9

ON THE VIRTUES OF FRAGILE SELF-CONTROL

Boredom as a catalyst for adaptive behavior regulation

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Self-control is an essential mechanism that is fragile by design

Most people are familiar with situations in which they struggle to achieve the goals they have set for themselves. Goal attainment can be compromised, for instance, because it requires someone to engage in a desired behavior (e.g., exercising to stay fit) or to refrain from engaging in an undesired behavior (e.g., denying oneself fast food to stay healthy) rather than indulging in a behavior that is preferred but not goal-oriented (e.g., lying on the couch and having snacks). Working towards one's superordinate goals despite such challenges and conflicts often requires self-control, which has accordingly been defined as the "efforts people exert to stimulate desirable responses and inhibit undesirable responses" (de Ridder et al., 2012, p. 77). On the one hand, self-control is conceived as a relatively stable and enduring trait, with individuals high in trait self-control assumed to be generally more effective in managing desirable and undesirable responses than individuals low in self-control (Tangney et al., 2004). In line with this notion, self-control has been shown to be essential for many aspects of human functioning (Bieleke & Wolff, 2021b), and robust links between trait self-control and various positive outcomes have been established (e.g., better health, higher income, greater happiness; Baumeister et al., 1994; Hofmann et al., 2014; Moffitt et al., 2011).

On the other hand, self-control is conceived as a transient state that is subject to fluctuations within the individual, and there has been considerable interest in studying situations in which self-control does not seem to work (e.g., de Ridder et al., 2018). Indeed, personal experience and research consistently suggest that self-control is an inherently fragile mechanism (e.g., Ainslie, 2021). This has been famously illustrated by research on the (lack of) delay of gratification in intertemporal choice settings like the marshmallow test (Ainslie, 1975; Mischel et al., 1989). Here, people essentially sacrifice their initial preferences for large but delayed rewards (e.g., staying healthy into old age, waiting to earn two marshmallows) in favor of immediately available but smaller rewards (e.g., skipping a training session to watch TV, eating one marshmallow without waiting). Self-control is additionally affected by contextual factors like the prior exertion of mental effort in unrelated tasks (Giboin & Wolff, 2019; Hagger et al., 2010). For instance, people might find it more challenging to summon the self-control required for exercising in bad weather after an exhausting work day compared to a restful day of leisure (e.g., Schöndube et al., 2017). This malleability of self-control is commonly interpreted as a self-regulatory failure

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in effective goal striving, and its high prevalence in everyday life (e.g., Hofmann et al., 2012) has sparked considerable interest in understanding the fragility of self-control. In this chapter, we highlight why this fragility is not a bug, but the very feature that allows self-control to be a functional mechanism in the adaptive orientation of goal-directed behavior.

Explaining the fragility of self-control

The question of why self-control is a fragile mechanism is subject to an ongoing debate in the literature, and different perspectives have emerged (for an overview, see Inzlicht et al., 2021). Resource-based models like the strength model of self-control (Baumeister et al., 1998) have long provided the prevailing perspective. They explain the fragility of self-control by proposing that self-control relies on a limited resource. According to this view, performing self-control–demanding behaviors consumes a portion of this resource that is not immediately replenished. This temporary state of "ego depletion" ostensibly impairs the performance of subsequent self-control–demanding behaviors by reducing an individual's ability to draw from the underlying resource. However, the empirical evidence for the assumptions of the strength model of self-control is inconsistent (e.g., Hagger et al., 2010, 2016), the supporting literature is affected by publication bias (Wolff et al., 2018), and its mechanistic underpinnings have been questioned (Inzlicht et al., 2014). This encouraged the development of models that are more precise with respect to the mechanistic underpinnings of self-control. These models revolve around the premise that self-control represents the force through which mental effort is exerted (Shenhav et al., 2017). In turn, mental effort and self-control are intrinsically related. Importantly, mental effort is commonly experienced as aversive (Kool & Botvinick, 2018) and linked to negative sensations like fatigue and frustration (Wolff et al., 2021b). Therefore, people tend to mobilize effort sparingly and only to the maximum necessary extent (Richter et al., 2016). The experience of effort can thus be understood as the signal for the costs of applying self-control, and these perceived costs of control are thought to directly bias control allocation.

