-level engagement (Row 3 in Table 2), where available resources are high and demands are high (e.g., an energized reviewer reading a well-written and fascinating manuscript).

Attentional failure, in contrast, results from the mismatch between cognitive demands and mental resources. Critically, there are two ways in which demands can be ill-matched with resources. As seen in the first row of Table 2, such mismatches can take the form of *understimulation*, whereby mental resources exceed cognitive demands. Understimulation as a cause of boredom has been well-documented, as reviewed earlier. At one extreme, understimulation can occur when people have nothing to do (e.g., sitting on an airplane without

Table 2

Profiles of Boredom (in ***bolded italics****) and their Predicted Outcome (in italics) as a Function of Meaning and Attention.*

Attention Component	Meaning Component: **Low Meaning:** Task is INCONGRUENT with Valued Goals	Meaning Component: **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.*

reading material); more often, understimulation occurs whenever people perform simple undemanding tasks that require few cognitive resources.

However, attentional failure can also result from *overstimulation* (see the bottom row of Table 2), when cognitive demands exceed mental resources (Eastwood et al., 2012). Overstimulation occurs when demands exceed resources, either because demands are particularly high or resources are particularly low, such as an exhausted reviewer trying to read and understand a poorly-written, dense manuscript. Boredom resulting from overstimulation is less well-documented than boredom from understimulation and has been identified primarily in work and academic domains (Fisher, 1987; Tanaka & Murayama, 2014).

That overstimulation can lead to boredom may seem counterintuitive, at least in part because it can also result in a different emotion: frustration. But whereas frustration results from being displeased about undesirable outcomes (and is thus outcome-oriented), boredom is the result of an inability to pay attention in the process of pursuing those goals (and is thus process-oriented). When people's inability to pay attention reduces the likelihood of attaining a desired goal, frustration and boredom are likely to co-occur. However, people can fail to achieve desired goals for reasons that have nothing to do with cognitive limitations or processes (e.g., a cancelled concert event), or may achieve desired outcomes despite struggling to pay attention while doing so (e.g., successfully solving a long sequence of mind-numbingly easy addition problems). I report results in Study 2 consistent with these predictions.

Meaning Component: Matching Current Activities with Valued Goals

The columns of Table 2 represent the meaning component, or 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. The more congruent current activities are with valued goals, the more meaningful they feel in the moment. The left-hand column represents instances in which people perceive the current activity as *incongruent* with valued goals, resulting in low meaning. The right-hand 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 goals, like emotions, are rooted deeply in the moment (Clore et al., 2001) and reflect currently accessible thoughts, not long-term abstractions. They concern issues that are highly valued, imminently attainable, under threat, or require action in the present or near future (Klinger, Barta, & Maxeiner, 1980, call these “current concerns”). An otherwise unimportant goal, such as attending a party, may thus trump long-term goals, such as being admitted to law school--at least momentarily. Goals are particularly conducive for facilitating a sense of meaning when they themselves are deeply held or valued.

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 conditions for attentional engagement have been met. Thus, the meaning component complements the attentional component as an independent cause of boredom.

Types of Boredom: Meaning vs Attention Deficits

Perhaps the most important implication of the MAC model is that there are multiple types of boredom that result from distinct causes (i.e., attentional or meaning failure), as outlined in Table 2.

Attentional Boredom. Attentional boredom occurs with a mismatch between cognitive demands and available mental resources, regardless of whether the activity is congruent with valued goals. Attentional mismatches may occur either because cognitive demands outweigh available mental resources (i.e., overstimulation, Row 4 of Table 2) or because mental resources exceed cognitive demands, (i.e., understimulation, Row 1 of Table 2). Attentional boredom thus corresponds to Cells E and H of Table 2, or instances where an activity is meaningful, but *not* interesting or enjoyable, due to the inability to satisfactorily maintain attention. Attentional boredom thus corresponds most closely to the environmental theories and attentional theories of boredom reviewed earlier. Attentional boredom may motivate people to restore attention by regulating cognitive demands or resources to re-establish successful attentional fit; if such approaches fail (as is likely), an alternative strategy is to switch to another activity altogether.

Meaningless Boredom. Meaningless boredom, on the other hand, occurs when an activity is incongruent with valued goals (column 1 of Table 2). Meaningless boredom corresponds most closely to functional theories of boredom that focus on a lack of meaning or goals as the cause of boredom. Although meaningless boredom may be alleviated by goal regulation or reconstrual, I predict that it primarily motivates a *change of activity*, with the aim of bringing activity into alignment with currently salient and valued goals. Meaningless boredom may be particularly likely in conditions where people lack control over their environment, and are thus unable to switch activities to serve such goals.

Mixed States. Observant readers may have noticed that while attentional and meaning boredom are discussed as occurring independently of each other, meaning and attentional deficits may co-occur. Such mixed states, where both meaning and attention deficits occur, are represented in cells A and D of Table 2. Cell A represents instances where people have more than sufficient resources to complete a meaningless and undemanding task (e.g., peg-turning), whereas Cell D represents instances where people have insufficient resources to complete a meaningless but highly demanding task (e.g., listening to an academic talk in an unrelated field of study).

I. Validating the MAC Model of Boredom

Below, I review correlational evidence from fourteen completed studies validating the MAC model of boredom and providing initial support for its underlying attentional and meaning components. I then report experimental evidence in a causal test of key aspects of the model

(Study 1), showing that experimentally manipulating attention and meaning produce boredom, and that boredom can occur not only when a task is too easy but also when a task is too hard (Study 2). Finally, I conclude with a final study examining people's preferences of enjoyable versus interesting activities when bored (Study 3).

Preliminary Evidence

A basic postulate of the MAC theory is that both attentional and meaning deficits contribute to boredom. I tested this postulate in 14 studies. Some were conducted for other purposes, but all included measures of attention, meaning, and boredom. I conducted regression analyses in each study and then aggregated the results via an internal meta-analysis. I included in the meta-analysis all studies I have conducted that included identical items for the core constructs of interest, namely attention, meaning, and boredom. By doing so, I was able to directly compare the unstandardized regression coefficients in our analyses across all 14 studies (Becker & Wu, 2007).

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 minutes (Westgate et al., 2017 Study 5; Westgate et al., 2017 Footnote 5; Wilson, Westgate, Buttrick, & Gilbert, 2018). In others participants completed a 5-10 minute 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 & Wilson, 2018, 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 minutes (Westgate 2017d), or engaged in

Table 3
Details of individual studies reported in the meta-analysis of preliminary evidence

Study	Outlet	N	Population	Paradigm	Locati
Westgate et al., 2017, Study 5	Westgate, Wilson, & Gilbert (2017)	110	Undergraduate	Thinking	Lab
Westgate et al., 2017, Footnote	Westgate, Wilson, & Gilbert (2017)	164	Undergraduate	Thinking	Lab
Westgate, 2016a*	Unpublished pilot data	71	Undergraduate	Air Traffic Control	Lab
Westgate, 2016b*	Unpublished pilot data	33	Undergraduate	Air Traffic Control	Online
Westgate, 2016c*	Unpublished pilot data	171	mTurk	Air Traffic Control	Online
Westgate, 2016d*	Unpublished pilot data	208	mTurk	Air Traffic Control	Online
Westgate, 2016e*	Unpublished pilot data	53	Undergraduate	Air Traffic Control	Online
Wilson et al., 2017	Wilson, Westgate, Buttrick, & Gilbert (2017)	178	Undergraduate	Thinking, Planning, or Normal Activity	Field
Westgate & Wilson, 2017, Study 2	Westgate & Wilson (2017)	228	Undergraduate	Air Traffic Control	Lab
Westgate, 2016f*	Unpublished pilot data	14	Undergraduate	Air Traffic Control	Online
Westgate, 2017a*	Unpublished pilot data	62	Undergraduate	Air Traffic Control	Online
Westgate, 2017b*	Unpublished pilot data	32	Undergraduate	Air Traffic Control	Online
Westgate, 2017c*	Unpublished pilot data	40	Undergraduate	Air Traffic Control	Online
Westgate, 2017d*	Unpublished pilot data	21	Undergraduate	Letter Detection	Lab

Note. Studies are listed in chronological order by date conducted. Studies with an * are unpublished. Sample sizes reflect the number of participants for which I 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.

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]*. A list of all studies can be found in Table 3.

I 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 1,364 undergraduate and mTurk participants. 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: -.41, -.28], $z = -10.72$, $p <$. 00000000001. As predicted the interaction between attention and meaning was not significant, $b = .004$ [95% CI: -.03, .04], $z = .27$, $p = .79$ (see Figure 1). The results were consistent across all 14 studies; the test of heterogeneity of effects was nonsignificant, all *p*s > .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, I 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], $z = 12.05$, $p < .00001$, and meaning, $r = -.38$ [95% CI: -.45, -.31], $z = -10.59$, $p < .00001$, 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], $z = -2.97$, $p = .003$, suggesting that multicollinearity was not an issue.

In sum, across 14 studies I 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. Many attentional theories of boredom argue that, as the “final mediating

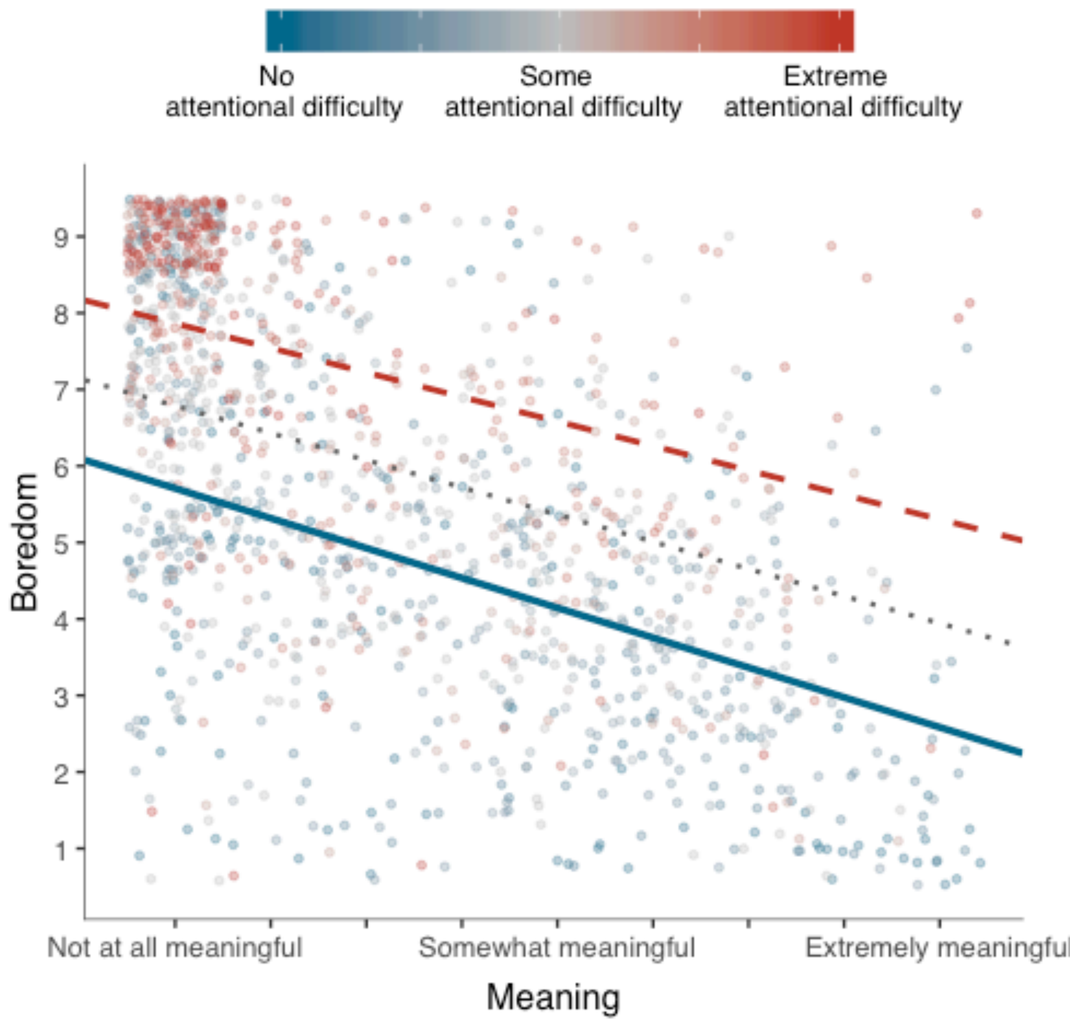

Figure 1. The aggregated correlational effects of self-reported attention and meaning on boredom pooled across 14 studies.

