An appraisal framework to understand why negative affect is both good and bad for self-control

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Word count: 10, 504 (not including abstract, captions, footnotes, references).

Abstract

Self-control and emotion have often been cast in mutual opposition. However, recent accounts suggest that emotion and cognition overlap so greatly that they are largely inseparable. Despite this overlap, existing perspectives provide a seemingly paradoxical account of the integration of control and emotion, where negative affect is viewed as both good and bad for self-control. Here, we present an appraisal based framework that aims to reconcile these perspectives by closely considering the evaluative and homeostatic principles that unite emotion and self-control. Incorporating diverse appraisal processes from affective science into existing cybernetic models of self-control, we suggest that all variation in self-control is motivated by the overarching goal of the organism to maintain a positive hedonic homeostasis in its environment. Depending on the amount of value that ongoing appraisal processes see in the current goal, this might mean responding to goal threatening, aversive events with increased self-control and vigour, or, alternatively, disengaging from the current goal and pursuing more pleasurable activities. These strategies simultaneously serve the need to flexibly manage priorities between different goals, and, perhaps more fundamentally, maintain affective homeostasis within the immediate environment.

Keywords: self-control; emotion; conflict; motivation; goals;

Self-control allows us to override habitual but unwanted thoughts, emotions, and behaviours in favour of more effortful routes to our long-term goals (Baumeister, Vohs & Tice, 2007). We might resist unhealthy snacks when sticking to a diet, forego sexual desires to uphold marital fidelity, or suppress outward expressions of happiness to win a hand in poker. In light of this integral role in goal-directed behaviour, self-control has become one of the most highly lauded facets of higher cognition, with variation in control associated with the greatest triumphs and weaknesses of the human condition.

Self-control has often been cast as the antithesis of emotion. Here, cold and reflective control combats the hot and impulsive reactions that underlie temptations and the discounting of future rewards (Ainslie, 1975; Kahneman, 2011; Metcalfe & Mischel, 1999). While these accounts have spurred considerable research and theoretical development, there is a growing consensus that such dualistic perspectives provide only a caricature of how the mind works. Rather than arising from discrete systems, cognition and emotion appear almost inseparable (Barrett, 2006; Cunningham & Kirkland, 2012; Koban & Pourtois, 2014; Etkin, Egner & Kalisch, 2011; Pessoa, 2009; Shackman et al., 2011), particularly in regard to self-control (Inzlicht, Bartholow, & Hirsh, 2015).

Indeed, while self-control might promote the good life, the exertion of control is both effortful and aversive (Dreisbach & Fischer, 2012; Botvinick, 2007; Kurzban, 2016; Westbrook & Braver, 2015). And, for better or for worse, variation in self-control coincides with many classic elements of emotion, including bodily arousal (Critchley, Tang, Glaser, Butterworth & Dolan, 2005; Hajcak, MacDonald & Simons, 2003), facial expressions (Elkins-Brown, Saunders & Inzlicht, 2016; Elkins-Brown, Saunders, He, & Inzlicht, 2017; Lindström et al., 2013), and a broad

spectrum of subjective experiences (e.g., frustration, anxiety, hopelessness, fatigue, exhaustion, vitality, and pride; Hagger, Wood, Stiff, & Chatzisarantis, 2010; Moller, Deci & Ryan, 2006; Saunders, Milyavskaya & Inzlicht, 2015a; Williams & DeSteno, 2008).

Consequently, far from being a cold, unfeeling process, self-control overlaps substantially with—and may even have foundations in— emotion (Inzlicht et al., 2015). While such results clearly rally against the strict partitioning of emotion and cognition, the field currently lacks an overarching framework to understand this functional integration. According to some, the emotions that arise during self-control have a detrimental influence on goal-directed actions. Negative feelings of exhaustion, fatigue, frustration, or even boredom lead people to disengage from beneficial goals (e.g., be tolerant, eat healthily), resulting in performance dominated by self-defeating, impulsive responses (e.g., aggression, unhealthy snacking; Boksem & Tops, 2008; Dai, Milkman, Hofmann, & Staats, 2015; Denson, DeWall & Finkel, 2012; Inzlicht, Schmeichel & Macrae, 2014). Yet, other models have suggested that the negative experiences that arise during self-control are a call to arms, recruiting increased attention, motivation, and effort, to improve self-control (Botvinick, 2007; Dreisbach & Fischer, 2015; Inzlicht et al., 2015).

These theoretical viewpoints at first seem paradoxical: How can negative affect be both good and bad for self-control? However, as considerable evidence has emerged from divergent research disciplines to support each of these accounts, it seems unlikely that one theoretical perspective will replace the other as the dominant framework to understand the interplay between control and emotion. The current article focuses on the reconciliation of these

perspectives, proposing an appraisal based framework that can explain why negative affect is *both* good and bad for self-control.

An appraisal framework for understanding self-control

Virtually all theories from affective science suggest that emotions arise from evaluative processes that govern adaptive interactions with the immediate environment (Barrett, 2006; Clore & Huntsinger, 2007; Cunningham, Dunfield & Stillman, 2013; Frijda, 1988; Frijda & Scherer, 2009; Levenson, 1991; Panksepp, 2008; Scherer, 2001; 2009; Smith & Ellsworth, 1985). This evaluative nature of affective processing, we believe, is central to understanding the integration of emotion and self-control.

Evaluation is particularly vital to appraisal perspectives on emotion (e.g., Arnold, 1960, Scherer, 1984; Lazarus, 1991). Broadly speaking, appraisal refers to a cognitive process that evaluates or interprets information from the immediate environment and causes changes in the components of an emotional episode, including peripheral arousal, facial expression, behaviours, and experience (Moors, 2013). Information can be appraised over a number of dimensions, such as inherent valence (good vs. bad), goal relevance, coping potential, agency, and relation to self or existing moral standards (Lazarus, 1991; Scherer, 2001), and these evaluations can occur rapidly, with great automaticity, or slowly, as a more reflective and deliberative process (Lazarus, 1991; Moors, 2013; Moors & De Houwer, 2006; Scherer, 2001).

While the causal role of appraisal in emotion is still hotly debated (see Moors, 2013 for review), almost all models of emotion evoke the concept of appraisal to either initiate or augment the nature, form, or duration of an emotional episode (e.g., Barrett, 2006; Gross, 1998; Lazarus, 1991; Russell, 2003; Scherer, 2009). Evaluating the implications of the current

situation for personal wellbeing, for example, can determine the urgency and potency (e.g., arousal) of the emotion eliciting situation, and also allows items that are not inherently affective (e.g., flag) to become emotive. A threatening situation might be met with a *fight* response if the person feels powerful and in control, whereas a *flight* response is more likely if appraisals suggest the inability to cope. Finally, emotions with self-conscious or moral overtones (e.g., pride, shame, guilt) are more likely to be experienced when the situation is appraised in relation to self-worth or what is considered normative by the person or their social group.

In this article we explore the idea that the integration of self-control and emotion is achieved through the continuous application of these appraisal processes over time in control demanding contexts. Take as an example a dieter who ends up staring down a plate of poutine—a Canadian food icon that packs a mighty caloric punch. The dieter might initially feel a vague unpleasant state when the temptation to eat the poutine conflicts with the goal to eat healthily. This negative affect might make them take notice of the goal conflict, halting the immediate urge to eat. In parallel to this pause for thought, more elaborate evaluations can be applied to the control dilemma. The potential caloric intake might be more troubling if the dieter needs to lose weight for health reasons, rather than for an upcoming beach vacation. They will also likely appraise their willpower to resist the food: Have I ever been able to turn down poutine in the past?! And, even more reflectively, the dieting goal might feel more worthwhile if they view healthy eating as essential to maintaining their self-esteem or social status.