The important role of effort as a cost signal is a basic tenet of reward-based models of self-control, which assume that its fragility reflects changes in individuals' willingness to apply self-control. For instance, the schema model of self-control (Bertrams, 2020) assumes that the experienced effort during self-control allocation activates a cognitive fatigue/decreased vitality schema, which is associated with the motivation to reduce the expenditure of further effort to save energy. This cognitive approach may explain why imagining the exertion of self-control without actually performing the initial self-control behavior leads to decrements in subsequent self-control–demanding tasks (Englert & Bertrams, 2014; Graham et al., 2014): Possibly, the mere imagination of self-control effort primes the assumed fatigue/decreased vitality schema which then had motivational effects on further behaviors. The process model of self-control (Inzlicht & Schmeichel, 2012), on the other hand, assumes that performing self-control–demanding behaviors initiates temporary shifts in motivational and attentional processes toward more rewarding alternative behaviors. These processes eventually undermine an individual's motivation to invest further effort into subsequent self-control–demanding behaviors. This perspective can also account for empirical findings that are difficult to reconcile with the assumption of a limited resource, such as the observation that the emergence of ego depletion is contingent on whether individuals believe that self-control is limited (Job et al., 2010). From the perspective of reward-based models, what appears to be a self-control failure from the outside might thus be indicative of a behavior that is subjectively optimal under the given conditions: Individuals should align their application of self-control with changes in the associated costs and values.

Although differing in their specifics, reward-based models thus converge to the conclusion that the fragility of self-control reflects a shift in motivation. They explicate the role of effort in the decision to apply self-control, allowing them to account for a wide range of empirical findings that are difficult to reconcile with resource-based models of self-control. For example, the finding that monetary rewards can offset "ego depletion" (Muraven & Slessareva, 2003) is inconsistent with a resource-based based account but fully consistent with reward-based choice models of self-control. Importantly, some reward-based models even explicate the computational properties and the mechanistic properties that govern self-control processes (Shenhav et al., 2017) and offer a plausible explanation for the apparent fragility of self-control. A prime example is the expected value of control theory (EVC theory; Shenhav et al., 2013, 2016), a neurocomputational framework that conceptualizes the application of self-control as a reward-based choice, when humans choose the control signal that optimizes the EVC (i.e., the type and intensity of self-control allocation whereby EVC is maximized). It offers nuanced perspectives on the dynamics of motivational shifts according to the underlying cost-benefit analysis. Effort is assumed to serve as a dynamic signal that quantifies the costs of self-control, in accordance with the definition of self-control as effortful (Ainslie, 2021; de Ridder et al., 2012). The benefits refer to positive outcomes that are expected to result from the application of self-control, such as attaining a valued goal or avoiding negative consequences. There is a plethora of afferent signals that are integrated by subcortical structures to compute the EVC of available control signal configurations. Simply put, to compute the EVC for a specific controlled action, such as going for a run, the available information regarding the value (e.g., high value: getting fitter; low value: being bored while training) and the costs (e.g., more or less required effort) of this action need to be taken into account. In this chapter, we focus on the role of core sensations that signal the potential value of various activities. One fundamental signal that informs people about the value of various activities is boredom (e.g., Agrawal et al., 2022; Wolff & Martarelli, 2020), which has consequently been suggested to play a crucial part in the optimization process underlying self-control (Bieleke & Wolff, 2021a).