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, I found very little evidence that attention was fully mediating the effects of meaning (or vice versa). Rather, as predicted by the MAC model, deficits in attention and meaning predicted boredom independently and were only weakly correlated.

These data thus address an important concern: that rather than acting as independent components, attention and meaning are, in fact, hopelessly entangled. While it may certainly be true that at extremes, deficits in attention trigger deficits in meaning and vice versa, we found very little evidence that attention and meaning were related in this sample. As we have seen, they are only weakly correlated and do not interact across a variety of populations, domains, and settings. A limitation of these results, 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 I employed an experimental design in Study 1, manipulating deficits in attention and meaning while participants performed a boring task. I also expanded the dependent measures to test whether, as predicted, attentional and meaning deficits produce different profiles of boredom.

Study 1

Manipulating Attention and Meaning

Attentional models argue that boredom is the result of insufficient stimulation, which leads to boredom when people become aware of their attentional failure. As such, most boredom manipulations have consisted of an optimally stimulating and under-stimulating condition. Conversely, meaning models argue that boredom arises from a lack of meaning. As such, most meaning manipulations have varied the meaningfulness of an otherwise under-stimulating task. I predicted that attentional and meaning deficits independently contribute to boredom but would do so via different routes. To test this hypothesis Study 1 employed a 2 (Low- vs Optimal Attention) x 2 (Low vs High Meaning) design, which corresponds to the top two rows of Table 2, presented earlier. I predicted that 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, but would do so in different ways. Attentional deficits were predicted to lower boredom through a lack of attention to the task, whereas low meaning was predicted to lower boredom through disengagement in the task. One consequence of this prediction is that a situation will be perceived as boring even when people are successfully maintaining attention, if the task is lacking in meaning.

Method

Participants. Participants were 226 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. I had partial data for 10 participants due to computer glitches which prevented them from completing the study, leaving a final sample of 216 participants. Participants were recruited from the Department of Psychology participant pool and completed the study individually in a single 30-minute laboratory session. They were compensated with course credit.

Procedure. Participants stored all of their personal belongings (e.g., cellphones, watches, and backpacks) in a locker and then completed the study alone on a computer in an unadorned room. All instructions and dependent measures were delivered via a Qualtrics program. Participants first indicated their mood by rating how much they were currently experiencing 7 emotions (3 positive, 4 negative) on a series of 5-point Likert scales that ranged from 1 = *very slightly or not at all* to 5 = *extremely*. They also reported how many hours they had slept the previous night.

Participants then completed a variant of an air traffic control task (adapted from Markey et al, 2014) in which participants viewed a series of circular plots with two lines. They pressed one key if the lines eventually crossed or collided, and another key if they did not. Attentional difficulty was manipulated by varying the difficulty of the task. In the low attention condition, participants completed an extremely easy version of the task, in which the lines collided in only a small number of trials (3%) and were extremely easy to identify (e.g., were either parallel or perpendicular to each other). In the optimal attention condition, participants completed a more challenging version of the same task, in which the lines collided more frequently (47% of trials) and were more difficult to identify (e.g., were either parallel or only a few degrees off from parallel). Meaning was manipulated by increasing meaning via a charitable contribution. In the high meaning condition, participants were told that the task would consist of approximately 300 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 from a predetermined list and asked to write 3-5 sentences on the reason for their choice. Participants in the low meaning condition were told that the task would consist of approximately 300 trials, but were not given the chance to contribute to charity. The task itself lasted 10 minutes, with no time limit per trial.

Dependent measures. Participants rated how boring, interesting, enjoyable, and entertaining the thinking period was on 9-point Likert scales that ranged from 1 = *not at all [boring, interesting, enjoyable, entertaining]*, 5 = *somewhat [boring, interesting, enjoyable, entertaining]*, and 9 = *extremely [boring, interesting, enjoyable, entertaining]*. To test whether the charity manipulation was effective, I 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, I 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*. To assess the alternative hypothesis that participants were feeling frustrated rather than bored I additionally measured frustration on a 9-point Likert scale that ranged from 1 = *not at all frustrated*, 5 = *somewhat* frustrated and 9 = *extremely frustrated.* I also asked how difficult and mentally tiring the task was (on 9-point Likert scales that ranged from 1 = *not at all*, 5 = *somewhat*, and 9 = *very much),* as well as how stimulated participants felt during the task (1 = *understimulated*, 5 = *just Right*, 9 = *overstimulated*). I also asked how many trials they thought they answered correctly from 0-100%.

Participants then completed 28 items from the Multidimensional State Boredom Scale (Fahlman, Mercer-Lynn, Flora, & Eastwood, 2011), which includes subscales on 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*. I modified items on the MSBS to refer to the participant's past experience on the Air Traffic Control Task rather than their current experience. In addition, for participants in the high meaning condition, I asked how much they cared about their chosen charity and how meaningful it felt to contribute to that charity (both on 7-point Likert scales that ranged from 1 = *not at all* to 7 = *extremely*).I also included several exploratory measures of participants' experience and preference for future activities.

Results and Discussion

Manipulation checks. The manipulation of meaning was successful. All participants in the high meaning condition chose a charity (29.5% Doctors Without Borders, 24.1% American Cancer Society, 15.2% World Wildlife Fund, 12.5% American Red Cross, 10.7% UNICEF, 6.3% GiveDirectly, 1.8% Guide Dogs for the Blind) and they reported that their chosen charity was personally important ($M = 5.30$, $SD = 1.18$) and represented a meaningful contribution ($M = 4.74$, $SD = 1.64$). To test whether the meaning manipulation increased meaning, I created a meaning index by combining the three items on personal meaningfulness, accomplishing a worthwhile goal, and contributing to an important cause (alpha = .87). Participants in the high meaning condition had higher scores on this index ($M = 3.54$, $SD = 1.99$) than did participants in the low meaning condition ($M = 1.87$, $SD = 1.13$), a difference that was highly significant, $F(1,214) = 58.69$, $p < .001$, $d = 1.04$. Neither the main effect of the attention manipulation nor the interaction reached significance, Fs(1, 214) < 3.21, ps > .07.

The attention manipulation was successful as well. Participants in the easier low attention condition estimated that they achieved higher accuracy on the task than participants in the more difficult optimal attention condition (Ms = 87.6% vs. 64.5%, SDs = 15.3, 17.8), rated the task as much less difficult, $F(1,214) = 42.01$, $p < .001$, and slightly less stimulating $F(1,214) = 4.35$; $p = .04$, than did participants in the optimal attention condition. There was no difference in how mentally tiring they were, $F(1,214) = .57$; $p = .45$. In addition I created an attention index by combining the four items on mind-wandering, difficulty concentrating, forced attention, and successful attentional focus (alpha = .80). Participants in the low attention condition reported

Table 4
Manipulating Attention and Meaning: Effects on Boredom

	df	η^2_p	*F*	*p*
	Boredom Index			
Attention	1	.027	5.94	.016*
Meaning	1	.029	6.29	. 013*
Attention x Meaning	1	.004	.79	.374
	Inattention (MSBS Subscale)			
Attention	1	.063	14.32	<.001***
Meaning	1	.010	2.05	.154
Attention x Meaning	1	<.001	.08	.779
	Disengagement (MSBS Subscale)			
Attention	1	<.001	.06	.801
Meaning	1	.071	16.17	<.001***
Attention x Meaning	1	<.001	.02	.876
	Agitated Affect (MSBS Subscale)			
Attention	1	<.001	.01	.945
Meaning	1	.046	10.28	. 002**
Attention x Meaning	1	.012	2.50	.116
	Dysphoric Affect (MSBS Subscale)			
Attention	1	.004	.93	.336
Meaning	1	.033	4.60	. 033*
Attention x Meaning	1	.368	.81	.368
	Time Perception (MSBS Subscale)			
Attention	1	.009	2.04	.155
Meaning	1	.025	5.48	. 020*
Attention x Meaning	1	.001	.71	.650

Note: $N = 217$. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

more attentional difficulties ($M = 5.79$, $SD = 1.49$) than participants in the optimal attention condition ($M = 4.91$, $SD = 1.80$), a difference that was highly significant, $F(1, 214) = 15.77$, $p < .001$, $d = .54$. There was also a small but significant effect of the meaning manipulation, $F(1, 214) = 3.96$, $p = .048$, but no interaction, $F(1, 214) = 1.55$, $p = .22$.