By viewing self-control through the lens of appraisal, we propose that variation in self-control—from states of high engagement and control to low engagement, frustration and fatigue—emerges from multiple, hierarchically organised evaluations that play out over time.

Overview of the integration of self-control and appraisal

Self-control can be defined as an effortful process that overrides unwanted and habitual tendencies in favour of goals that would not occur without deliberate intervention (Inzlicht & Berkman, 2015). By this definition seemingly effortless routes to goal attainment—such as forming good habits (Adriaanse, Kroese, Gillebaart, & De Ridder, 2014; Galla & Duckworth, 2015) —are considered a facet of self-regulation more broadly, rather than self-control specifically (cf., Fujita, 2011).

Depending on psychological sub-discipline, self-control is also known as cognitive control, executive functioning, or willpower. Control can also be operationalized using diverse methods including laboratory tests of executive function (e.g., the Stroop paradigm), daily diary studies, experience sampling, and self-reported willpower. Despite this heterogeneity, measures of self-control show some convergence (Duckworth & Kern, 2011), with even seemingly low-level laboratory measures predicting a range of real-world outcomes, including academic attainment (Hirsh & Inzlicht, 2010), the restriction of racial prejudice (Payne, 2006), daily stress regulation (Compton et al., 2008), well-being (Robinson, 2007), dietary self-regulation (Nederkoorn et al., 2010), and sexual fidelity (Pronk, Karremans & Wigboldus, 2011), to name a few. Thus, while social, personality, and cognitive neuroscience approaches to self-control often exist in different literatures, we take the view that evidence from these sub-disciplines can usefully inform the other (see also Hofmann, Schmeichel, & Baddeley, 2012).

Cybernetic principles suggest that self-control is directed by negative feedback loops (Carver & Scheier, 1998). This process starts by setting a goal (e.g., name colours, eat healthily, be a good person), and comparing this desired state to feedback from the immediate internal (mental) or external physical environment (e.g., accidental word reading, the temptation to cheat, unexpected good test results, changes in room temperature). As such, control dynamics are fundamentally driven forward by the detection of conflict between unwanted impulses and desired outcomes (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Carver & Scheier, 1998; Inzlicht, Legault, & Teper, 2014).

In addition to signalling the need for increased self-control, however, goal conflict is aversive (Botvinick, 2007; Dreisbach & Fisher, 2012), with these negative evaluations occurring in tandem with the detection of conflict (e.g., Aarts, DeHouwer & Pourtois, 2013; Elkins-Brown et al., 2016; Lindström et al., 2013; Fritz & Dreisbach, 2015) and a widespread increase in peripheral nervous system arousal (Critchley et al., 2005; Hajcak et al., 2003). Together, this psychophysiological profile suggests that conflict initiates a core affective state of tense aversive arousal (Russell, 2003). Rather than being epiphenomenal, it has been suggested that this aversive arousal is necessary to drive self-control forward (Botvinick, 2007; Dreisbach & Fischer, 2015; Inzlicht et al., 2015). By acting as a kind of alarm signal, the negative sting of conflict is hypothesised to bring a sense of urgency to the situation, increasing attention and action towards the resolution of conflict (Inzlicht et al., 2015; Inzlicht & Legault, 2014). These findings suggest that cybernetic theories of control-related motivation can be revised to include the affective consequences of goal conflict (see Figure 1).

Figure 1: A cybernetic implementation of self-control on the Stroop task. The feedback loop for classic self-regulation theory is extended to incorporate recent ideas that the transient aversive arousal triggered by goal conflict motivates control implementation.

Evaluations of goal congruency and valence occur at a temporal resolution of milliseconds: we rapidly detect conflict and assign such inconsistencies a negative valence (cf., Aarts et al., 2013; Fritz & Dreisbach, 2015). Therefore, our framework suggests that this basic evaluation of the aversiveness of conflict (i.e., good vs. bad) represents self-control's first line of defence. Such rapid, if rudimentary, reactions can be highly adaptive; aligning with prevalent views that affect serves the organism by quickly and intuitively guiding processing towards beneficial outcomes (Frijda, 1988; Keltner, Haidt & Shiota, 2006; Seo, Barrett, & Bartunek, 2004).

Aversive arousal alone, however, is insufficient to comprehensively explain variation in self-control. Indeed, many negative experiences that arise during self-control, such as frustration, exhaustion, hopelessness, and fatigue, accompany seemingly maladaptive responses, such as impulsiveness and the detachment from goals (Berkowitz, 1989; Hagger et al., 2010). To resolve this apparent affective paradox in control—where negative affect is both good and bad for self-control—we draw from existing appraisal accounts of emotion (cf., Lazarus, 1991; Scherer, 2004), suggesting that the following forms of appraisal are engaged to determine the desirability of engaging self-control:

- **Implications.** What are the consequences of controls success and failure? Will successfully resisting conflict lead to enhanced wellbeing, rewards, or punishment avoidance?
- **Coping potential.** Is it possible to exert control over current impulses or temptations? Is it humanly possible to self-regulate in the current domain? Am I skilled, powerful, and energized enough to engage effort?
- **Relationship to self-concept and norms.** Does engaging self-control help me to maintain or strengthen a positive view of myself? Is effortful self-regulation necessary to conform to existing or perceived social and moral norms?

While control demanding situations can be subjected to these heterogeneous appraisals, we suggest that the overall goal of the system is simply to achieve a positive state of hedonic homeostasis. Here, positive states can be achieved by approaching goals that produce high levels of subjective value by satisfying the majority of the above appraisals. In contrast,

negative affect can arise either because conflict threatens a valued goal, or because the individual is obliged to engage with goals that are themselves of low value. In these situations, the individual is still motivated to regain more positive states, and this can be achieved either by focusing control on the task at hand or switching from the current goal and pursuing more pleasurable alternatives.

Figure 2 demonstrates how this appraisal framework can be realised using hierarchical cybernetic principles. As can be seen, the negative feedback loop presented in figure 1 is nested beneath a higher-order appraisal loop that determines the subjective value of engaging with a relatively concrete goal (e.g., name colours, eat a salad, etc). Consistent with other cybernetic models (Carver & Scheier, 1998; Gross, 2015), the environment not only contains information pertinent to the low-level feedback loop (i.e., goal progress), but also informs higher level appraisal dimensions. Reward signals from the environment, for example, might signal that control will benefit wellbeing (*implications*), the repeated conscious experience of conflict may provoke feelings of incompetence (*coping potential*), or a disapproving look from a friend might suggest that performance should be evaluated through a social lens (*relationship to self-concept and norms*). As with emotions more broadly, different values arising from these appraisals can also be felt subjectively as a broad spectrum of phenomenal experiences, such as anxiety, frustration, guilt, or fatigue (Frijda, 1988; Scherer, 2001). Thus, by evoking these appraisals, our framework can explain why a broad range of emotions can emerge during self-control.