Boredom makes self-control less worthwhile and more costly

Boredom has two crucial characteristics that influence the outcome of the cost-benefit analysis for self-control according to the EVC theory (see Figure 9.1). First and foremost, it signals that the current activity has little personal value, emphasizing that there might be alternative activities that are more rewarding (e.g., higher levels of value) and/or make better use of the individual's mental resources (e.g., providing an optimal fit to one's abilities; Pekrun et al., 2010; van Tilburg & Igou, 2012; Westgate & Wilson, 2018). On a neural level, for instance, boredom has been found to increase an individual's sensitivity to rewards (Milyavskaya et al., 2019), which renders alternative activities more attractive than the current activity and prompts people to engage in these activities—even if they are aversive themselves (Bench & Lench, 2013, 2019). Consequently, boredom reduces the value of the current activity relative to alternative goals. From the perspective of EVC theory, this translates into a decrease in the benefits derived from self-control. To illustrate with the example of revising an academic paper: The value ascribed to revising the paper might be high because the aspiring author really wants to publish the paper, so the EVC is high and the author invests substantial effort into the revision. Over time, the author might become bored, however, and the value of revising the paper and the reward the publication would yield starts to fade. Now, the control signal where EVC is maximized is much lower and the author starts to invest less effort into the revision. In Figure 9.1, this is illustrated by a decrease in the value for high versus low levels of boredom at each level of control signal intensity.

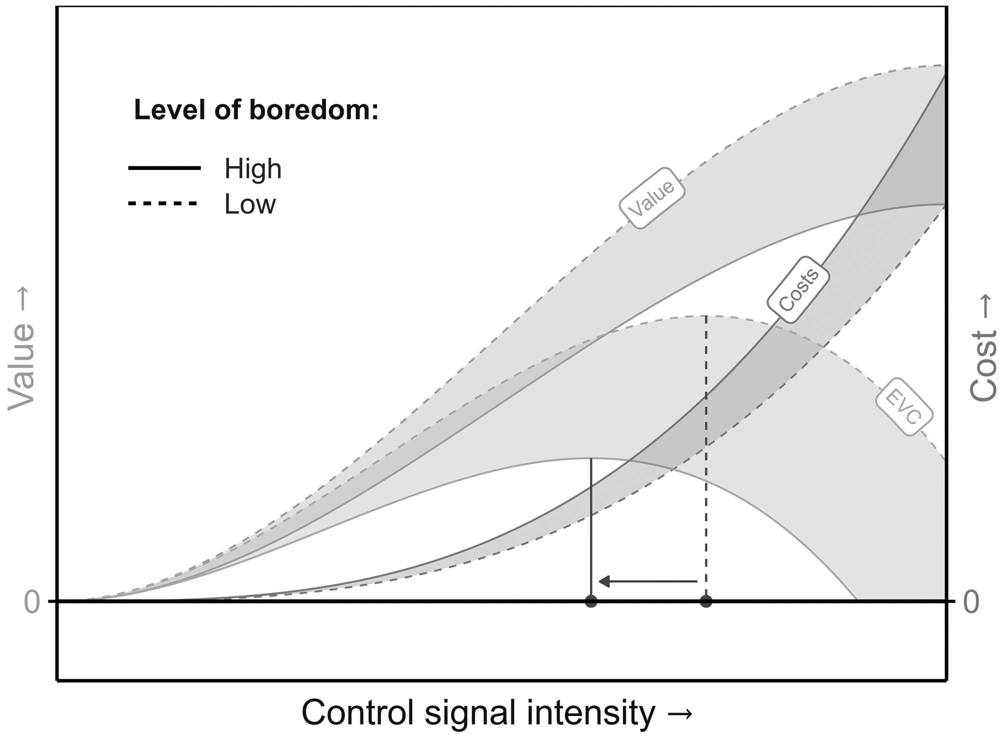

Figure 9.1 According to the EVC theory, the intensity of the control signal is selected such that the expected value of control (EVC) is maximized, thereby optimally solving the tradeoff between the value and the costs associated with a given signal strength. Boredom enters this cost-benefit analysis via two routes: First, boredom decreases the expected value associated with a given control signal intensity by devaluing the current activity relative to alternative activities. Second, boredom increases the costs associated with a given control signal intensity by increasing the effort required to continue. The continuous transition from low levels of boredom (dashed lines) to high levels of boredom (solid lines) is represented by the semi-transparent areas in the figure, taking into account that boredom is a highly dynamic and continuous signal (Mills & Christoff, 2018). All other things being equal, increasing levels of boredom are thus associated with a decrease in the optimal control signal intensity.