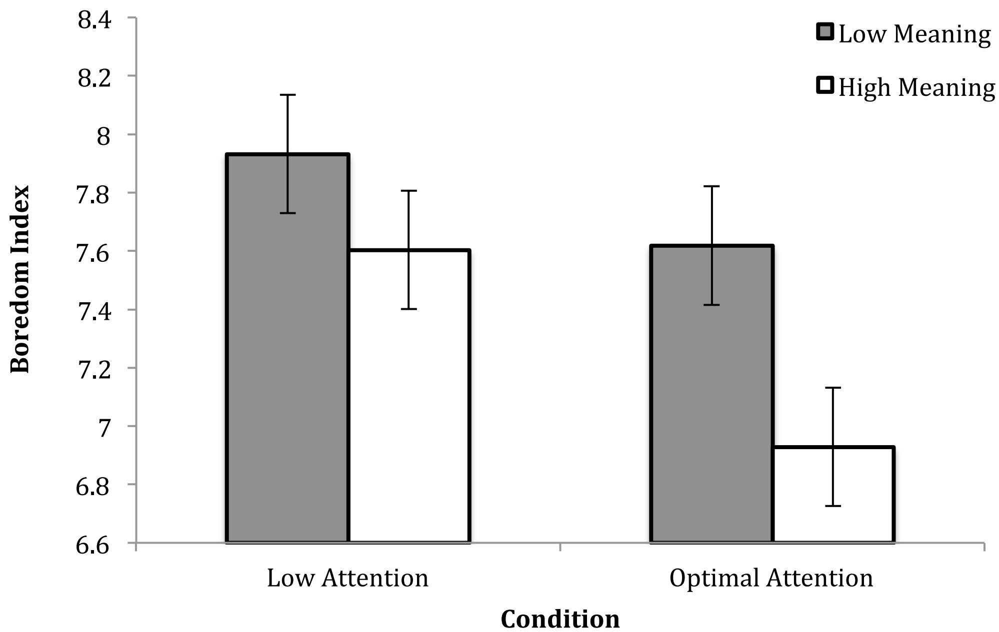

Figure 2. *The Effects of Attention and Meaning Conditions on Boredom*

Boredom index. Did manipulating attention and meaning affect boredom? To find out, I created a boredom index by averaging participants' ratings of how boring, interesting (reversed score), and enjoyable (reversed scored)[1] the air traffic control task was (alpha = .89). As predicted, participants were more bored when the task was easy (*M* = 7.77, *SD* = 1.46) than when the task was difficult (*M* = 7.27, *SD* = 1.57), as reflected by a significant main effect of the attention manipulation (see Table 3). Also as predicted, participants were more bored when the task lacked meaning (*M* = 7.77, *SD* = 1.33) than when the task was more meaningful (*M* = 7.26 , *SD* = 1.67), as reflected by a significant main effect of the meaning manipulation (see Table 4). Even within the optimal attentional condition, people were more bored when the task was

[1] Adding a fourth item to the index – namely, how entertaining the task was – did not change results and was thus not retained in the final analyses.
[2] In addition to the effect of difficulty, I also anticipated a main effect of boredom, such that more intense boredom states would translate into a preference for enjoyable activities.

meaningless compared to when it was meaningful, $F(1,215) = 5.63$, $p = .019$. Thus, as predicted, participants were most bored when the task was both meaningless and a poor attentional fit, and least bored when the task was both meaningful and a good attentional fit, see Figure 2. The interaction between attention and meaning was not significant.

I hypothesized that the attention and meaning manipulations would affect boredom in different ways. I anticipated that manipulating attention would primarily have effects on attentional processes directly, such as successfully maintaining attentional focus on the task, distractibility, and mindwandering. On the other hand, I anticipated that manipulating meaning would increase feelings of disengagement (e.g., lack of "caring" about the task) and lead to higher arousal. I tested these hypotheses by examining the effects of the attention and meaning manipulations on the subscales of the Multidimensional State Boredom Scale (Table 4). As expected, the attention manipulation (but not the meaning manipulation) significantly predicted Inattention, such that people were more inattentive during the easy version of the task. In contrast, the meaning manipulation (but not the attention manipulation) significantly predicted Disengagement, Dysphoric Affect, Agitated Affect, and Time Perception, such that people were more disengaged, more dysphoric, more agitated, and perceived time to be passing slower when the task was meaningless.

Did these differences between the two manipulations explain their effects on boredom? Mediation analyses calculated with bootstrapping procedures using 10,000 samples (Hayes, 2013) suggested that they did. As seen 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. Conversely, the Disengagement, Dysphoric Affect, Agitated Affect, and Time Perception

Table 5
Mediators of the Effect of Attention Condition on Boredom

Mediator	*a*	*b*	*ab*	95% CI
	Attention Condition			
Inattention	**-.36*****	**.54*****	**-.19**	**-.32, -.10**
Disengagement	.02	.86***	.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*****	**.43****	**-.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 enjoyment of the thinking period, controlling for condition; *ab* = the indirect effect. The results that are bolded represent significant mediation, because the 95% confidence intervals do not include zero.
*$p < .05$ *$p < .01$ ***$p < .001$

subscales of the MSBS were significant mediators of the effect of the Meaning manipulation on boredom, whereas the Inattention subscale was not. Thus, as predicted, manipulating attention and meaning not only independently increased boredom, but appear to have done so via separate mechanisms.

An alternative hypothesis is that low engagement and/or a lack of meaning produces frustration but not boredom. I believe instead that boredom and frustration are related but separate emotional constructs. Consistent with this view, frustration and boredom were only weakly correlated, $r(217) = .20$, $p = .003$. Notably, participants in every cell reported being much more bored ($M = 7.52$, $SD = 1.53$) than they were frustrated ($M = 4.78$, $SD = 2.22$), suggesting that boredom was the dominant emotion in this study

More importantly, the manipulations influenced frustration and boredom in somewhat different ways. Although participants in the optimal attention condition reported significantly less boredom then did participants in the low attention condition (as seen above), they reported somewhat greater frustration, $F(1, 214) = 3.45$, $p = .065$. In other words, participants who performed the more difficult task found it slightly more frustrating but less boring, which is consistent with the hypothesis that optimal engagement lowers boredom. In contrast, the meaning manipulation influenced boredom and frustration in similar ways. Participants in the low meaning condition were both more frustrated (and more bored) than participants in the high meaning condition, $F(1,214) = 6.46$, $p = .012$. Taken together, these findings suggest that rather than frustration acting as a proxy for boredom, frustration may be a related but separate emotional state. Specifically, frustration appears to be more related to meaningless boredom (caused by low meaning) and less related to attentional boredom due to understimulation. Bolstering this hypothesis, frustration was strongly correlated with agitated affect on the MSBS subscale, r(216) = .67, < .001 more so than it was with inattention, r(216) = .31, $p < .001$. This difference was highly significant, $z = 6.67$, $p < .001$. And agitated affect, as seen above, is a central dimension in meaning (but not attentional) boredom.

Thus, as predicted, Study 1 provides support for two hypotheses made by the MAC model: that both attentional and meaning deficits produce boredom, and that they result in different profiles of boredom. These results, I 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 1). They further suggest that a task will be perceived as boring if it is understimulating, even if it is viewed as high in meaning—inconsistent with functional theories (see the two left-hand bars in Figure 1). Perhaps most importantly, Study 2 demonstrated that boredom is experienced in different ways under these different conditions (see Table 4).

Study 2

The Curvilinear Relationship between Boredom and Cognitive Demand

The previous study induced attentional boredom by placing participants in a state of understimulation; that is, their resources exceeded the low-level demands placed by the easy simulated air traffic control task. As a result, they experienced inattention and boredom. However, the MAC model posits that not only understimulation, but overstimulation can lead to boredom, because both induce a state of resource-demand mismatch that leads to attentional failure. Thus, whereas Study 1 examined attentional failures due to understimulation, Study 2 examines attentional failure due to overstimulation, and how this state is distinct from feeling such as frustration.

According to appraisal theories, frustration is the state of being displeased about an unsatisfying outcome. Thus, a task should give rise to boredom to the extent that people feel they do not have the appropriate cognitive resources to focus on it, but frustration to the extent that their inability to focus blocks a desired outcome. In other words, while boredom is about the process, frustration is about the outcome of that process. There should, therefore, be a curvilinear relationship between the cognitive demands of a task and boredom: When cognitive demands are too low, people should feel understimulated and bored as a result (as we saw in the understimulation condition of Study 1). When cognitive demands are "just right," people should feel engaged and not bored (as we saw low-level engagement condition of Study 1). When cognitive demands are too high, however, people will become overstimulated, and boredom should return to high levels.

In contrast to this curvilinear relationship, I predict that frustration will be linearly related to cognitive demands, because the more demanding the task, the lower the probability that people will successfully achieve their desired outcome. 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 2 investigated these hypotheses using a correlational design. In addition, Study 2 included an experimental manipulation intended to manipulate subjective feelings of resource-demand fit via false feedback on a Stroop task; because that manipulation had no effects on the manipulation check or any other downstream variables, all data were collapsed across condition for the remaining analyses.

Participants. Participants were 130 undergraduate psychology students (73 female, 54 male, 1 other) between the ages of 18 and 28 (*M* = 19.01, *SD* = 1.29). Sixty-four percent identified as White/Caucasian, 20.8% as Asian, 2.3% as Hispanic 7.7% as Black/African American, 3.8% as Other, and 2% declined to answer. I had partial data for 1 participant due to computer glitches which prevented them from completing the study, leaving a final sample of 129 participants. Participants were recruited from the Department of Psychology participant pool and completed the study individually in a single 30-minute laboratory session. They were compensated with course credit.

Methods. Participants stored all of their personal belongings (e.g., cellphones, watches, and backpacks) in a locker and then completed the study alone on a computer in an unadorned room. All instructions and dependent measures were delivered via a Qualtrics program. Participants first completed four filler questions about their mood, hours of sleep the previous night, major, and current GPA. They also reported how many hours they studied the night before and how many hours they planned to study that night, as part of the cover story regarding the measurement of cognitive resources. Participants who continued were randomly assigned to condition at this point.

At this point, participants were introduced to the Stroop task as a measure of cognitive resources, strongly emphasizing their transient nature. Participants read that cognitive resources vary throughout the day and represent “mental energy.” They read that sometimes “I'm particularly high in cognitive resources, like in the morning after a good night's rest or after drinking a nice cup of coffee. Other times I may be unusually low in cognitive resources, like after I've worked really hard on a class assignment or spent the day listening to a friend's problems.” They then learned that when resources are low, it may be hard for people to concentrate on tasks, and that the Stroop Test they were about to complete would measure their current resources. Importantly, all participants were told to do their best on the Stroop test and that “to make this more interesting, I will share your results with you after you complete the activity.”

All participants then read detailed instructions for the Stroop task and completed five multiple choice practice trials. I emphasized that “Your score depends on how fast you correctly identify the color when the word and color do not match. Although sometimes the color and word may match, you will do much better on the important trials and get a more accurate score if you always ignore the written word." They then completed a 231-trial Stroop task (Stroop, 1935), consisting of four words ("red," blue," "green," "yellow") displayed on the screen in red, blue, green, or yellow font. Participants were told to use the keyboard to respond to each word (e.g., "b" for blue, "g" for green, "r" for red, "y" for yellow). In 135 trials, the words and font colors were congruent; in 47 trials, they were incongruent. In addition, I employed three meaningless character strings as 47 "filler" trials (%%%%, @@@@, ####), displayed in the same four colors as above.

Afterwards, participants read about how the Stroop task is scored. They learned that "People are faster at responding when the color + word match (red) than when they don't match (red). This happens because reading the word "interferes" cognitively with identifying its color. To calculate your score, we subtract your average response time (in ms) for congruent trials (e.g., red) from your average response time for incongruent trials (e.g., red). This difference - or "d-score" - represents how much longer it took you to respond when the word and color didn't match." They then read that an average college student (neither tired, nor well-rested) should take approximately 200ms longer on average to respond when the word and color don`t match.