Most important for current concerns, these appraisals are proposed to converge on a compound valuation system that ultimately determines the willingness to engage with the focal goal. This calculation of subjective value likely reflects a weighted average of the higher-level

appraisal systems (i.e., implications, coping potential, relation to self-concept and norms) and their concomitant phenomenal experience. Independently, each of these appraisals can contribute either a positive-appetitive or a negative-avoidant signal to the desirability of the focal goal. These single appraisals can then be combined into a single valuation signal by computing the net gain (or loss) across these signals (Berkman, Livingston, Kahn, & Inzlicht, 2016; Boureau, Sokol-Hessner, & Daw, 2015; Shenhav, Botvinick & Cohen, 2013). During a dietary dilemma, for example, the goal to override the temptation for a fatty snack might have a positive value signal if appraisals applied to the situation determine that the benefits to avoiding the food (e.g., feelings of competency, health gains, pride) outweigh the desirability of eating the food.

Figure 2: A hierarchical appraisal framework for understanding variation in self-control.

Accordingly, a state of vigour arises when a positive (high) subjective value is assigned to the goal. Here, control implementation is engaged with greater zeal, and events that threaten attainment of this valued goal (e.g., conflict, errors) trigger tense negative states (cf., Figure 1). In this circumstance hedonic homeostasis is achieved by increasing control within the context of the valued goal to avoid the aversive experience of conflict in the future. Here, negative affect promotes better control on the task at hand. Conversely, if appraisals determine that the current focal goal is a low priority (e.g., it has low relevance to self-esteem, control implementation seems unattainable), continued engagement with the goal can become a source of negative affect (cf., Hagger et al., 2010). Instead of increasing self-control, this depreciation in value leads to disengagement from the primary source of discomfort—the goal itself—and instead considering more gratifying alternative pursuits (Inzlicht et al., 2014; Kurzban et al., 2013).

While common wisdom might view goal disengagement as a form of weakness or indolence, we view this motivational realignment as an adaptive response that facilitates the flexible prioritization of goals (Inzlicht et al., 2014). More specifically, by driving the organism to switch from unrewarding goals to more gratifying alternatives, this mechanism ultimately allows the individual to strike a balance between different types of goals and rewards that are present in the immediate environment (Kurzban et al., 2013). However, on a more immediate hedonic level, shifting to more enjoyable pursuits satisfies a homeostatic drive to avoid aversive stimulation (i.e., fatigue) and maintain positive states. As such, our framework suggests that both conflict regulation at the lower level during states of vigour and shifting between goals can

be viewed as affect regulation strategies that are differentially selected depending on the output of dynamic appraisal processes (Saunders et al., 2015b).

In the remainder of this article, we further specify our appraisal framework, defining the types of processing that might lead self-control challenges to be met with vigour in some cases, and disengagement and fatigue in others.

Evidence for multi-level appraisals during self-control

Central to our framework is the idea that multiple appraisals are engaged both in the moment and over time to determine the value of engaging self-control. We next take more detailed look at each of these appraisal dimensions, presenting evidence supporting the role of each type of evaluation during self-control.

Goal conflict is aversive

It is clear why a number of prototypical emotional antecedents are aversive. Pain signals the risk of physical harm (e.g., tissue damage) to the organism, bad smells confer the risk of contagion, and angry facial expressions communicate interpersonal threat. In each of these situations, it is clearly adaptive to detect the emotional trigger early to ensure counteractive, harm-avoidant behaviours. But why might conflict between two seemingly benign cognitions (e.g., word-reading vs. colour naming) similarly arouse negative evaluations?

Conflict is likely aversive for two reasons. Conflicts arise when rival alternatives are simultaneously active (e.g., one option that is goal conducive and another that is goal incongruent). As such, conflict may be aversive because it reflects an indecisive mental state that threatens attainment through the appearance of goal confusion, the inability to act, and the increased likelihood of mistakes (see also Brown & Braver, 2005; Harmon-Jones, Amodio &

Harmon-Jones, 2009). Second, because self-control is typically required to resolve conflicts (Cohen, Dunbar & McClelland, 1990; Kerns et al., 2004), conflict is closely and reliably coupled with the experience of effort, which people typically find unpleasant and avoid (Kool, McGuire, Rosen & Botvinick, 2010). This association with cognitive labour itself might cause conflict to acquire a negative valence (Botvinick, 2007).

The latter suggestion is born out of the law of least effort (cf., Hull, 1939), where easier rather than more effortful routes are preferred to obtain equivalent rewards. Analogous concepts are also evoked in social psychology where cognitive misers prefer information processing ease over complexity (Fiske & Taylor 1991), mental consistency is preferred to dissonant states that arise when two thoughts, beliefs, or attitudes are inconsistent (Festinger, 1962), and conceptual uncertainty is aversive (McGregor, Nash, Mann & Phillips, 2010; Proulx, Inzlicht, & Harmon-Jones, 2012). While these mechanisms suggest that conflict and effort might be a relatively ubiquitous source of negative affect across theoretical perspectives, many of these contexts still seem more intuitively emotive than the seemingly trivial conflicts experienced during a Stroop task. So what evidence supports the proposal that even such low-level conflicts trigger negative appraisals?

Modified affective priming paradigms have provided perhaps the most direct evidence that conflict is aversive. In these studies, conflict primes (e.g., incompatible Stroop stimuli) facilitate the subsequent processing of negative—but not positive—target words (Aarts, De Houwer & Pourtois, 2012, 2013; Dreisbach & Fischer, 2012; Fritz & Dreisbach, 2015). This facilitation occurs within a few hundred milliseconds (Aarts et al., 2013; Fritz & Dreisbach, 2015), suggesting that conflict is rapidly assigned a negative valence. Further indicating that

conflict is aversive, people show a preference for tasks with low conflict situations (Kool et al., 2010; McGuire & Botvinick, 2010; Schouppe, Ridderinkhof, Verguts, & Notebaert, 2014), and even passively viewing conflicting stimuli aids both the voluntary expression and ease of avoidance related lever movements (Dignath & Elder, 2015).

Evidence for the aversive quality of conflict has also arisen in social and affective neuroscience. Goal conflicts trigger widespread patterns of arousal in the peripheral nervous system that are consistent with a state of aversive arousal (Critchley et al., 2005; Danev & De Winter, 1971; Elkins-Brown et al., 2016; Hajcak & Foti, 2008; Hajcak et al., 2003; Lindström et al., 2013; van Steenbergen & Band, 2013). In the central nervous system, the neural correlates of conflict monitoring—particularly the dorsal anterior cingulate (dACC)—also accompany a broad range of socio-affective events, including pain (Rainville, Duncan, Price, Carrier & Bushnell, 1997; Woo et al., 2014), social rejection (Eisenberger, Lieberman & Williams, 2003), cognitive dissonance (van Veen, Krug, Schooler, & Carter, 2009), emotional disorder (Cavanagh & Shackman, 2014; Mayberg, 1997; van Tol et al., 2010), and the evaluation of negative feedback (Holroyd & Coles, 2002). Consistent with an affective conceptualisation of goal conflict, recent integrative meta-analyses have proposed that the dACC plays a relatively domain-general role in evaluating aversive events and signalling the need for remedial control (Shackman et al., 2011).