The second route for boredom to enter the cost-benefit analysis of self-control pertains to the cost side. Boredom is assumed to become an aversive experience when it must be endured for a prolonged time, for instance, when people are stuck in unsatisfying activities (Eastwood et al., 2012). This aversiveness reflects the mental effort required to maintain engaged in boring activities, which raises self-control costs. This is supported, for example, by studies showing that boring tasks induce higher levels of fatigue than cognitively straining tasks (Milyavskaya et al., 2019) and that boredom crowds out the effort devoted to task performance (Bieleke et al., 2021a). Moreover, people display an urge to avoid and escape boredom that parallels the urge to evade pain and psychological distress (Bieleke et al., 2022a), up to the point that people willingly trade boredom against physical pain (e.g., self-administering electric shocks; Nederkoorn et al., 2016; T. D. Wilson et al., 2014b). In terms of the EVC theory, these findings suggest that the effort required to endure boredom adds to the costs of self-control. Coming back to the author struggling with revising a paper: Maintaining focus on the revision and resisting the urge to do something else requires extra effort due to the boredom that sets in. In Figure 9.1, this is illustrated by an increase in the costs of high versus low levels of boredom at each level of control signal intensity.

Both effects of boredom combined—the decrease in value and the increase in costs—instigate a pronounced shift in the optimal EVC associated with the current activity. This is shown in Figure 9.1, whereby the optimal control signal is considerably reduced for high compared to low levels of boredom. This implies that boredom is a powerful catalyst for disengagement from unrewarding goal pursuits. Indeed, empirical research has demonstrated that boredom arises in situations with little useful information (i.e., minimized prediction errors) and motivates people to engage in exploration of the environment (Geana et al., 2016). Computational modeling suggests that this feature makes boredom essential for achieving an optimal balance between exploration and exploitation (Gomez-Ramirez & Costa, 2017), which is in line with conceptual considerations about the relevance of boredom as a guiding signal for human behavior (Wolff & Martarelli, 2020). Importantly, it is conceivable that boredom encourages explorative behaviors that are undirected and unsystematic (undirected exploration) rather than goal-directed and systematic (directed exploration: R.C. Wilson et al., 2014a; see also Chapter 5). For instance, it has been shown that individuals with a tendency to experience boredom display noisy decision-making, alternating aimlessly between behaviors that they may later regret (Wolff et al., 2022b; Yakobi & Danckert, 2021).

These considerations have important implications for framing self-control as a fragile mechanism. The fragility of self-control, far from being a bug or failure, is an essential and highly adaptive feature that allows people to adjust their behavior dynamically. Simply put, self-control must be fragile to be valuable. It needs to be flexibly adjusted to promote behaviors whose direction and vigor make optimal use of one's resources in light of ever-changing internal and external states that maximize one's EVC. For example, self-control needs to be adjusted when boredom prompts a decrease in the value and an increase in the costs of performing a particular activity. If humans had "perfect" self-control, the control signal intensity in Figure 9.1 would remain at a non-optimally high level and one would be strictly better off by applying less self-control. This probably explains why evolution has favored dynamically adjusting rather than "perfect" self-control (Hayden, 2019), which also plays a role for exploitation and exploration. Self-control is arguably involved in initiating, maintaining, and balancing goal-directed behaviors that aim at either exploiting well-known options or intentionally exploring alternative options (Cogliati Dezza et al., 2019; Daw et al., 2006; Mansouri et al., 2017). For instance, someone might need self-control to consistently perform the same well-known exercises to reap its predictable benefits (exploitation; e.g., going for the weekly run in a nearby park) as well as to systematically search for new exercises that provide unknown but potentially higher benefits (directed exploration; e.g., starting to cycle in the vicinity of the city). The sensitivity of self-control to changes in value and costs, however, allows fundamental afferent signals like boredom to bias behavior away from such goal-directed forms of behavior and towards less directed forms of exploration (Bieleke & Wolff, 2021a; Danckert, 2019). For instance, one might become bored of the regular run in the park and spontaneously decide to take a new and unknown route. This undirected exploration should depend crucially on the distribution of EVCs in an individual's action space, such that the activity with the next highest EVC compared to the current activity is enacted. These EVC distributions might be shaped by inter- and intra-individual factors, as discussed in the following section.