Participants then viewed a 4s loading screen, before purported Stroop performance score was displayed on the screen. The feedback report consisted of their participant number and computing ID, date, and time, printed on the screen above a visual and textual print-out of their score. All feedback was portrayed by a bar graph visually portraying participants` score relative to typical college student levels in millisecond response latencies, and whether it was in the Very High, High, Normal, Low, or Very Low range. The participants` score was portrayed as a vertical black bar with the milleseconds printed above it. Under the image, the participant`s exact score and range (e.g., "Normal") was typed. Contrary to participants` beliefs, these feedback images were generated in advance (indicating low, normal, or high levels of resources) and assigned randomly to participants. In other words, the feedback did not reflect their actual performance on the Stroop task. Participants in the "insufficient resources" condition read that they had a 267 ms response time, which was in the low range for college students. Participants in the "sufficient resources" condition read that they had a 157 ms response time, which was in the normal range for college students. I timed how long participants spent on the feedback page.

Afterwards, participants read that they would next be completing a judgment and decision making activity, and that I were interested in how sleep and cognitive resources affect people`s decisions. They then read that, more specifically, they would be completing an air traffic control task, and they would have the chance for their performance to contribute to a charity of their choice. Critically, they learned that I`d adjust the required performance on the task to account for their existing level of cognitive resources. They then chose their charity from the list of seven described previously and wrote a few sentences as to the reason for their choice. They were told that the task would last 300 trials, and that I would donate $1 if they finished the task successfully. In the "insufficient resources" condition they then read that "Based on your performance on the Stroop task earlier, your mental energy levels are lower than average for this time of day. The Air Traffic Control Task will likely exceed your current cognitive resources. You may struggle to focus on this task once you get going because of its difficulty." In the "sufficient resources" condition they then read that "Based on your performance on the Stroop task earlier, your mental energy levels are about average for this time of day. The Air Traffic Control Task should be a good fit for your current cognitive resources. You should do very well focusing on this task once you get going." Thus meaning was held constant at a high level for all participants, but perceived difficulty of the task was manipulated. In actuality, all participants completed the same moderately challenging version of the task; the moderate level of challenge was intended to lend itself to being interpreted as either just right or too easy, depending on participants` Stroop feedback and construals of their own performance. For this reason, the task was limited to five minutes in duration.

Afterwards, they reported how boring, enjoyable, entertaining, and interesting the air traffic control task was on 9-point Likert scales that ranged from 1 = *not at all [boring, enjoyable, entertaining, interesting]*, 5 = *somewhat [boring, enjoyable, entertaining, interesting]*, and 9 = *extremely [boring, enjoyable, entertaining, interesting]*. Afterwards they indicated how personally meaningful it was, whether they felt they were accomplishing a worthwhile goal, how much it contributed to an important cause, how frustrated they felt, how difficult the task was, and how much they mind-wandered (all on 9-point Likert scales that ranged from 1 = *not at all*, 5 = *somewhat*, and 9 = *extremely).* They then reported how many trials they estimated they got correct (from 0-100% on a slider bar) and how many minutes they estimated the task lasted, before completing the Multidimensional State Boredom Scale (Fahlman et al., 2011).

Participants then indicated their preference for playing one of two video games, and reported how much they cared about their chosen charity and how meaningful it felt to contribute to that charity on 9-point Likert scales that ranged from 1 = *not at all*, 5 = *somewhat*, and 9 = *extremely.* As a manipulation check to see whether participants had paid attention to the false feedback, they were then asked to report their score on the Stroop task in milliseconds, and indicate (multiple-choice) into which category their score fell (from Very Low to Very High). Finally, participants reported demographics, frequency of smartphone and social media use, and experience with meditation. Participants then completed a short debriefing and suspicion prompt on the computer, before completing an extensive funneled debriefing with the experimenter eliciting suspicion and feedback, followed by a detailed explanation of the feedback deception and its purpose. Because this study involved deception, participants were then asked to complete a post-debriefing consent form, indicating whether they wished to withdraw their consent and have their data destroyed, or whether they still wished for us to use their data. All participants consented to the use of their data following debriefing.

Manipulation checks. There was little to no suspicion regarding the false Stroop feedback. Across both conditions, the majority of participants correctly remembered their score (approximately 83% in the low resources condition vs 92.3% in the high resources condition), and the category into which their score fell (99% in the low resources condition, 95.5% in the high resources condition).

However, there was no effect of the false feedback manipulation on perceived difficulty in the low resources ($M = 5.96$, $SD = 1.57$) versus normal resources ($M = 5.41$, $SD = 1.76$) conditions, $t(125) = 1.51$, $p = .13$. Likewise, there was no effect of the manipulation on perceived accuracy in the low resources ($M = 52.51\%$ accuracy, $SD = 19.91$) versus normal resources ($M = 56.81\%$, $SD = 19.04$) conditions, $t(125) = 1.25$, $p = .22$. Given that the manipulation did not succeed in manipulating perceived difficulty, I did not expect to see an effect on boredom ratings. Indeed, there was no downstream effect of the manipulation on boredom in the low resources ($M = 6.95$, $SD = 1.65$) or normal resources ($M = 6.69$, $SD = 1.47$) conditions, $t(127) = .95$, $p = .34$.

Correlational results and discussion. Given that there was no significant effect of the manipulation on perceived difficulty, accuracy, or boredom ratings, I collapsed across conditions and examined whether overstimulation and understimulation both resulted in boredom. If so, people should be bored when the task was too hard, as well as when it was too easy, which should lead to a curvilinear relationship between how difficult people perceived the air traffic control task to be and their reported boredom. I 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 2 and Table 5). As expected, I 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, I 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. Model comparison tests confirmed that a quadratic effect of difficulty on boredom, and a linear effect of difficulty on frustration, were the best fits for those two emotions, respectively (see Table 6). In other words,

Figure 3. The relationship between self-reported difficulty and boredom (on the left) versus frustration (on the right)

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 2 found evidence for a curvilinear relationship between boredom and cognitive demand, even after controlling for self-reported frustration. This is in contrast to attentional models that define boredom in terms of understimulation (Eastwood et al., 2012; van Tilburg & Igou, 2017b), which 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 and boredom requires directly manipulating cognitive demand. I did so elsewhere in a re-analysis of data from Westgate, Wilson, & Gilbert (2017), showing that

Table 5
Effects of subjective difficulty on boredom versus frustration

	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: $N = 126$. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

an experimental manipulation designed to make a cognitively demanding thinking task easier did indeed decrease signs of inattention (i.e., difficulty concentrating, mind-wandering), and reduced boredom as a result (Westgate & Wilson, 2018). That is, lowering the demands of a difficult task reduced overstimulation, increased attention, and led to decreased boredom experimentally, as well as correlationally. Together, the correlational and experimental data presented here and in

Westgate and Wilson (2018) suggest that overstimulation (i.e., when cognitive demands exceed cognitive resources) leads to attentional deficits which produce boredom. 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, 2017; Czikszentmihayli, 2000), 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).

II. The Interest-Enjoyment Pathway

One of the model's main predictions is that the cause of boredom matters. 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 either attentional deficits or meaning deficits, as illustrated in Table 2, and these different signals lead to different strategies to reduce boredom. Broadly, meaning deficits are best addressed by bringing activities into alignment with valued goals, while attention deficits are best addressed by calibrating cognitive demands to available mental resources. These two broad strategies result in four primary routes to alleviating boredom: regulating goal value, regulating cognitive demand, regulating mental resources, and switching activities (which can address both meaning *and* attention deficits). Below, I focus on this last route – switching activities – and ask, what kind of activity do bored people seek?

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 have offered participants a dichotomous choice when bored (e.g., electric shocks or food). 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 Tilbourg & Igou, 2012; van Tilburg & Igou, 2017). However, these results do not explain why or when people prefer certain alternatives over others. I 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, 2006) and enjoyment (Nett, Goetz, & Hall, 2011). Therefore, when people are bored and wish not to be, I 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 documentary about the genocide in Rwanda), or enjoyable without being interesting (e.g., playing a mindless cell phone game). People readily distinguish between enjoyable and interesting 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 and novelty, for instance, increase interest and decrease enjoyment (Aitken, 1974; Berlyne et al., 1974; Boykin, 1977; Brown & Farha, 1966; Crozier, 1974; Day, 1967, 1968; Eisenman, 1966; Evans & Day, 1971; Normore, 1974; Reeve, 1989; Russell, 1994; Russell & Gray, 1991; Silvia, 2005; Van den Bergh & Vrana, 1998; Zajonc, 1968). In contrast, certainty increases enjoyment, but decreases interest (Crozier, 1974; Iran-Nejad, 1987).

Silvia (2006) defines interest as the affective state that results from a joint appraisal of novelty-complexity and coping potential. In other words, interest is about those things that are “not understood but are understandable” (Silvia, 2006, p. 58). In contrast, people enjoy simple positive familiar things that have been rewarding in the past (Silvia, 2008; Turner & Silvia, 2006). An implication of these differences between interest and enjoyment is that interest must require more cognitive work than enjoyment, if people are to make sense of complex, novel, uncertain situations. For instance, participants in one study who were asked to read an abstract 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 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 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 I would predict, that such boredom results in a preference for interesting alternatives, such as “exciting” foods (Moynihan et al., 2015).

In contrast, when boredom is the result of overstimulation, as in Cell D of Table 2, I 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).

Study 3

The Interest vs Enjoyment Pathway

I tested this hypothesis in Study 3, using a 2-cell (overstimulation vs understimulation) design, holding meaning constant at a high level. All participants completed a letter detection task using pen-and-paper, where they asked to cross out the letter “E” on a page of randomly generated letters according to a series of rules. In the easy (understimulation) condition, participants were simply told to cross out every “E” on the page. In the cognitively taxing (overstimulation) condition, participants were told to cross out letters according to four complicated criterion rules.

Afterwards participants were given a choice of which cell phone game they would prefer to play: either a game described as “quite enjoyable (but not very interesting)” or a game described as “quite interesting (but not very enjoyable).” If, as expected, boredom due to overstimulation leads people to seek out enjoyable alternatives (while boredom due to understimulation leads people to seek out interesting alternatives) then participants completing the easy version of letter detection task should prefer the interesting cell phone game, while participants completing the more difficult version of the letter detection task should prefer the enjoyable one.

Participants. Participants were 79 undergraduate psychology students (62 female, 17 male) between the ages of 17 and 21 (M = 18.34, SD = .88). Participants were recruited from the Department of Psychology participant pool and completed the study in large groups (e.g., approximately 20-40 students) in a thirty-minute session in an empty classroom. All participants were instructed to bring their laptop, cellphone, and pen or pencil to the session, and were compensated with course credit.

Method. I greeted participants and directed them to take a seat at any desk with study materials. After completing informed consent as a group, participants completed a paper packet using pen-and-paper at their own pace. They first learned that the researchers would donate $1 to a charity of their choice for successfully completing the visual perception task in the packet, and that they would be able to select from a list of 7 charities at the end of the study. They then read that the researchers were interested in people's perception and detection skills, and saw a long list of randomly generated letters. They read that they should cross out the letter "E" in every row of letters on the page, working horizontally row by row, beginning with the top row without returning to any rows they had previously completed. Participants in the easy (understimulation) condition were simply told to cross out every "E" on the page. Participants in the cognitively taxing (overstimulation) condition, were told to cross out every "E" according to the four rules listed below:

- Cross out every "E" preceded by a vowel (a, e, i, o, u)
- Cross out every "E" that is followed by an "x", "t", or "r"
- Cross out every "E" that is exactly five letters away from a vowel on the same line

- Cross out every "E" preceded *or* followed by a "k", "m", or "v"

To ensure equivalent boredom levels across conditions, in the easy condition participants completed 75 rows of letters; participants in the cognitively taxing condition completed 24 rows[2]. All participants were asked to write down their "start time" and told that they could begin whenever they were ready. When they finished the task, they were also asked to write down their "end time."