Finally, studies investigating the error-related negativity (ERN)—a negative-going event related potential (ERP) related to conflict monitoring that occurs within 100 ms of making a mistake (Dehaene, Posner & Tucker, 1994; Falkenstein, Hohnsbein, Hoormann & Blanke, 1991; Gehring, Gross, Coles, Meyer & Donchin, 1993)—have also supported an affective account of

performance monitoring. For example, the ERN is increased with avoidance motivation (Amodio, Master, Yee & Taylor, 2008; Boksem, Tops, Wester, Lorist, & Meijman, 2006; Nash, Inzlicht, & McGregor, 2012), when people evaluate mistakes particularly negatively (e.g., Aarts et al., 2013; Hajcak, Moser, Yeung & Simons, 2005; Wiswede, Münte & Rüsseler, 2009), and when instructions direct participants to focus on their emotions during self-control (Saunders, Rodrigo & Inzlicht, 2016). Together, these results suggest that even these very rapid neural performance monitoring processes reflect rapid negative appraisals of goal conflict.

Negative appraisals promote increased self-control.

A widely held view across multiple affective theories is that people are generally motivated to reduce the experience of negative stimulation when it is present in the immediate environment. Therefore, it follows that the aversive sting of conflict might motivate the increased behavioural expression of self-control (Inzlicht et al., 2015), with control implementation itself serving as one strategy to regain hedonic homeostasis in the wake of conflict (Saunders, Milyavskaya & Inzlicht, 2015b). This theory puts forward the prediction that the need for increased self-control will be most great when the aversive sting of conflict is felt most strongly.

Multiple findings support this hypothesis. In one study, for example, the engagement of the frowning musculature of the face after mistakes predicted the extent of subsequent increases in control (Lindström et al., 2013). In other studies, self-control increases when threatening images signal that a dominant response tendency must be withheld (Senderecka, 2016), after negative mood inductions (van Steenbergen, Band & Hommel, 2010; van Steenbergen, Booi, Band, Hommel, & van de Does, 2012), and when trials that are preceded by

disfluent (i.e., aversive) rather than fluent (i.e., non-aversive) targets (Dreisbach & Fisher, 2011). In contrast, positive events presented in the interval between trials (e.g., rewards or positive feedback) counteract remedial control adjustments that happen immediately after conflict (Saunders & Jentsch, 2012; van Steenbergen, Band & Hommel, 2009, 2012). Similarly, neural monitoring is attenuated and performance suffers when emotion regulation strategies are engaged during performance to reduce the affective sting of conflict (Bartholow, Henry, Lust, Sauls, and Wood, 2012; Hobson, Saunders, Al-Khindi & Inzlicht, 2014; Inzlicht & Al-Khindi, 2012). Together, these results suggest that the exertion of self-control varies depending on the extent to which conflict is experienced as aversive.

Finally, traits and states associated with the ability to track emotion also predict systematic variation in self-control. Alexithymia—a trait associated with the reduced capacity to identify internal affective signals—predicts impaired conflict resolution on a canonical conflict paradigm (de Galan, Sellaro, Colzato & Hommel, 2014). In contrast, states associated with an increased ability to evaluate emotions in an accepting manner without elaboration or defensiveness are associated with more sensitive neural monitoring and heightened conflict control (Teper & Inzlicht, 2013; Legault, Al-Khindi & Inzlicht, 2012).

Each of these findings supports the idea that feeling the negative affective sting of conflict is good for self-control, particularly if the individual is able to appraise this emotion even-handedly. This mechanism does not appear to depend on any discrete emotional experience—even basic manipulations of avoidance motivation cause increased control adjustment in the short term (Hengster, Holland, van Steenberg, & van Knippenberg, 2010; Koch, Holland & van Knippenberg, 2008; Schouppe et al., 2012). We suspect that this lack of reliance on a fully

formed emotional experience, however, represents a strength of this mechanism rather than a limitation. More specifically, as changes in negative affect, arousal, and motivational orientation arise early during emotion generation (Scherer, 2009; Cunningham et al., 2013), relying on these fast evaluations likely allows control implementation to rapidly determine that something has gone wrong, and then act to bring the system back to a more desirable state. Supporting the role of control implementation in this homeostatic drive to reduce aversive arousal, successful conflict control is associated with a transient increase in positive affect (Schouppe et al., 2015).

Negative affect is not *always* good for control

From the evidence presented so far it is tempting to suggest that negative affect and self-control are related in a unidirectional fashion. Here, increased self-control works as a remedial mechanism to avoid aversive experiences emerging from the task. However, several other lines of research suggest that this is not the case. Negative feelings of frustration and anger, for example, are often associated with aggressive and impulsive behaviours that are typically detrimental to the overall goals of the individual (Berkowitz, 1989; Harmon-Jones, 2003; Saunders et al., 2015a). Feelings of hopelessness also emerge when goals are unattainable (e.g., Hadley & MacLeod, 2010), and fatigue is associated with diminished self-control and goal disengagement that arises when cognitive labour is demanded over long time periods (Boksem & Tops, 2008; Hagger et al., 2010). These results suggest that the comprehensive integration of control and emotion must go beyond simple valence judgments, as negative valence appears related to both controls success and failure.

The proposed appraisal framework aims to address this apparent paradox, and in the next sections we will use the example of mental fatigue to demonstrate how appraisals can moderate the bidirectional relationship between negative affect and control. We focus on mental fatigue here both for the sake of brevity and because a larger body of empirical work is available for this motivational state. That said, we think that similar evaluations can also explain why hopelessness, frustration, anger, and perhaps even boredom would also lead to diminished self-control.

Mental fatigue. Rather than being engaged uniformly over time, self-control appears to diminish with repeated use (Baumeister et al., 2007; Boksem & Tops, 2008). In laboratory studies, this temporal decay is manifest in many forms, including when a second demand for control is encountered after initial self-regulation (the ego depletion effect; Baumeister et al., 2007; Hagger et al., 2010; but see Carter & McCullough, 2014), when sustained control is required for extended time-periods (e.g., 2hrs) in a single context (Boksem et al., 2006), and even as the hours drag on through the course of a typical day (Dai et al., 2015; Kouchaki & Smith, 2013; Zadra & Proffitt, 2014). These drops in self-control are also accompanied by reduced reactivity to goal conflict in both the central (Boksem et al., 2006; Inzlicht & Gutsell, 2007; Wang, Yang & Wang, 2014) and peripheral nervous system (Hopstaken, van der Linden, Bakker, & Kompier, 2015a, 2015b), and a range of low arousal negative experiences, including fatigue and exhaustion (Hagger et al., 2010; Hopstaken et al., 2015a; Job et al., 2010).

Such temporal fluctuations in performance have recently been accounted for by the process model, or shifting priorities model of control (Inzlicht et al., 2014). Here, mental fatigue and ego depletion arise when individuals no longer see utility in exerting continued self-control

towards a current goal, particularly if this goal is unrewarding or is selected through external obligations (e.g., being asked to perform a Stroop task for a very long time by an experimenter). This diminishment control is often met with an increased desire for gratification, be that from engaging effort in a more gratifying activity or from avoiding labour altogether (i.e., resting). This motivational account can explain, for example, why people become more willing to engage control for a second time if they perform a gratifying task in the interim period (Derrick, 2012; Friese & Wänke, 2014; Heckman, Ditre, & Brandon, 2012; Tice, Baumeister, Shmueli, & Muraven, 2007) more readily than previous accounts that cast depletion as the unavoidable consequence of the metabolization of a limited control resource (Gailliot et al., 2007; see Inzlicht & Berkman, 2015; Kurzban, 2010; Schimmack, 2012 for extended critiques of this strength model).