Advancing boredom research: an EVC perspective on trait boredom

In our chapter, we have so far focused on boredom as a dynamic and transient experience (Mills & Christoff, 2018). However, some individuals might be more prone than others to experience boredom across time and in different situations—an assertion that lies at the heart of the concept of *boredom proneness* (Farmer & Sundberg, 1986). The associated boredom proneness scale constitutes the prevailing approach to assessing trait boredom (Vodanovich & Watt, 2016; see also Chapter 3). It has been shown to capture not only whether individuals experience boredom frequently and intensively but more generally whether they perceive their entire life as boring (Tam et al., 2021). From an EVC perspective, experiencing boredom frequently and intensively should increase the costs of self-control and reduce its value, leading to chronically low self-control signals (see Figure 9.1). This should result in a negative association between measures of trait self-control and boredom proneness. In line with this hypothesis, research has consistently demonstrated substantial negative correlations between these two traits (Bieleke et al., 2021b; Wolff et al., 2020). Moreover, boredom proneness and trait self-control overlap considerably in psychometric networks with negative associations (Wolff et al., 2022a) and contribute inversely to personality profiles underlying behavior (Wolff et al., 2021a).

Importantly, self-control signal intensity should be reduced not only for one but *for all available activities*, as boredom proneness has been shown to reflect a "holistic perception of life being boring" (Tam et al., 2021, p. 832). When everything in life seems boring, the EVC should be generally low (see Figure 9.2). This has intriguing implications for characterizing boredom proneness: First, it implies that people high in boredom proneness should be inclined to engage primarily in activities with rather low self-control demands. In line with this idea, boredom-prone individuals have consistently been shown to engage in fewer behaviors indicative of good self-control (for an overview, see Bieleke et al., 2022a), such as physical activity (Wolff et al., 2021a), and in more behaviors indicative of poor self-control, such as emotional eating (Crockett et al., 2015). Second, perceiving every available action as boring should compromise behavior aiming at exploitation and exploration alike (Danckert, 2019), a prediction that is probably captured best by the characterization of boredom proneness as a "failure to launch" (Mugon et al., 2018). Indeed, people high in boredom proneness find it difficult to engage in new goals when their current goals become futile (Bieleke et al., 2022b), and they demonstrate weaker preferences for exploration even though they can be more curious than others (Martarelli et al., 2022). Importantly, both of these characteristics of boredom proneness—the inclination to engage in behaviors indicative of poor self-control and the failure to engage in both exploration and exploitation—are not characteristic of transient boredom discussed so far, which decreases the EVC selectively and not holistically.

Boredom proneness thus deviates markedly from contemporary definitions of boredom (Eastwood et al., 2012; see Chapter 2), which emphasize its function as a signal to instigate behavior change and its impartiality concerning the adaptiveness of the behavior (Bench & Lench, 2013, 2019; see Chapter 5). To address this issue, trait boredom has recently been conceptualized as the urge to avoid and escape boredom (Bieleke et al., 2022a). In terms of the EVC theory, individuals with a strong urge to avoid and escape boredom should experience rapid increases in costs and/or decreases in value when an activity becomes boring (or is anticipated to become boring; see Tam et al., 2023). In line with definitions of boredom but in contrast to research on boredom proneness, this should in turn instigate swift changes in behavior that keep the intensity of experienced boredom at low levels. Although research on the urge to avoid and escape boredom is limited to date, the available evidence lends preliminary support to these assumptions (Bieleke et al., 2022a, 2022b). Measures of the urge to avoid