After finishing the letter detection task, participants read that for the second part of the study, they should indicate which of two games they would prefer to play "right now" on their cell phones. They read that "These games have been previously rated by UVA students for how enjoyable and interesting they are to play. As you can see, **Game A** is seen as pretty enjoyable (but not very interesting), whereas **Game B** is seen as pretty interesting (but not very enjoyable)." They then saw a bar plot indicating that Game A had been rated in the mid-eighties out of a hundred) for how enjoyable it was, but in the mid-twenties for how interesting it was (and vice versa for Game B). Participants then indicated which game they would like to play from "Definitely prefer Game A (Enjoyable)," "Somewhat prefer Game A (Enjoyable)," "Somewhat prefer Game B (Interesting)," to "Definitely prefer Game B (Interesting)."

Afterwards, they reported how boring, interesting, enjoyable, frustrating, and personally meaningful the letter detection task was from 1 = *Not at all,* 5 = *Somewhat*, 9 = *Extremely*, as well as how difficult it was to concentrate on the task. They also reported how difficult the task

[2] In addition to the effect of difficulty, I also anticipated a main effect of boredom, such that more intense boredom states would translate into a preference for enjoyable activities. Thus, it was important that the easy and difficulty versions of the task were equally boring. To ensure that any effect of condition was due to difficulty and not boredom intensity, I therefore piloted previous versions of the two task variants with the goal of equalizing boredom intensity across the two conditions. This resulted in an easy condition that was slightly longer but equally boring when compared to the more difficult condition.

Table 6.
Task ratings and game preference in the easy and difficult letter detection conditions

	Easy Condition *n = 41*		Difficult Condition *n = 38*		*t*	*p*	Cohen's *d*
Dependent Measure	*Mean*	*SD*	*Mean*	*SD*			
Task Ratings							
Boring	5.34	2.02	5.21	2.21	0.27	.784	.06
Interesting	3.34	1.82	3.79	2.13	1.01	.318	.23
Enjoyable	3.44	1.60	3.10	1.71	0.90	.372	.21
Frustrating	2.71	1.79	3.63	2.21	2.05	.044	.47*
Personally meaningful	1.56	1.32	1.34	.97	0.83	.407	.19
Difficulty concentrating	2.59	1.55	3.63	1.87	2.72	.008	.62**
Difficulty	3.37	1.48	4.76	1.48	4.20	<.001	.96***
MSBS Subscales							
Agitated Affect	2.78	1.57	3.26	1.55	1.37	.175	.31
Time Perception	3.63	1.71	3.47	1.67	0.42	.675	.10
Dysphoric Affect	2.00	1.18	2.24	1.28	.85	.396	.19
Inattention	2.66	1.57	3.16	1.81	1.31	.194	.30
Disengagement	4.20	1.62	4.24	1.68	0.11	.911	.03
Game Preference	2.37	.83	1.95	.84	2.23	.029	.51*

Note. * = < .05, ** = < .01, *** = < .001

was from 1 = *Too Easy*, 5 = *Just Right*, to 9 = *Too Hard.* Participants then completed a single item from each of the five Multidimensional State Boredom Subscales, including agitated affect ("I felt agitated"), time perception ("It seemed like time was passing slowly during the task"), dysphoric affect ("I felt down"), inattention ("I was easily distracted"), and disengagement ("I was wasting time that would be better spent on something else"), all on 7-point scales ranging from 1 = *Strongly Disagree,* 2 = *Disagree*, 3 = *Somewhat Disagree*, 4 = *Neutral*, 5 = *Somewhat Agree*, 6 = *Agree*, 7 = *Strongly Agree.* Finally, participants completed three short demographic items reporting gender, age, and household income, before indicating their charity of choice. For the remainder of the thirty-minute session, participants completed an unrelated study on their laptops.

Results and Discussion. According to the MAC model, both understimulation and overstimulation should lead to boredom via attentional misfit. As expected, participants reported that the difficult (overstimulation) condition was significantly more difficult than the easy (understimulation) condition, $t(77) = 4.20$, $p < .001$, $d = .96$, but that there were no differences between the easy ($M = 5.34$, $SD = 2.02$) and hard conditions ($M = 5.21$, $SD = 2.22$) in how boring they were, $t(77) = .27$, $p = .78$, $d = .06$. Likewise, there were no differences in meaning between the two conditions, $t(77) = .83$, $p = .41$ (see Table 6 for full descriptives). That is, both conditions resulted in attentional misfit and boredom, but in the easy (understimulation) condition this was due to the task being too easy, while in the difficult (overstimulation) condition it was due to the task being too hard.

Did these differences in difficulty during a boring task lead to downstream changes in activity preferences? As predicted, after completing the easy version of the task, participants slightly preferred playing the interesting game next ($M = 2.37$, $SD = .83$), whereas after completing the difficult version, participants slightly preferred the enjoyable game ($M = 1.95$, $SD = .84$), $t(77) = 2.23$, $p = .03$, $d = .51$. Thus, as expected, people preferred interesting (over enjoyable) activities when they were bored due to understimulation, but enjoyable (over interesting) activities when they were bored due to overstimulation.

The evidence above is consistent with our prediction that people should prefer interesting activities when they are bored due to understimulation, and enjoyable activities when they are bored due to overstimulation, and that these preferences are due to a change in perceived mental resources. However, we were unable to test this mediational path directly due to the lack of a non-boring comparison condition. In addition, we deliberately confounded difficulty and time in Study 3 to equalize boredom levels across conditions, and ensure that changes in downstream preferences were not due to greater boredom in one condition than the other. Although participants did not report differences in time perception across conditions (Cohen's $d = .10$, $p = .68$), it is possible that the increased duration of the boring activity itself may have affected participants' subsequent preferences. To address these concerns, future work should equalize task duration across conditions and include a non-boring control that is neither too hard nor too easy (i.e., optimal attentional fit) to investigate whether preference for subsequent activities is indeed mediated by perceived changes in participants' baseline cognitive resources.

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; Silvia, 2008), which build a framework for avoiding boredom in the future.

General Discussion

In the preceding sections I reviewed existing theories of boredom and proposed a new model – the Meaning and Attentional Components (MAC) model - that unifies and expands upon previous work. In short, I argue that boredom is an affective indicator of unsuccessful attentional engagement in goal-congruent activity. I provide correlational and experimental support for the basic postulate of the model, that attention and meaning independently lead to boredom, do not interact, and are not highly correlated . In addition, I show that attention and meaning lead to different profiles of boredom, with attentional boredom (due to understimulation) characterized primarily by difficulty concentrating, in contrast to meaningless boredom, which was characterized by disengagement, high arousal, dysphoric affect, and altered time perceptions (Study 1). Finally, I show that both over- and under-stimulation can lead to boredom through resource-demand mismatches that provoke attentional failure (Studies 2 & 3), and that these different causes of boredom can have different consequences (Study 3).

The MAC model reconciles previous conflicting models of state boredom by unifying them under a single over-arching theoretical umbrella. Existing attentional and functional theories of boredom make conflicting predictions for what should happen when attention is high (but meaning low), and vice versa (see Fig. 1). Attentional theories argue that people should be bored only if they are unable to pay attention (regardless of whether they want to), while functional theories argue that people should only feel bored when they don't want to pay attention (regardless of whether they are able to). The MAC model reconciles these competing predictions by positing that attention and meaning are top-down and bottom-up processes that are both integral to establishing meaningful engagement; thus, a failure of either is sufficient (but not necessary) for boredom to occur. Attentional theories are thus correct that people feel bored when they are unable to pay attention, and functional theories are correct that people feel bored when their activity lacks meaning: the errors lie in each prediction's assumption that its cause is the *sole* cause of boredom.

Classic environmental theories of boredom can thus be explained via the two component mechanisms of the MAC model – attention and meaning. These mechanisms are understood to mediate the effects of such environmental inputs. For instance, understimulating environments are often boring, both because they lead to resource-demand mismatches (and thus attentional failure), and because they do not advanced valued goals and thus lack meaning. To the extent that either is true, boredom is likely to prevail in such environments. One contribution of the MAC model is in understanding when such environments will be boring and when they will not – that is, the model provides space for the interaction between the person and the environment to unfold. For instance, understimulating environments should *not* be boring when their low cognitive demands provide a good attentional fit (e.g., for an exhausted parent with temporarily scarce cognitive resources) or when their lack of stimulation furthers valued goals and thus confers meaning (e.g., for a monk meditating in an empty cell).

It should be noted that while the evidence reported above offers strong support for the basic postulates of the model - that attention and meaning form two independent components that jointly produce boredom - many of the model's cells and predictions remain untested. For instance, the difference between high-level engagement (when resources and demands are both high) versus low-level engagement (when resources and demands are both low) has not yet been empirically established. Likewise, a broader and more varied range of manipulations and dependent variables is needed to establish the generalizability and external validity of causes and consequences of boredom as currently predicted by our model. Our measure of preference for interesting versus enjoyable activities in Study 3, for instance, consisted of a very blunt description of an activity as either interesting or enjoyable. Whether such effects persist in more naturalistic settings with more realistic alternatives remains to be seen. Further evidence is also needed in establishing the relationship between boredom and related states, such as frustration and anxiety, to determine when such states are expected to co-occur and the extent to which people are able to distinguish between them when they do.

Perhaps most notably, we have limited data for what happens at the extremes of the MAC model. Although we find no evidence for an interaction between attention and meaning to date, it is possible – indeed, likely – that attention may interact with meaning (perhaps even ceasing to contribute to boredom), when an event is extraordinarily meaningful (e.g., death, childbirth) or lacks meaning altogether. Such instances are rare in the data currently presented, and difficult to induce in the lab. An alternative approach lies in the use of naturalistic experience sampling or daily diary methods to track extreme events as they occur spontaneously in everyday life. By focusing on populations where such events are likely to occur (e.g., expectant mothers, deployed military personnel), we may maximize our chances for finding correlational evidence of what happens to attention and meaning at the extremes.

