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It's not a bug, it's boredom: Effortful willpower balances exploitation and exploration

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Abstract

The continuous revaluation of rewards lies at the core of Ainslie's account of willpower. Yet, he does not explicate the underlying experiential mechanisms. We draw upon theoretical, neuroscientific, and computational evidence to demonstrate that boredom evokes revaluation. By biasing behavior toward exploration, boredom necessitates effortful willpower to balance it against exploitation, thereby rendering suppression a highly adaptive function of willpower.

In the target article, Ainslie differentiates between effortless ("resolve") and effortful ("suppression") functions of willpower. Our focus is on suppression, which is thought to stabilize ongoing behavior against revaluations instigated by hyperbolic discounting. Crucially, suppression is conceived as a fragile and costly mechanism that needs to be "stiffened by resolve." Here, we argue that hyperbolic discounting and the fragility and costliness of suppression are both adaptive features that aid humans in navigating exploration–exploitation tradeoffs. Drawing upon theoretical, neuroscientific, and computational evidence, we argue that boredom is an experiential mechanism that drives revaluation and interacts with suppression in orienting goal-directed behavior. Incidentally, boredom has already been discussed in the context of willpower (e.g., Ainslie, 2013), but only as one mechanism among many and without a dedicated theoretical framework that explicates its unique functional relevance: (1) boredom instigates the revaluation of potential rewards, (2) increases the costs of the resulting suppression, (3) and thereby biases behavior away from exploitation and toward exploration. Thus, we extend Ainslie's proposal by explicating boredom as a powerful mechanism that drives hyperbolic discounting and by highlighting why suppression is a highly adaptive mechanism that has consequently been favored by evolution.

Ainslie identifies hyperbolic discounting as an "inborn psychophysical tendency" that manifests itself in the dynamic revaluation of rewards. However, although he is explicit about the experiential mechanism that tracks the temporal dynamics of task-induced costs (i.e., effort), the target article remains silent on the mechanisms that underly revaluation. One ubiquitous experience linked to revaluations by recent research on willpower is boredom (Wolff & Martarelli, 2020). Boredom emerges in situations that are perceived as meaningless and/or as misfitting one's mental resources (Westgate & Wilson, 2018). Its experience serves as a dynamic (Mills & Christoff, 2018), functional signal that an ongoing behavior decreases in value, prompting people to seek more rewarding alternative behaviors (Bench & Lench, 2019). In line with this, neuroscientific research has shown that boredom, but not suppression, increases reward sensitivity (Milyavskaya, Inzlicht, Johnson, & Larson, 2019). This logic can be extended to long-term goals, whose pursuit should then decrease in value relative to alternative goals that promise immediate gratification. Thus, boredom can be assumed to instigate the exact revaluations that underly hyperbolic discounting, which may lead to impulsive behaviors that must be suppressed to avoid what willpower research generally refers to as self-control failure. Consequently, boredom directly contributes to the demand for suppression (Wolff & Martarelli, 2020).

In line with the literature, Ainslie argues that effort serves as a dynamic signal to quantify the ongoing costs of suppression (Shenhav et al., 2017). He attributes these costs to the need for "continuous vigilance against impulses" and suggests that "wastes of time do not typically feel effortful." Although we agree with the first, we object to the latter assertion. Boredom does not constitute an affectively neutral signal; instead, it is an aversive sensation that increases the effort to continue with a course of action (Eastwood, Frischen, Fenske, & Smilek, 2012). Therefore, we argue that experiencing boredom does contribute to the costs of suppression by making it more effortful to persist (for initial experimental evidence, see Bieleke, Barton, & Wolff, 2020) – up to the point that people even become willing to trade boredom for pain (Wilson et al., 2014). Consequently, boredom not only devalues the pursuit of ongoing (long-term) goals, it simultaneously

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increases the costs of suppressing the pursuit of alternative (short-term) goals. This twofold effect makes the experience of boredom a powerful mechanism behind the disengagement from goal pursuit. Neuroscientific evidence provides tentative support for the implied interplay of boredom and suppression: Boredom has been linked to activation changes in the ventromedial prefrontal cortex (Mathiak, Klasen, Zvyagintsev, Weber, & Mathiak, 2013), an area that is involved in valuation processes (Gläscher, Hampton, & O'Doherty, 2009) and that plays a key role in indicating that a change in behavior is required (Domenech & Koechlin, 2015). Crucially, information from such valuation areas is integrated by the dorsal anterior cingulate cortex, whose role in specifying control commands and in relaying those commands to executive areas like the lateral prefrontal cortex is well established (Shenhav, Botvinick, & Cohen, 2013). Thus, the ventromedial prefrontal cortex's sensitivity toward rewards and the dorsal anterior cingulate cortex's role in weighing prospective rewards against the costs of suppression is in line with the proposed twofold effect boredom has on goal pursuit.

Understanding boredom in terms of a functional signal that facilitates the disengagement from ongoing goal pursuit – by instigating revaluation and feeding into the costs of suppression – raises an important question: Are the fragility and the costliness of suppression undesirable properties? We argue they are not: These very properties allow for suppression to assume the role of flexibly balancing exploration against exploitation. Computational research has shown that boredom facilitates an intelligent system's ability to explore the environment (Gomez-Ramirez & Costa, 2017). This shift from the longstanding and exclusive focus on prediction error minimization is in line with empirical (Geana, Wilson, Daw, & Cohen, 2016) and theoretical research (Wolff & Martarelli, 2020) on the role of boredom in driving exploration. Willpower by resolve, which is a function that favors long-term effortless goal pursuit (e.g., Bieleke, Keller, & Gollwitzer, 2020), is not designed to adaptively account for boredom-induced impulses to explore. Instead, a more fragile mechanism like suppression is better suited to respond adequately to the dynamic changes in the costs and benefits of ongoing goal pursuit; it thereby provides degrees of freedom for flexibly balancing exploration against exploitation. This functional role of suppression as a fragile and costly mechanism might explain why evolution has favored imperfect self-control (Hayden, 2019).

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Increasing resolution in the mechanisms of resolve

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Abstract

Ainslie offers an encompassing and compelling account of willpower, although his big-picture view comes occasionally at the cost of low resolution. We comment on ambiguity in the metacognitive and prospective mechanisms of resolve implicated in recursive self-prediction. We hope to show both the necessity and promise of specifying testable cognitive mechanisms of willpower.

Although Ainslie frames resolve in terms of game-theoretic intertemporal bargaining, he leaves the cognitive and neural