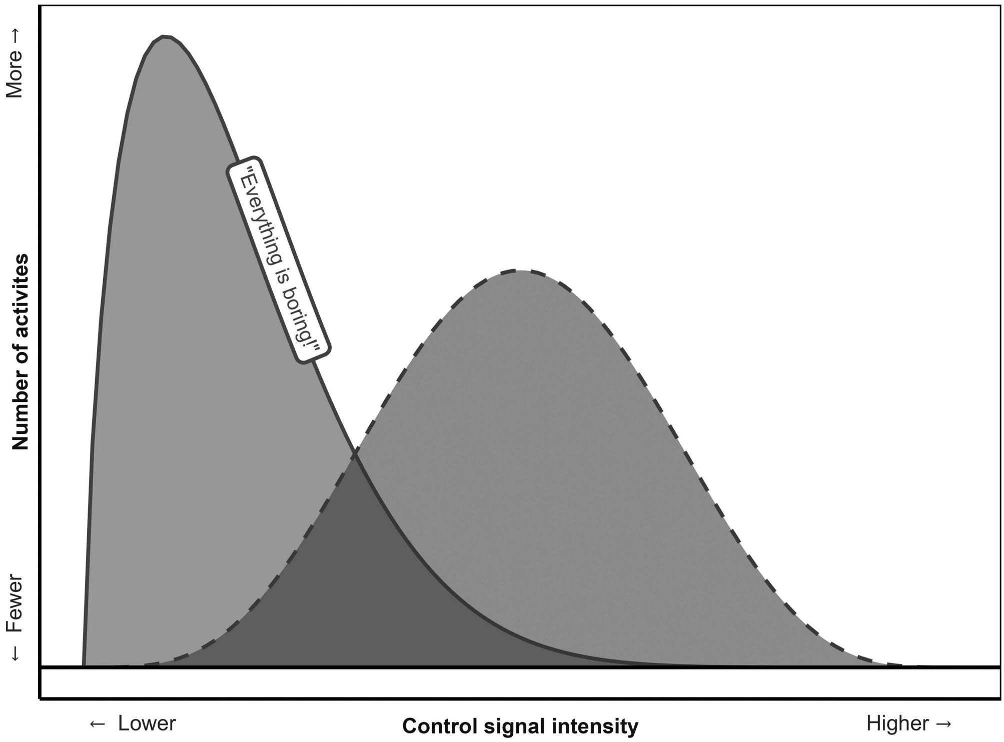

Figure 9.2 While the distribution of EVCs across all potential activities likely fluctuates considerably within and across individuals, there might be systematic differences. For instance, people high in boredom proneness might generally face activities with predominantly low EVCs (solid curve), rather than a more balanced continuum of low–high EVC activities (dashed curve). Even though many activities might be available to them, none is worth investing a lot of effort, nurturing their impression that life as a whole is boring. Temporarily, such a distribution with primarily low EVC might arise in situations with strong contextual constraints as well, such as academic or vocational settings that limit the set of available activities. From this perspective, it is interesting that boredom in these situations seems to be similarly associated with a plethora of undesired outcomes as trait boredom (e.g., low effort, little self-control, poor performance; see Chapters 15–16).

and escape boredom display only weak correlations with measures of boredom proneness as well as little latent overlap, suggesting the presence of two distinct concepts. Unlike boredom proneness, the urge to avoid and escape boredom is not linked to self-control but is associated with both more adaptive and more maladaptive behaviors alike, attesting to its impartiality in terms of adaptiveness.

Advancing self-control research: boredom as a potential confound

The tight link between boredom and self-control has important implications for designing experiments that investigate situational fluctuations in self-control. These experiments commonly rely on a sequential two-task paradigm (e.g., Hagger et al., 2010), in which the initial task is designed to require either little self-control (e.g., transcribing a text without special rules; low-demand condition) or much self-control (e.g., transcribing a text while omitting certain letters; high-demand condition). The question then is whether these differences in self-control demands affect the performance in a subsequent self-control–demanding task. According to the strength model of self-control, for instance, self-control resources should be depleted more strongly in the high-demand condition than in the low-demand condition, which is expected to impair performance in the second task (Baumeister et al., 1998).