As noted when first introducing this approach, the basic idea underpinning the MAC model - that people must both want to engage in a task and be able to do so - is not new. Nor is it confined to academics; even flight attendants are mandated by federal regulations to routinely question passengers seated in exit rows of the aircraft as to whether they are "willing and able" to assist in the event of an emergency (F.A.A. Exit Seating, 2017). That the MAC model is able to predict boredom along these two dimensions illustrates a broader point: in defining boredom in this way, we are drawing upon an underlying structure that underpins many, if not most, theories in psychology. While we focus specifically on two critical pieces of information boredom provides – attention and meaning – those two pieces can be thought of as special cases of "ability" and "motivation" more generally. This airplane "exit row" assumption – that people must have both the capacity to act and the desire to do so - can be seen in many other theories both within (automatic processes, Strack & Deutsch, 2004; Wilson et al., 2000; belief formation, Gilbert, 1991; componential theory of creativity, Amabile, 1983; ELM, Petty & Cacioppo, 1986; expectancy-value theory of achievement motivation, Wigfield & Eccles, 2000; protection-motivation theory of fear, Rogers, 1975; theory of planned behavior, Ajzen, 1985) and outside (e.g., interpersonal theory of suicide, Van Orden et al., 2010; motivation-opportunity-ability (MOA) model of consumer behavior, MacInnis, Moorman, & Jaworski, 1991; path-goal theory of leadership, House & Mitchell, 1975; preventative health behaviors, Moorman & Matulich, 1993) of social psychology. Indeed, different areas of psychology may focus differentially on these two aspects, with some concerned more with the precursors and antecedents of ability (e.g., cognitive psychology) and others more with motivation (e.g., social psychology).

This thus makes the MAC model a special case of a broader ability-motivation framework that applies to psychology more generally, a kind of psychological “exit row,” where people’s thoughts, feelings, and behavior are determined by their perceptions (or construals) of what they are willing and able to do. A common criticism of psychology (and social psychology in particular) is precisely this lack of unified model. Where biology has evolution, and physics has quantum mechanics and relativity, psychology is said to lack a central guiding theory. In contrast, I suggest, we have had one all along.

Below I discuss additional limitations regarding the MAC model’s generalizability and practical applications, as well as its relation to trait boredom and why state boredom was so long overlooked in the literature.

Beyond College Students

Just as different environments are likely to produce different boredom outcomes, individual differences in boredom should emerge to the extent that individual, intergroup, and cultural differences affect the attention and meaning components involved. Although the studies above focus predominantly on young adults and undergraduates from American samples, we expect the underlying mechanisms to generalize across other populations. Indeed, the correlational effects of attention and meaning were strongest in the two mTurk samples reported in the preliminary data, which were older and more socioeconomically diverse than our undergraduate samples. Additional empirical testing is needed for the further implications of the model, including how the MAC model interacts with individual and socioecological variables (including time) to create variations within and across people, and to understand how state boredom (described here) relates to the well-established literature on trait boredom.

Across the Lifespan

Some dimensions of the MAC model may be particularly salient for certain age groups. For instance, children and teenagers may be more easily bored, while older adults are less so. Such differences in both boredom type and intensity may stem from the differential importance of the attention versus meaning components at different lifestages. For instance, children and teenagers lack the kind of elaborated goal structures and values that confer meaning in adults. Without a firm goal compass to steer by, children and teenagers may be left to stumble upon meaningful activities beyond those provided by caregivers. Boredom itself may, in turn, be a means to shaping those very values and goals, as a child leans on feelings of boredom-as-information to learn what matters to the child and what does not. In this way, boredom may be an obnoxious but necessary feedback system by which children develop a sense of values and elaborate goal structures.

This may explain, in part, why children and teenagers so readily complain of boredom. Adults, who largely control their own everyday activities, may fear being labeled as "boring" people if they complain, because they have the power to change their behavior and find meaning – and have failed to do so. In contrast, children are often not in control of their own time, and thus not responsible for their own boredom. Thus, their complaints of boredom may be an accusation – "You are boring me" – and bid for change, rather than self-expression. That is, children's complaints may stem from external attributions for boredom whereas adults' complaints reflect internal ones. If so, similar expressions of boredom are likely to emerge among adults with little control over their own environment, such as occurs in prison, the military, or certain highly-regimented workplaces (e.g., telephone call centers).

In contrast, older adults may be less susceptible to boredom (Chin et al., 2017), both because (1) they have fewer cognitive resources, which may make understimulating activities a better attentional fit, and because (2) they prioritize activities with greater personal meaning over extrinsic benefits and thereby experience greater meaning in life (Carstensen, 1995; Steger, Oishi, & Kashdan, 2009). Older adults may also be more practiced in meaning reconstrual and less likely to engage in other competing activities (e.g., cell phone use), both of which result in greater meaning and attentional focus.

Boredom Interventions

If attention and meaning deficits lead to boredom, intervening early in these processes to remedy such deficits (or redirect people experiencing boredom to more appropriately challenging or meaningful activities) may lead to decreases in boredom and increases in overall well-being.

This may be true, in particular, of certain at-risk populations, including people with impaired cognitive functioning (e.g., dementia), chronic activity constraints (e.g., students, prisoners, military personnel), or sudden losses of goals (e.g., retirees, the unemployed), all which may lead to deficits in attention and/or meaning that put them at greater risk of boredom. Although boredom itself is a healthy signal, it can be problematic when it becomes chronic or when people's reactions to it are maladaptive. Much like chronic pain, chronic boredom ceases to serve its useful signaling function and instead impairs well-being. Likewise, boredom is helpful only insofar as people respond to it in adaptive ways; maladaptive responses, including electric shock (Wilson et al., 2014), substance use (Lee et al, 2007), and gambling (Mercer & Eastwood, 2010), may mitigate boredom but at great cost.

There is great potential for targeted interventions to reduce boredom and improve well-being, especially in populations at-risk for attention and meaning deficits. For instance, boredom interventions targeted at improving attentional fit may be particularly helpful for individuals with dementia, who are unable to maintain sustained attention and additionally lack the executive function to recognize and address such difficulty. On the other hand, boredom interventions targeting meaning may be more helpful for retirees, who have abruptly lost goals that formerly structured meaning in their daily lives. By using the MAC model to predict and address the types of deficits likely to lead to boredom in individual populations, we can intervene early to promote more adaptive responses to boredom, or pre-emptively prevent it.

Boring Thoughts, Other Minds

Such concerns are not limited to humans. There are serious practical and ethical implications for understanding boredom in non-human animals, given the prevalence of animals in captivity (including agriculture, zoos, aquariums, and pet ownership) and questions of wildlife conservation (Burn, 2017). For instance, debate over free-range chickens has focused on how much space a chicken really wants or needs; such answers are not obvious (Dawkins, Cook, Whittingham, Mansell, & Harper, 2003). Similarly, debates over wildlife conservation have serious fiscal consequences and often revolve around the protected wildlife's needs, not only in terms of physical or nutritional requirements (e.g., sufficient prey or grazing land) but also psychological well-being. How much space *does* a wolf need to not only survive but flourish? While we know much about the former, we lack rigorous theoretical frameworks to predict the latter and rely instead on descriptive norms, where they exist. The MAC model provides such a framework for humans; can it predict the needs of non-human animals as well?

There is evidence for the attentional component of boredom in animals, particularly for understimulation. Fur-farmed mink housed in standard cages approach new stimuli (both pleasant and aversive) more readily than mink housed in environmentally enriched cages, as do mice (Meagher & Mason, 2012). Rats likewise desire normally unwanted stimuli (e.g., flashes of bright light, non-preferred food items) after periods of monotony (Berlyne, 1960; Galef & Whiskin, 2003). Boredom has likewise been used as a rationale for providing enriched environments to captive octopuses (Anderson & Wood, 2001; Mather, 2001). Many of these findings, however, may alternatively be interpreted as failures not of attention – but of meaning.

On first glance, it may seem odd to discuss meaning in the context of non-human animals. However, meaning as we define it – the extent to which an activity is congruent with a valued and currently salient goal – presumes only that animals have goals (e.g., reproduction, nutrition, etc.) and are motivated to achieve them. This assumption is a critical component of nearly all operant conditioning, which is effective in both human and non-human animal populations. When we manipulated meaning in Study 1 by offering a charity donation for completing an otherwise meaningless air traffic control task, we used the same logic as operant conditioning in offering a contingent reward for performing otherwise meaningless tasks. Such rewards vary in value, but often take the form of food or social rewards, which do appear to be motivating (and perhaps be a source of meaning) for many non-human animals. Thus, in theory, adding a food payoff at the end of an otherwise boring task should reduce boredom in animals, in much the same way our charity donation reduces boredom in humans – by making it more meaningful.

The Trouble with Trait Boredom

Given the richness of these questions, it is surprising that state boredom has been so long overlooked – indeed, as of 2016, there were only 20 studies of state boredom in the literature (Struk, 2018). Instead, past work has focused overwhelmingly on trait boredom, or “boredom proneness,” by correlating differences in trait boredom with individual differences in outcome measures of interest (e.g., depression, anxiety). This focus on trait boredom often strikes outside observers as odd. After all, boredom does, not on its face, seem like a personality trait; we rarely describe someone as “a bored person,” in the way we might describe someone as a happy person or an anxious person. There is good reason for that hesitation.

Measuring Trait Boredom

The two most common scales – the Boredom Susceptibility Scale (10-item subscale of the sensation seeking scale; Zuckerman et al., 1978) and the Boredom Proneness Scale (Farmer & Sundberg, 1986) - suffer from significant conceptual[3] and psychometric issues[4], and despite

---

[3] The creators of the Boredom Proneness Scale theorized that “boredom and depression can both be described as ‘depressions’ in mood,” differing largely in intensity (Farmer & Sundberg, 1986). Accordingly, many of the items on the Boredom Proneness Scale have significant overlap with clinical measures of depression and anxiety, and the BPS correlates quite well with clinical measures of depression (r = .44-.54), hopelessness (r = .41), loneliness (r = .53), and low

purporting to both be measures of trait boredom, correlate only weakly with each other (r = .25; Farmer & Sundberg, 1986), and even more weakly with measures of state boredom.

Relationships to state boredom. If trait boredom is thought to reflect how often or how intensely people experience boredom, then measures of trait boredom ought to predict measures of state boredom during actual boring experiences. Given the dearth of research on state boredom, it is perhaps unsurprising that few studies examined whether trait boredom actually predicts state boredom. I therefore combined the studies of boredom reported earlier in the preliminary data into a meta-analysis, and found that across three studies, the Boredom Proneness Scale was only a modest predictor of state boredom, r = .17 [.05, .29], p = .004. Likewise, across six studies, the revised Short Boredom Proneness Scale[5] did not predict state boredom at all, r = .02 [-.08, .13], p = .67. This is consistent with experience sampling data, which suggests that trait boredom may largely be due to a difference of activity choice (Chin et al., 2017).

Research Islands and Evolving Ideas of Boredom

Given these issues, why has trait boredom been the focus of boredom research for the past forty years? Many of the basic theoretical underpinnings of the MAC model, including

---

subjective well-being (r =-.42). Indeed, it correlates more strongly with such clinical measures than it does with lab-induced state boredom (r = .17).

[4] The Boredom Susceptibility Scale loads appropriately only for male participants, and not for female participants (Zuckerman et al., 1978). Likewise, the Boredom Proneness Scale has an unstable factor structure, with anywhere from two to seven factors, said to indicate boredom due to internal versus external stimulation. However, these factors appear to be artifacts of reverse-scored items and similarly worded items; when those items are rewritten, the Boredom Proneness Scale forms only a single factor (Struk, Carriere, Cheyne, & Danckert, 2017).