Most important for current concerns, the shifting priorities account provides a clear example of a situation where a negative emotion (e.g., fatigue) does not benefit control on the task at hand. We next start to consider how evaluations that are made during self-control might critically differentiate between situations where the aversive nature of self-control is met with increased vigour from those where negative affect (e.g., fatigue) promotes goal disengagement.

The implications of engaging self-control

One critical appraisal that underlies the longer-term maintenance of effort might consider the consequences of success or failure for individual wellbeing. Will exerting self-control bring rewards, enhance wellbeing, or help to avoid punishment? Or, alternatively, is sustaining effort towards a given goal relatively trivial and inconsequential to my security and immediate needs?

Existing evidence suggests that such sources of value do bring a strong sense of urgency to control demanding situations, moderating the willingness to engage effort (Brehm & Self, 1989; Westbrook & Braver, 2015). External incentives and punishment, for example, both lead to increased neural performance monitoring (Hajcak et al., 2005; Riesel, Weinberg, Endrass, Kathmann, & Hajcak, 2012; Potts, 2011; Saunders et al., 2015a; Stürmer, Nigbur, Schacht, & Sommer, 2011), and, often, remedial increases in control to avoid further mistakes (e.g., Riesel et al., 2012; Lindström et al., 2013; Stürmer et al., 2011). These situations, where the implications for self-control failure are high, also provoke subjective anxiety (Saunders et al., 2015a) and increased contraction of the frowning musculature of the face (Lindström et al., 2013). Together, these results are consistent with suggestions that anxiety and behavioural inhibition arise from a common process associated with increased attention and caution (see Gray & McNaughton, 2003).

Besides imbuing self-control with a sense of urgency, rewards can offset the aversiveness of effort. Broadly speaking, the willingness to expend effort increases with present appetite for available rewards (i.e., incentive value; Brehm & Self, 1989; Gendolla, 2015), and, conversely, increasing cognitive demands require ever increasing levels of rewards to encourage their selection over less demanding alternatives (Apps, Grima, Manohar & Husain, 2015; Westbrook, Kester, & Braver, 2013, Westbrook & Braver, 2015). Thus, effort might resemble a cost subtracted from the willingness to engage self-control (Francis & Inzlicht, *in press*). Analogous mechanisms are also prevalent in everyday life: We frequently engage in quite tedious tasks (e.g., data entry, administrative work) in occupational settings simply because they are instrumental to maintaining our salary.

The willingness to engage effort might also vary with the desirability of reward outcomes. A 25 cent reward, for example, will likely have a lower subjective value for someone who has already won \$10, than to another individual with an empty wallet. This law of diminishing marginal utility (Gossen, 1854/1983) can also be applied to self-control where the value of restricting impulses in the pursuit of goal attainment decreases as a function of obtained rewards in this domain (Berkman et al., 2016). In short, the consequences of failing to engage self-control to achieve one unit of any reward likely decreases with increasing goal progress and reward satiation (see also Carver & Scheier, 1990; Fishbach, Zhang, & Koo, 2009; Schwarz et al., 2002).

Rather than reflecting an irrevocable reduction in effort, however, implication related appraisals suggest that the willingness to expend effort will be re-instantiated if the stakes are high enough (Boksem & Tops, 2008; Inzlicht et al., 2015). Supporting this idea, fatigue effects are greatly diminished (or even reversed) when a number of incentives are introduced post-depletion (Boksem et al., 2006; Hopsaken et al., 2015; Moller et al., 2010; Muraven, Gagné, & Rosman, 2008; Muraven & Slessareva, 2003). This re-incentivization also revives central and peripheral nervous system reactivity to conflict, as well as increasing subjective task engagement and reducing fatigue (Boksem et al., 2006; Hopstaken et al., 2015a, 2015b).

Taken together, these results suggest that consideration of the implications associated with engaging effort is an important moderator of self-control. These appraisals can increase the urgency of conflict resolution, and also moderate entry into and out of states of depletion and mental fatigue.

Coping potential

In addition to evaluating the potential implications associated with action or inaction, appraisals can focus on our potential to cope with the emotion eliciting event (Lazarus, 1991; Fontaine et al., 2007; Scherer, 2001, 2009). These evaluations consider if it is possible for a human agent to exert control over the situation, and also if the individual is personally powerful, skilled, or motivated enough to bring about this change (Bandura, 1982; Lazarus, 1991; Moors, 2013). Despite being more common in emotion research, these appraisals are also clearly applicable to the domain of self-control. During dietary self-regulation, for example, an individual might perceive low coping potential either because they attribute weight gain to an inevitable decrease in metabolism with age, or, alternatively, because they consider themselves lacking in the willpower needed to override temptation.

Even in situations where approaching a goal has the potential to bring desired rewards, effort might be marred with futility and hopelessness if the individual is incapable of implementing the steps necessary to gain reward (Hadley & MacLeod, 2010; Melges & Bowlby, 1969). Conversely, goals can become more valuable—and perhaps more enjoyable—if the individual foresees competency and success (cf., Bandura, 1982; Brehm & Self, 1989; Deci & Ryan, 1985; Gendolla, 2015; Martijn, Tenbült, Merckelbach, Dreezens, & de Vries, 2002; Vallerand & Reid, 1982).

An early contributor to coping appraisals is the belief that a human agent of any kind can exert control in the present situation (Baumeister, 2008). For instance, belief in the existence of free will can be distinguished from determinism, where behaviours reflect an obligatory compliance with environmental, neurobiological, or genetic predispositions (Baumeister, 2008). Indeed, even relatively low-level self-control, including behavioural inhibition, neural reactivity

to conflict, and adaptive control adjustments after mistakes, are compromised when contexts undermine free will (Rigoni, Kühn, Gaudino, Sartori, & Brass, 2012; Rigoni, Pourtois & Brass, 2015; Rigoni, Wilquin, Brass & Burle, 2013). Analogous free-will effects have been reported in more ecologically rich scenarios, where deterministic beliefs predict elevated aggression and reduced helpfulness during social interaction (Baumeister, Masicampo, & DeWall, 2009).

Further to lay beliefs about the existence of free will, we can also consider if we are personally powerful enough to perform (Lazarus, 1991; Scherer, 2001), and a number of studies have found that people show an increased ability to override impulsive responses if experimental manipulations induce feelings of power (Guinote, 2007; Schmid, Kleinman & Amodio, 2015; Smith, Jostman, Galinsky & van Dijk, 2008).

Finally, while self-control strength probably does not arise from a finite metabolic resource (cf., Kurzban, 2010; Schimmack, 2012), individuals vary in lay beliefs held regarding the expendability of control (Dweck, 2006). While growth believers—those who believe that intelligence is malleable and can be fostered over time—evaluate goal conflict and effort as a learning opportunity, fixed believers see limitations in self-control, appraising conflict and mistakes as evidence for their unavoidable ineptitude (Burnette, O’Boyle, Van Epps, Pollack & Finkel, 2013; Job et al., 2010). Supporting these claims, growth mind-sets are positively correlated with increased self-control at a moment-to-moment resolution (Moser, Schroder, Heeter, Moran & Lee, 2011), reduced depletion effects (Chow, Hui & Lau, 2015; Job et al., 2010; Job, Walton, Bernecker, & Dweck, 2013), and diminished desire for rest after prolonged cognitive labour (Job, Bernecker, Miketta, & Friese, 2015).