The adequateness of the sequential two-task paradigm for investigating fluctuations in self-control critically depends on the assumption that the low- and high-demand conditions actually differ in terms of their self-control demands. However, this assumption has been contested by arguing that the lack of challenge in the low-demand condition might induce boredom (Milyavskaya et al., 2019; Wolff & Martarelli, 2020). Indeed, it has been shown that commonly used self-control tasks can induce boredom (Hunte et al., 2022; Mangin et al., 2021), unless these tasks are sufficiently challenging (Bieleke et al., 2021a), with downstream effects on performance in subsequent tasks (Bieleke et al., 2021a; Lott, 2023). In line with our previous arguments, the experience of boredom constitutes a self-control demand because it renders the current activity less worthwhile and more costly. This should attenuate the intended differences between low- and high-demand conditions in terms of self-control, which could explain the inconsistencies in the literature on ego depletion effects (Wolff & Martarelli, 2020). In line with this reasoning, an ego depletion effect has been found in experiments only after boredom had been eliminated successfully in the low-demand condition (Mangin et al., 2021). To complicate matters even further, boredom might also arise in self-control–demanding tasks (Bieleke et al., 2021a). This might reflect overchallenge when the task demands exceed an individual's abilities, or a decrease in difficulty due to learning (Wolff & Martarelli, 2020).

Taken together, this suggests that boredom might be an important confounding factor in self-control research. This conclusion is in line with predictions derived from existing models of self-control. For example, the schema model of self-control (Bertrams, 2020) introduced at the outset of the chapter assumes that self-control depends on the automatic activation of the cognitive concept of fatigue and its motivational consequences. From this perspective, boredom may contribute to the fragility of self-control from the points in the model at which various variables moderate the process from initial effortful self-control exertion to subsequent reductions in self-control performance (i.e., ego depletion), which is mediated via the activation of the fatigue/decreased vitality schema. For instance, as studies have found, boring tasks cause significant fatigue (Milyavskaya et al., 2019), and consequently, the subjective state experiences of boredom and fatigue are substantially associated (Dora et al., 2021). Thus, boredom may be considered to instigate or amplify the activation of the fatigue/decreased vitality schema. In this way, boredom may lead to or intensify the reduction of effort investment for self-control, which is in line with the findings of Bieleke et al. (2021a). Whether such causal relationships to explain the ego depletion phenomenon actually exist is still an open question. However, these considerations illustrate that self-control research must take boredom as a potential confound into account.

Conclusion

In this chapter, we have highlighted why the apparent fragility of self-control is a required feature that makes self-control an effective mechanism for behavior regulation. For such a mechanism to be truly adaptive, it needs to flexibly integrate information about ever changing internal (e.g., "I am bored") and external (e.g., "The task I plan to do seems quite monotonous") states, and use this information to allocate control optimally towards certain goals. One fundamental source of information that aids the flexible adjustment of the currently optimal control signal is boredom. Boredom signals that one is not putting one's resources to optimal use and should rather do something else (see Chapter 2). By providing information about diminishing value, incurring additional costs, and instigating undirected exploration, boredom directly alters the control signal that is currently deemed optimal. Indeed, an emerging body of research confirms the intricate relationship between boredom and self-control as momentary state and generalizable traits. By integrating the functionality of boredom into an established theory of self-control, we provide a parsimonious framework for understanding and investigating how boredom—as a state and a trait—can alter self-controlled behavior. Importantly, a better understanding of how boredom affects behavior is dearly needed, and not only in the field of self-control research: Recent work outside the self-control context shows that participants get bored during tasks that are frequently used in behavioral science research (Jangraw et al., 2023), and they even report that boredom alters their behavior in such tasks (Meier et al., 2023).

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