[5] The Short Boredom Proneness Scale (SBPS) is a short revised form of the Boredom Proneness Scale that addresses its unstable factor structure, but not its theoretical confounding of boredom as a less intense state of depression (Struk et al., 2017).

appraisal theories of emotion and affect-as-information, date back many years. What explains the decades-long gap between their emergence and subsequent application to boredom?

Much as one species dispersed across isolated islands diverges over time to evolve unique features, work on trait boredom and state boredom diverged and came to look quite different. Many definitions of emotion put forward in the 1970s and 80s specifically excluded boredom and similar phenomena such as interest, by classifying them as non-emotions or "not-quite" emotions (Ekman, 1992; Lazarus, 1991; Johnson-Laird & Oatley, 1992; Ortony, Clore, Collins, 1988; Ortony & Turner, 1990). If emotions are affective states concerning an object – in other words, feelings about the goodness or badness of a specific thing – then boredom was thought to fail the test. Instead, boredom was characterized variously as lacking an affective component, comprising a mood state rather than an emotion, or conceptualized as the absence of emotion or feeling altogether.

This early pronouncement that boredom was not, in fact, an emotion led to profound consequences for how it was studied and by whom. Abandoned by emotions researchers, boredom was picked up by experts in those domains where it most obviously mattered: education (Pekrun, 2006; Troutwine & O'Neal, 1981; Goetz et al., 2014), and the workplace (Fisher, 1993, 1998; Kass & Vodanovich, 2001). There it progressed quietly in parallel to theoretical work on emotion in psychology. Despite very different aims, I/O and educational psychology share a common prioritizing of external validity (and descriptive observation) over tight causal influence, driven both by the nature of their questions and by the feasibility constraints of research in settings which limit the application of experimental designs. Boredom research in these areas thus naturally gravitated towards a correlational approach, with a focus on individual differences. To a focus, in other words, on trait, rather than state boredom.

Meanwhile, work on boredom was emerging independently in cognitive psychology (Eastwood et al., 2012) and cognitive neuroscience (Danckert & Merrifield, 2016). This work focused narrowly on one cognitive mechanism – attention - and rarely overlapped with theoretical work on emotion or appraisal structures. Thus, while I/O and educational approaches, on the one hand, and cognitive work on attention, on the other hand, made valuable contributions to their areas of interest, their work was largely divorced from new constructivist and appraisal theories of emotion, and from experimental approaches capable of establishing causal relationships. Recognition that boredom is an emotion allows for the application of longstanding theories in emotion to the domain of boredom. We see the product here: a model of boredom that predicts not only when, but why people experience boredom, and what should happen next when they do. Certainly treating boredom *as if* it were an emotion bears fruit. But is it one?

As seen in the studies and evidence presented above, boredom is an inherently negative affective state constrained to particular circumstances, events, and even stimuli. In other words, it is an affective evaluative state experienced via multiple modalities that confers information about the goodness (or in its case, primarily the badness) of its object. In biology, species are classified not only on the basis of their superficial similarity (e.g., physical appearance) but on the basis of their evolutionary origins and their downstream consequences. Different species *do* different things, developmentally and ecologically. Do emotions and boredom do different things? Do they share the same causal origins and mechanisms? As we have seen above, boredom has the same causal origins as other emotions and the same consequences, and can be explained by the same theories. And if boredom acts like an emotion, perhaps it makes sense, finally, to conclude it is one.

References

Aitken, P.P. (1974). Judgments of pleasingness and interestingness as functions of visual complexity. *Journal of Experimental Psychology, 103*, 240-244.

Ajzen, I. (1985). From intentions to actions A theory of planned behavior. In J. Kuhl, & J. Beckman (Eds.), *Action control: From cognition to behavior* (pp. 11-39). Heidelberg Springer.

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology*, *45*, 357-376.

Anderson, R. C., & Wood, J. B. (2001). Enrichment for giant pacific octopuses: Happy as a clam?. *Journal of Applied Animal Welfare Science*, *4*, 157-168.

Barbalet, J. M. (1999). Boredom and social meaning. *The British Journal of Sociology*, *50*, 631-646.

Becker, B.J., & Wu, M. (2007). The synthesis of regression slopes in meta-analysis. *Statistical Science, 22,* 414-429.

Bench, S. W., & Lench, H. C. (2013). On the function of boredom. *Behavioral Sciences*, *3*, 459-472.

Berlyne, D. E. (1960). *Conflict, arousal and curiosity*. New York, NY: McGraw-Hill.

Berlyne, D.E. (1971). *Aesthetics and Psychobiology.* New York: Appleton-Century-Crofts.

Berlyne, D.E., Robbins, M.C., & Thompson, R. (1974). A cross-cultural study of exploratory and verbal responses to visual patterns varying in complexity. In D.E. Berlyne (Ed.) Studies in the new experimental aesthetics (pp. 259-278). Washington, DC: Hemisphere.

Boykin, A.W., Jr. (1977). Verbally expressed preference and problem-solving proficiency.

Journal of Experimental Psychology: Human Perception and Performance, 3, 165-174.

Brown, L.T., & Farha, W. (1966). Some physical determinants of looking time under three instructional sets. *Perception and Psychophysics, 1,* 2-4.

Bryant, J., & Zillmann, D. (1984). Using television to alleviate boredom and stress: Selective exposure as a function of induced excitational states. *Journal of Broadcasting & Electronic Media*, *28*, 1-20.

Burn, C. C. (2017). Bestial boredom: A biological perspective on animal boredom and suggestions for its scientific investigation. *Animal Behaviour*, *130*, 141-151.

Carstensen, L. L. (1995). Evidence for a life-span theory of socioemotional selectivity. *Current Directions in Psychological Science*, *4*, 151-156.

Chapman, A. L., & Dixon‐Gordon, K. L. (2007). Emotional Antecedents and Consequences of Deliberate Self‐Harm and Suicide Attempts. *Suicide and Life-Threatening Behavior*, *37*, 543-552.

Chater, N., & Loewenstein, G. (2015). The Under-Appreciated Drive for Sense-Making. *Available at SSRN 2596897*.

Clore, G. L., Gasper, K., & Garvin, E. (2001). Affect as information. In J. P. Forgas, (Ed.). *Handbook of Affect and Social Cognition* (pp. 121-144). Mahwah, NJ.: Lawrence Erlbaum Associates.

Cox, T. (1980). `Repetitive work'. In: Cooper, C. L. and Payne, R. (Eds) Current Concerns in Occupational Stress, Wiley, Chichester, U.K.

Crozier, J.B. (1974). Verbal and exploratory responses to sound sequences varying in uncertainty level. In D.E. Berlyne (Ed.), *Studies in the new experimental aesthetics* (pp. 27-90). Washington, DC: Hemisphere.

Csikszentmihalyi, M. (2000). *Beyond boredom and anxiety: Experiencing flow in work and play.* San Francisco: Jossey-Bass.

Csikszentmihalyi, M., & LeFevre, J. (1989). Optimal experience in work and leisure. *Journal of Personality and Social Psychology*, *56*, 815-822.

Cupchik, G.C., & Gebotys, R.J. (1990). Interest and pleasure as dimensions of aesthetic experience. *Empirical Studies of the Arts, 8*, 1-14.

Damrad-Frye, R., & Laird, J. D. (1989). The experience of boredom: The role of the self-perception of attention. *Journal of Personality and Social Psychology*,*57*, 315-320.

Danckert, J., & Merrifield, C. (2016). Boredom, sustained attention and the default mode network. *Experimental Brain Research*, 1-12.

Daschmann, E.C., Goetz, T., & Stupnisky, R.H. (2011). Testing the predictors of boredom at schools: Development and validation of the precursors to boredom scales. *British Journal of Educational Psychology, 81,* 421-440.

Dawkins, M. S., Cook, P. A., Whittingham, M. J., Mansell, K. A., & Harper, A. E. (2003). What makes free-range broiler chickens range? In situ measurement of habitat preference. *Animal Behaviour*, *66*, 151-160.

Day, H.I. (1967). Evaluations of subjective complexity, pleasingness, and interestingness for a series of random polygons varying in complexity. *Perception and Psychophysics, 2,* 281-286.

Day, H.I. (1968). Some determinants of looking time under different instructional sets. *Perception and Psychophysics, 4,* 279-281.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer Science & Business Media.

Eastwood, J. D., Frischen, A., Fenske, M. J., & Smilek, D. (2012). The Unengaged mind defining boredom in terms of attention. *Perspectives on Psychological Science*, *7*, 482-495.

Eisenman, R. (1966). Pleasing and interesting visual complexity: Support for Berlyne. *Perceptual and Motor Skills, 23,* 1167-1170.

Ekman, P. (1992). Are there basic emotions?. *Psychological Review*, *99*, 550-553.

Evans, D.R., & Day, H.I. (1971). The factorial structure of responses to perceptual complexity. *Psychonomic Science, 27,* 357-359.

Exit Seating, 121 Code of Federal Regulations. §585 (2017).

Exit Seating, 135 Code of Federal Regulations. §129 (2017).

Fahlman, S. A., Mercer-Lynn, K. B., Flora, D. B., & Eastwood, J.D. (2011). Development and validation of the Multidimensional State Boredom Scale (MSBS). *Assessment*.

Farmer, R., & Sundberg, N. D. (1986). Boredom proneness - The development and correlates of a new scale. *Journal of Personality Assessment*, *50*, 4-17.

Fisher, C. D. (1987). *Boredom: construct, causes and consequences* (No. TR-ONR-9). Texas A&M University, College Station, Department of Management.

Fisher, C. D. (1993). Boredom at work: A neglected concept. *Human Relations, 46*, 395–417.

Fisher, C. D. (1998). Effects of external and internal interruptions on boredom at work: Two studies. *Journal of Organizational Behavior, 19,* 503–522.

Fiske, D. W., & Maddi, S.R. (1961). *Functions of Varied Experience*, Homewood, Ill., Dorsey.

Frankl, V. E. (1962). *Man's Search for Meaning: An Introduction to Logotherapy: a Newly Revised and Enlarged Edition of from Death-camp to Existentialism*. Beacon Press.

Galef, B. G., Jr., & Whiskin, E. E. (2003). Preference for novel flavors in adult Norway rats

(Rattus norvegicus). Journal of Comparative Psychology, 117, 96-100.

Gilbert, D. T. (1991). How mental systems believe. *American Psychologist, 46*, 107-119

Goetz, T., Frenzel, A. C., Hall, N. C., Nett, U. E., Pekrun, R., & Lipnevich, A. A. (2014). Types of boredom: An experience sampling approach. *Motivation and Emotion*, *38*, 401-419.

Hamilton, J. A. (1981). Attention, personality, and the self-regulation of mood: Absorbing interest and boredom. *Progress in Experimental Personality Research*, *10*, 1-315.

Harackiewicz, J. M., Abrahams, S., & Wageman, R. (1987). Performance evaluation and intrinsic motivation: The effects of evaluative focus, rewards, and achievement orientation. *Journal of Personality and Social Psychology*,*53*, 1015-1023.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis.* New York: Guilford.