Each of these results suggests that appraisals of the ability to cope in the current situation, including feelings of agency, personal power, and lay beliefs about willpower, are critical moderators of the willingness to engage self-control.

Relation to self-concept, moral, and social norms

Beside implications and coping potential, the willingness to engage self-control can be moderated by even broader evaluations, such as the current context's relevance for the person's self-concept and what is morally or socially normative in their culture or social group. These higher level appraisals reflect self-referential or social motivations of the individual, helping to maintain individual self-esteem (e.g., good, worthwhile, respected), positive social status, and feelings of interpersonal connectedness (Cohen & Sherman, 2014; Deci & Ryan, 1985, 2000; Steele, 1988). Evaluations made in reference to these appraisals are also associated with a range of self-conscious or moral emotions, such as pride, guilt, gratitude and shame (Keltner, 1996; Sheikh & Janoff-Bulman, 2010; Williams & DeSteno, 2008). And, while almost any factor in life is susceptible to evaluations in relation to the self and existing social norms, for the sake of brevity we focus here on select examples to highlight the moderating effects of such appraisals on self-control.

First, the willingness to engage self-regulatory effort increases when goals are selected as a personal choice relating to a person's internalised values, rather than by external coercion (Deci, 1971; Deci & Ryan, 1985, 2000; Sheldon & Elliot, 1999). A college undergrad, for example, is more studious if learning is appraised as inherently valuable and self-determined, rather than a necessary chore to please parents or teachers. In the laboratory, contexts that support autonomous motivation are associated with improved self-control (Deci, 1971; Moller, Deci &

Ryan, 2006) and increased neural reactivity to conflict (Legault & Inzlicht, 2013). Fewer goal incongruent temptations are also experienced when goals are highly relevant to the self (Magen & Gross, 2007; Milyavskaya, Inzlicht, Hope & Koestner, 2015), while autonomous motivation consistently counteracts the harmful effects of mental fatigue (Englert & Bertrams, 2008; Moller et al., 2006; Muraven, Gagné & Rosman, 2008).

Self-control may also be required to manage ethical dilemmas that occur when internal or external standards (e.g., be a good person) compete with opportunities to gain immediate rewards (e.g., cheat). The motivation to engage control in these situations might depend on the relative value between behaving according to known ethical principles, and more selfish motives to cheat (Hutcherson et al., 2015). For example, dishonest but financially rewarding behaviours are less likely to occur when cues are used to reinforce internal moral codes (Ayal, Gino, Barkran, & Ariely, 2015; Mazar, Amir, & Ariely, 2008). Interestingly, such examples represent an example where appraisals related to objective rewards (i.e., implication appraisals) compete with appraisals related to the individual's self-worth. Interestingly, appeals to moral codes appear quite able to override objective reward signals during ethical dilemmas, even during states where control appears depleted (Gino, Schweitzer, Mead, & Ariely, 2011).

Finally, preserving a positive view of the self can also come under threat if self-control is required in intergroup contexts, particularly when contexts make prejudice possible (Allport, 1954; Tajfel & Turner, 1979). Considerable research indicates that group-level stereotypes (e.g., association between black people and violence) are automatically activated, even in groups expected to show little prejudice (e.g., African American students; Correll, Park, Judd & Wittenbrink, 2002). And overcoming these automatic associations appears to rely on self-

control (Amodio et al., 2004), with the restriction of stereotypes also being susceptible the deleterious effects of depletion (Govorun & Payne, 2006; Zadura & Proffitt, 2014). However, racial prejudice is not inevitable. People who have a strong internalised motivation to control prejudice—those who view being prejudiced as incongruent to their self-concept—are better able to restrain automatic race bias (Devine, Plant, Amodio, Harmon-Jones & Vance, 2002), engaging fewer neural processes to achieve this control than people who are motivated to control prejudice for less self-determined reasons (Amodio, Kubota, Harmon-Jones, & Devine, 2006).

In summary, appraisals relating to a concept of the self and existing moral and social codes are also critical moderators of self-control, often overriding values in more rudimentary appraisal systems (e.g., primary rewards) if these conflict with closely held, personal values.

The hierarchical integration of appraisals during self-control

As highlighted, evidence from multiple levels of analysis (e.g., physiology, behaviour, and phenomenology) indicates that the willingness to engage and sustain effortful self-control is guided by a diversity of appraisals. When evaluating a control demanding goal, we might consider valence (good vs. bad), the consequences of self-regulation for wellbeing (e.g., implications for desired rewards), the ability to cope with current demands, and, finally, the relevance of self-control for the self-concept or existing social norms. The diversity of these appraisals mirror the central importance of self-control processes across multiple life-domains, from satisfying relatively rudimentary and concrete needs (e.g., food, punishment-avoidance) to achieving more complex and abstract states of self-worth, social standing, and moral behaviour.

This far reaching influence is a considerable strength of control, allowing a relatively limited range of psychological processes to facilitate adaptive outcomes across contexts.

That being said, the evaluations that guide self-control at first appear to reflect a disparate collection of moderators without a clear framework to understand how each might be integrated during self-control. If self-control is indeed a valid, domain general construct, there needs to be processes in place for evaluations from multiple sources to converge in order to influence control. We now turn our attention to this integration, proposing a hierarchical structure of appraisal systems used to determine the value of engaging self-control across multiple domains.

To recap from the brief overview presented at the start of this review, the architecture of this integrative framework is presented in Figure 3. While the framework is multidimensional, the ultimate goal of the system is to maintain a positive hedonic homeostasis within the present environment. This idea coheres with the majority of theoretic perspectives from affective science in which emotions facilitate adaptive interactions between the organism and the environment (e.g., Barrett, 2006; Lazarus, 1991; Panksepp, 2008; Russell, 2003).

Figure 3: Schematic depiction of the proposed integrative model of emotion and self-control.

Consistent with other cybernetic implementations of self-regulation (e.g., Carver & Scheier, 1998; Gross, 2015), we evoke a multifaceted view of the environment, including both perceptions of external factors (i.e., the outside world, external reward contingencies, obligation) and internally generated representations (e.g., thoughts, motor programs, bodily arousal, proprioception, conscious representations of conflict). Each signal can serve as an input to appraisal, with different appraisal categories tuned to specific aspects of the environment (cf., Gross, 2015). The repeated conscious experience of conflict, for example, might signal low self-efficacy (e.g., coping potential), while the unexpected onset of external rewards can reinforce recent behaviours. Despite the diversity of these evaluations, they are proposed to

converge on a signal of subjective value that helps to decide if the individual should stick with the current focal goal, or, instead, shift to an alternative, more gratifying activity.

Subjective value and higher-level appraisals

A clear challenge to the integration of appraisals is the merging of information from heterogeneous evaluations into a single signal of subjective value. Take as an example a self-control dilemma where a person feels conflicted between a more pro-social goal, such as a volunteering with a local charity, and the urge to engage in a more self-indulgent, immediately gratifying activity, such as watching a movie. In this situation, each activity is not only evaluated based on its hedonic value, but also on more abstract dimensions, such as the ability to effect change during volunteering, or the effect of helping on perceptions of self-worth, and the ensuing feelings of pride or guilt. How can a single framework integrate these outputs to make a global evaluation if effort is worthwhile? Recently it has been proposed that this problem can be solved by incorporating a calculation of subjective value into models of self-control (Berkman et al., 2015; Boureau, Sokol-Hessner, & Daw, 2015; Shenhav et al., 2013).