Hebb, D. O. (1966). *A textbook of psychology.* Philadelphia, PA:W.B. Saunders.

House, R. J., Mitchell, T. R. (1975). Path-goal theory of leadership (Technical Report No. 75-67). Seattle: Department of Psychology, University of Washington.

Hill, A. B., & Perkins, R. E. (1985). Towards a model of boredom. *British Journal of Psychology,* 76, 235–240.

Hunter, J. P., & Csikszentmihalyi, M. (2003). The positive psychology of interested adolescents. *Journal of Youth and Adolescence*, *32*(1), 27-35.

Iran-Nejad, A. (1987). Cognitive and affective causes of interest and liking. *Journal of Educational Psychology, 79, 120*-130.

Johnson-Laird, P. N., & Oatley, K. (1992). Basic emotions, rationality, and folk theory. *Cognition & Emotion*, *6*, 201-223.

Kass, S. J., Vodanovich, S. J., & Callender, A. (2001). State-trait boredom: Relationship to absenteeism, tenure, and job satisfaction. *Journal of Business and Psychology*, *16*, 317-327.

Klinger, E., Barta, S. G., & Maxeiner, M. E. (1980). Motivational correlates of thought content frequency and commitment. *Journal of Personality and Social Psychology*, *39*, 1222.

Kubose, S. K. (1972). Motivational effects of boredom on children's response speeds. *Developmental Psychology*, *6*, 302-305.

Kurzban, R., Duckworth, A., Kable, J. W., & Myers, J. (2013). An opportunity cost model of subjective effort and task performance. *The Behavioral and Brain Sciences*, *36*, 661-679.

Lazarus, R. S. (1991). Progress on a cognitive-motivational-relational theory of emotion. *American psychologist*, *46*, 819-834.

Leary, M. R., Rogers, P. A., Canfeld, R. W. and Coe, C. (1986). Boredom in interpersonal encounters: Antecedents and social implications, *Journal of Personality and Social Psychology, 51*, 968-975.

Lee, C. M., Neighbors, C., & Woods, B. A. (2007). Marijuana motives: Young adults' reasons for using marijuana. *Addictive Behaviors, 32,* 1384-1394.

Lepper, M. R., & Greene, D. E. (1978). *The hidden costs of reward: New perspectives on the psychology of human motivation*. Lawrence: Erlbaum.

Libby, W.L., Jr., Lacey, B.C., & Lacey, J.L. (1973). Pupillary and cardiac activity during visual attention. *Psychophysiology,* 10, 270-294.

Locke E. A. & Latham G. J. (1990). *A Model of Goal Setting and Task Performance.* Englewood Cliffs, NJ: Prentice

London, H., & Monello, L. (1974). Cognitive manipulation of boredom. In H. London & R.

Nisbett (Eds.), *Thought and feeling* (pp.44–59). Chicago, IL: Aldine.

London, H., Schubert, D. S. P., & Washburn, D. (1972). Increase of autonomic arousal by boredom. *Journal of Abnormal Psychology, 80,* 29–36.

MacInnis, D. J., Moorman, C., & Jaworski, B. J. (1991). Enhancing and measuring consumers' motivation, opportunity, and ability to process brand information from ads. *The Journal of Marketing*, 32-53.

Maddi, S. R. (1970). The search for meaning. In W. J. Arnold & M. M. Page (Eds.), The Nebraska Symposium on Motivation (pp. 134–183). Lincoln, NE: University of Nebraska Press.

Markey, A., Chin, A., Vanepps, E. M., & Loewenstein, G. (2014). Identifying a Reliable Boredom Induction. *Perceptual & Motor Skills*, *119*, 237-253.

Mather, J. A. (2001). Animal suffering: An invertebrate perspective. *Journal of Applied Animal Welfare Science,* 4, 151-156.

Meagher, R. K., & Mason, G. J. (2012). Environmental enrichment reduces signs of boredom in caged mink. PLoS One, 7, e49180.

Mercer, K. B., & Eastwood, J. D. (2010). Is boredom associated with problem gambling behaviour? It depends on what you mean by 'boredom'. *International Gambling Studies*, *10*, 91-104.

Mercer-Lynn, K. B., Bar, R. J., & Eastwood, J. D. (2014). Causes of boredom: The person, the situation, or both?. *Personality and Individual Differences*, *56*, 122-126.

Merrifield, C., & Danckert, J. (2014). Characterizing the psychophysiological signature of boredom. *Experimental brain research*, *232*, 481-491.

Mikulas, W. L., & Vodanovich, S. J. (1993). The essence of boredom. *Psychological Record, 43,* 3–12.

Moorman, C., & Matulich, E. (1993). A model of consumers' preventive health behaviors: The role of health motivation and health ability. *Journal of Consumer Research*, *20*, 208-228.

Moynihan, A. B., van Tilburg, W. A., Igou, E. R., Wisman, A., Donnelly, A. E., & Mulcaire, J. B. (2015). Eaten up by boredom: consuming food to escape awareness of the bored self. *Frontiers in Psychology*, *6*.

Nett, U. E., Goetz, T., & Hall, N. C. (2011). Coping with boredom in school: An experience sampling perspective. *Contemporary Educational Psychology*,*36*, 49-59.

Normore, L.F. (1974). Verbal responses to visual sequences varying in uncertainty level. In D.E. Berlyne (Ed.), *Studies in the new experimental aesthetics* (pp. 109-119). Washington, DC: Hemisphere.

O'Connor, D. (1966). The phenomena of boredom. *Journal of existentialism*,*7*, 381-399.

O'Hanlon, J. F. (1981). Boredom: Practical consequences and a model. *Acta Psychologica, 49,* 53–82.

Ortony, A., Clore, G. L., & Collins A. (1988). The Cognitive Structure of Emotions. New York: Cambridge University Press.

Ortony, A., & Turner, T. J. (1990). What's basie about basic emotions? *Psychological Review, 97,* 315-331.

Ohsuga, M., Shimono, F., & Genno, H. (2001). Assessment of phasic work stress using autonomic indices. *International Journal of Psychophysiology*, *40*, 211-220.

Pekrun, R. (2006). The control-value model of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, *18*, 315-341.

Perkins, R. E., & Hill, A. B. (1985). Cognitive and affective aspects of boredom.*British Journal of Psychology*, *76*, 221-234.

Petty, R. E., & Cacioppo, J. T. (1986). *The Elaboration Likelihood Model of Persuasion*. New York: Springer.

Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and Psychopathology, 17,* 715–734.

Reeve, J. (1989). The interest-enjoyment distinction in intrinsic motivation. *Motivation and Emotion, 13,* 83-103.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change1. *The Journal of Psychology*, *91*, 93-114.

Russell, P.A., & George, D.A. (1990). Relationships between aesthetic response scales applied to paintings. *Empirical Studies of the Arts, 8,* 15-30.

Russell, P.A., & Gray, C.D. (1991). The heterogeneity of the preferability scale in aesthetic judgments of paintings. *Visual Arts Research, 17*, 76-84.

Schmeitzky, J.R., & Freund, A.M. (2013). Goal Focus and the Experience of Boredom. Poster presented at the Max Planck Institute on the LIFE Course, Ann Arbor, Michigan.

Schopenhauer, A. (1818). Die Welt als Wille und Vorstellung I. *Sämtliche Werke*, *1*.

Silvia, P. J. (2005). What is interesting? Exploring the appraisal structure of interest. *Emotion*, *5*, 89-102.

Silvia, P. J. (2006). *Exploring the psychology of interest*. Oxford University Press.

Silvia, P. J. (2008). Interest—The curious emotion. *Current Directions in Psychological Science*, *17*, 57-60.

Stone, A. (2012). Why Waiting is Torture. The New York Times.

Steger, M. F., Oishi, S., & Kashdan, T. B. (2009). Meaning in life across the life span: Levels and correlates of meaning in life from emerging adulthood to older adulthood. *The Journal of Positive Psychology*, *4*, 43-52.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8,* 220–247.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643-662.

Struk, A. (2018). A meta-analysis of state boredom studies. Unpublished raw data.

Struk, A. A., Carriere, J. S., Cheyne, J. A., & Danckert, J. (2017). A short Boredom Proneness Scale: Development and psychometric properties. *Assessment*, *24*, 346-359.

Tanaka, A. and Murayama, K. (2014) Within-person analyses of situational interest and boredom: Interactions between task-specific perceptions and achievement goals. *Journal of Educational Psychology, 106,* 1122-1134.

Thackray, R. ., Bailey, J. P., & Touchstone, R. M. (1977). Physiological, subjective, and performance correlates of reported boredom and monotony while performing a simulated radar control task. In R. R. Mackie (Ed.), *Vigilance: Model, operational performance and physiological correlates* (pp. 203–216). New York, NY: Plenum.

Troutwine, R., & O'Neal, E. C. (1981). Volition, performance of a boring task and time estimation. *Perceptual and Motor Skills*, *52*, 865-866.

Turner Jr, S. A., & Silvia, P. J. (2006). Must interesting things be pleasant? A test of competing appraisal structures. *Emotion*, *6*, 670-674.

Van den Bergh, O., & Vrana, S.R. (1998). Repetition and boredom in a perceptual fluency/attributional model of affective judgements. *Cognition and Emotion, 12,* 533-553.

Van Orden, K. A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S. R., Selby, E. A., & Joiner Jr, T. E. (2010). The interpersonal theory of suicide. *Psychological Review*, *117*, 575.

van Tilburg, W. A., & Igou, E. R. (2012). On boredom: Lack of challenge and meaning as distinct boredom experiences. *Motivation and Emotion*, *36*, 181-194.

van Tilburg, W. A., & Igou, E. R. (2017). Boredom begs to differ: Differentiation from other negative emotions. *Emotion*.

Westgate, E.C., & Wilson, T.D. (2018). Boring thoughts and bored minds: The MAC model of boredom and cognitive engagement. *Psychological Review.*

Westgate, E.C., Wilson, T.D., & Gilbert. D.T. (2017). With a little help for our thoughts: The difficulty of intentional reverie and how to make it more enjoyable. *Emotion*.

Wickens, C. D. (1991). Processing resources and attention. In D. L. Damos (Ed.), Multiple-task performance (pp. 3–34). Bristol, PA: Taylor & Francis.

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68-81.

Wilson, T. D., Lindsey, S., & Schooler, T. Y. (2000). A model of dual attitudes. *Psychological Review*, *107*, 101-126.

Wilson, T. D., Reinhard, D. A., Westgate, E. C., Gilbert, D. T., Ellerbeck, N., Hahn, C., Brown, C.L., . & Shaked, A. (2014). Just think: the challenges of the disengaged mind. *Science*, *345*, 75-77.

Wilson, T. D., Westgate, E. C., Buttrick, N. R., & Gilbert, D. T. (2018). Taking a thinking break: Pros and cons of thinking during spare moments. Manuscript under editorial review.

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology*, *9*, 1-27.

Zuckerman, M., Eysenck, S. B., & Eysenck, H. J. (1978). Sensation seeking in England and America: cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology*, *46*, 139-149.