Arising in behavioural economics, subjective value typically refers to the net amount of perceived reward (or lack of punishment) gained from a prospective goal or option, while taking into consideration an arbitrary number of input signals (Kable & Glimcher, 2007; Rangel, Camerer, & Montague, 2008). Crucially, subjective value differs from objective value by representing the net worth assigned to an option that is personal to the individual, rather than any innate property of the reward (e.g., monetary value, calorific content). This idiosyncratic nature of subjective value means that it possesses domain-generalizability, translating multiple classes of evaluation into a common currency to weigh choice options during decision making

(Rangel et al., 2008; Sullivan, Hutcherson, Harris, & Rangel, 2015). As such, the scope of this compound valuation process is broad, spanning the temporal discounting of distant rewards (Kable & Glimcher, 2007), comparison of different types of goods during consumer choice (Chib, Rangel, Shimojo & O'Doherty, 2009), competition between selfishness and altruism (Hutcherson, Bushong, & Rangel, 2015), and the weighing of emotional versus utilitarian considerations during moral reasoning (Hutcherson, Montaser-Kouhsari, Woodward & Rangel, 2015).

In the case of self-control, continuous calculations of subjective value can solve the aforementioned problem of integrating diverse appraisals by calculating a single value that ranges from a positive (appetitive) to a negative (avoidant) assessment of the current focal goal (Berkman et al., 2016; Boureau, Sokol-Hessner, & Daw, 2015). In the case of the dilemma between volunteering and watching a movie, the willingness to volunteer (and suppress movie watching) will be higher if positive signals relating to volunteer work (e.g., beliefs in competency, societal benefits, pride from helping) converge to outweigh the hedonic gains achieved by watching the movie.

Interactions between levels drive shifting priorities

Central to our model is a hierarchical control principle where abstract and enduring goals (i.e., be a good person, display competency, seek rewards) can be realised by engaging and monitoring lower-level, more concrete goals and implementation strategies (Carver & Scheier, 1990; Gross, 2015; Powers, 1973). Here, the higher level components refer to the multiple appraisals and feeling states that arise during control and converge on the calculation of subjective value. The lower level comprises a negative feedback loop that drives performance

towards these more concrete focal goals by detecting discrepancies between the current state of the environment and an internally held standard (cf., Figure 1). Critically, interactions between these levels can determine the dynamic waxing and waning of self-control often observed over time. This hierarchical structure of the framework allows the person to move between states characterised by high subjective value and self-control exertion (vigour), to depleted or fatigued states characterised by a decreased willingness to consider the proximal goal (fatigue), see Figure 4.

Vigour. This state of goal striving arises when the output from higher level appraisals determine that the current focal goal has a positive subjective value. Here, the concrete goal is prioritized and the organism is willing to exert effort to increase the probability of successful goal attainment. One further consequence of this top-down motivational signal is that goal conflicts become particularly threatening, triggering increased psychophysiological and affective reactivity. In a context where effective self-control has a financial payoff, for example, the best strategy to gain this reward is to exert control in the current task to achieve the desired payout.

Disengaging after experiencing the negative sting of conflict, in contrast, would not satisfy the overarching goal to maintain hedonic homeostasis. Although removing control from the situation would certainly evade conflict, it would also inevitably lead to the loss of desired outcomes. Here, homeostasis might best be achieved by tackling conflict head on and increasing top-down control (Dreisbach & Fischer, 2015; Inzlicht et al., 2015, see Figure 1). This strategy reduces the chance of experiencing further conflict in the future (e.g., Kerns et al., 2004), and the resolution of conflict results in a transient increase in positive affect in the

moment (Schouppe et al., 2015). When faced with the movie versus volunteering dilemma introduced previously, the aversive experience of conflicting priorities might be resolved by suppressing the urge to watch the movie and focus on volunteering, if the latter is assigned a sufficient subjective value. Here negative affect—and the changes in motivation and action that it brings—can function as an important input to self-control, helping the individual to steer performance towards their priorities.

Secondly, when the proximal goal is given priority, it is also beneficial for the individual to narrow their focus to avoid irrelevant cognitions and background information that might cause distraction. This narrowly focussed attention, known as *goal-shielding*, benefits the goal at hand by reducing interference caused by the consideration of alternative pursuits (Shah et al., 2002). This state might even become associated with a phenomenological experience of flow (Csikszentmihályi, 1990) or vitality (Moller et al., 2006) if the goal is particularly valuable and self-determined. In fact, in such situations, less strain might be placed on control processes simply because the individual is so focused on the current goal that other alternatives are blocked from stoking temptation (Milyavskaya et al., 2015).

Figure 4: Depiction of valuation processes that might lead to A) states of goal-shielding and vigour or B) fatigue and goal shifting. Dashed area indicates magnified area of full model. Processes shown in red and green are engaged less and more in each mode of operation, respectively.

While goal shielding is clearly beneficial for making progress on the task at hand, absolute fixation on any single priority would undoubtedly lead to problems in the longer term, often resulting in missed opportunities in other domains (Fishbach & Dhar, 2005; Goschke & Dreisbach, 2008; Kurzban et al., 2013). For example, while a volunteering opportunity might be very rewarding to the individual, unyielding dedication to this task would confer a cost to other objectives, such as paid work, recreation, or relationships with friends and family. To avoid

these opportunity costs, some system is required to continually update the value of goals and use these signals to manage priorities.

Fatigue. A goal that was once valuable to an individual might depreciate in worth over time for a number of reasons. Devaluation might arise because obtaining more of the same reward has little value (i.e., diminishing marginal utility; Berkman et al., 2016; Carver & Scheier, 1990), because the individual believes that he or she is no longer able to exert self-control (e.g., Chow et al., 2015; Job et al., 2010), or because the goal is no longer viewed as intrinsically motivating or relevant to the self-concept (Gino et al., 2011; Moller et al., 2006). While a pro-social act (e.g., volunteering) might achieve an initial high subjective value, these rewards might start to diminish as the individual feels that they have given enough to satisfy their altruistic goals. As such, we suggest that current activities are re-appraised using the same evaluative dimensions that can also produce states of vigour. Fluctuating appraisal values can then be integrated into a revised subjective value signal for the focal goal, producing changes in the willingness to exert effort.

The motivational and behavioural consequences of this depreciation in value can be quite severe. People are likely less willing to exert effort as goal value diminishes, perhaps even actively avoiding the goal altogether if it reaches a negative (i.e., punishing) value. This lack of motivation leads to a system wide disengagement of self-control from the proximal goal, reducing the reactivity of neural monitoring, bodily arousal, and remedial control implementation in response to goal conflict from the task at hand (e.g., Boksem et al., 2006; Hopstaken et al., 2014, 2015; Inzlicht & Gutsell, 2007; Wang et al., 2014). If we get tired from helping others as the value of volunteering diminishes, for example, we will put up less

resistance to distracting thoughts or goal-incongruent intentions. This reappraisal process and resultant reductions in engagement on the task at hand allows our framework to account for the steady decline in self-control over time as observed in the ego-depletion and mental fatigue literature.

In this devalued state, many of the ingredients—or components—that make up an emotional episode (e.g., appraisal, arousal, neural activity, behaviour; Barrett, 2006; Russell, 2003) have shifted. Here, a range of disengagement related emotions putatively emerge (e.g., frustration, fatigue, exhaustion, hopelessness) when this pattern of activation is consciously labelled or categorized (cf., Barrett, 2006; Lindquist et al., 2014; Scherer, 2009). Functionally, we suggest that these emotions are not mere epiphenomena—they are not the exhaust fumes of the engine that drives self-control. Instead, the conscious meta-experience of these emotions can act as stop signal, highlighting the futility of continued effort towards the current focal goal (Boksem & Tops, 2008; Hockley, 2014; Inzlicht et al., 2014). For example, the conscious experience of fatigue could accelerate the rate with which individuals reduce the subjective value of unrewarding goals. Both fatigue and frustration, for example, have been interpreted as signals that the current task does not return expected (or desired) rewards during effortful actions (e.g., Carver, 2015; Rolls, 2000).

Finally, while the reduction in effort and goal disengagement is undoubtedly problematic for the task at hand, mental fatigue can have adaptive outcomes by helping to achieve balance between goals. The reduced prioritization of the now unrewarding focal goal frees up the individual to consider other alternatives that are potentially more gratifying (Inzlicht et al., 2014; Kurzban et al., 2013). This might simply result in daydreaming and reduced concentration

if external factors oblige continuation with the incumbent goal. However, if goal switching is possible the individual might shift to other more rewarding activities that can be either cognitively demanding or restful. After tiring from engaging in pro-social labour, for example, the volunteer might change to less effortful pursuits, such as watching TV, or more effortful forms of leisure, such as sport.

In contrast to theories where fatigue is viewed as the depletion of some essential resource, goal disengagement and fatigue can be seen as an adaptive and vital process that helps people to achieve balance either between different types of goals (Kurzban et al., 2013), or between cognitive labour and cognitive leisure (Inzlicht et al., 2014; Kool & Botvinick, 2014). In this case, rather than by increasing self-control, the unpleasant experience of mental fatigue is alleviated by shifting priorities, providing a different route to satisfy the hedonic homeostasis (Saunders et al., 2015b).

Comparisons with existing models of control, outstanding questions, and future directions

In this final section we evaluate our proposed framework in relation to several factors, including the adaptive benefits of diverse appraisals to organism, and comparisons of our framework to other related accounts.

Why implement multiple appraisals?

Our framework implicates a broad array of appraisal processes in the maintenance of self-control, and this complexity raises a number of questions. Foremost, it should be asked why it is adaptive for the organism to implement a range of appraisals relative to determining priorities based on a more limited range of criteria (e.g., the negative experience of conflict, objective

rewards). The principle of parsimony requires us to justify theoretical complexity over less complex solutions.

One benefit of a multi-dimensional valuation mechanism, we think, is the facilitation of persistence despite minor setbacks. If goal desirability was evaluated on a single evaluative dimension of valence or reward, for example, it is unclear why an individual would persist towards a goal after experiencing set-backs, such as the aversive sting of conflict or the omission of rewards (Westbrook & Braver, 2015; raise a similar concerns in their neuroeconomic account). A fundamental feature our framework is the suggestion that willingness to act reflects the net integration of appetitive and aversive signals from multiple classes of appraisals. Although conflict, for example, might register as a hedonic cost (i.e., negative value), this cost can be counteracted if positive contributions to value are generated by other appraisals, such as objective rewards (e.g., Apps et al., 2015; Westbrook & Braver, 2015) or motivation related to maintaining a positive self-worth (Deci & Ryan, 2000; Sherman & Cohen, 2014).

Although more speculative, it is possible that this perseverance despite setbacks can help to turn motivated effortful self-control into good habits that can provide a more effortless route to goal attainment (Adriaanse et al., 2014; Galla & Duckworth, 2015). While the formation of habits is less often studied by self-regulation theorists, habits putatively arise when goal implementation strategies are repeatedly reinforced in a single context (cf., Wood & Rnger, *in press*). As such, the facilitation of persistence and vigour by positive appraisal values might provide fertile grounds for habits to be locked into associative memory through repeated actions. Ongoing research might investigate how both naturally occurring appraisals, as well as

interventions designed to foster broad evaluations of control situations, might promote the development of good habits to improve self-regulation in everyday life.

Comparison with existing accounts and ongoing questions

One key goal of our framework is the integration of findings from multiple sub-disciplines of psychology, including cognitive, affective, social, biological, and neuroeconomic perspectives. However, it is also important to consider where our proposal coheres with and differs from existing perspectives on self-control.

Our framework largely builds on, rather than replaces, many existing cognitive neuroscience accounts of control. Conflict monitoring, for example, is retained as the computational mechanism that sets off the processes that put control in action (Botvinick et al., 2001; Yeung et al., 2004). However, our framework incorporates suggestions that self-control critically depends on the degree of negative affect triggered by goal conflict (cf., Dreisbach & Fischer, 2015; Inzlicht et al., 2015). This affective contribution to control is inconsistent with a pure conflict monitoring account (cf., Botvinick et al., 2001), but can be accommodated by recent extensions in which conflict is understood as a cost (Botvinick, 2007). Moving forward, one key goal for ongoing research will be to produce computationally specific models of self-control that can accommodate the diversity of appraisals proposed in the current framework. A useful starting point for this challenge is provided by recent accounts where subjective value calculations are incorporated into computational models of control (e.g., Shenhav et al. 2013).

By proposing that dynamic variation in self-control has a locus in motivation and emotion, our framework strongly aligns with emerging social psychological accounts of self-control (Inzlicht et al., 2014; Kurzban et al., 2013), and clearly departs from metabolic perspectives on

self-control strength (Baumeister et al., 2007; Galliot et al., 2007). In fact, our appraisal based framework largely reflects a synthesis and extension of recent proposals that self-control is founded in emotion (Inzlicht et al., 2015), and that variation in control over time reflects dynamic shifts in goal prioritization (Inzlicht et al., 2014). We extend these previous suggestions by specifying the evaluative mechanisms (i.e., appraisals) that are applied during self-control. This extension allows for a comprehensive integration of emotion theory and self-control, and can also explain the dynamic evaluations that give rise to the willingness to exert self-control.

The hierarchical structure of our framework also overlaps with cybernetic models of self-regulation in which negative affect arises when feedback loops detect a slower rate of goal progress than expected (Carver, 2015; Carver & Scheier, 1990, 1998). Rather than suggesting that affect arises from a parallel system that monitors the rate of goal progress (cf., Carver, 2015), we suggest that negative affect reflects the phenomenological correlate of the discrepancy (i.e., conflict) monitoring process itself. This aspect of the framework mirrors recent theoretical and empirical suggestions that the processes that detect conflict *themselves* are a source of aversive arousal (e.g., Aarts et al., 2013; Botvink, 2007).

Finally, an important future direction is to consider the often neglected role of positive emotion in self-control. On the one hand, many existing accounts suggest that positive emotion has an appetitive influence on goal pursuit, increasing the desirability of goals associated with positive hedonic states (e.g., Bagozzi et al., 1998; Fishbach, Shah, & Kruglanski, 2004; Williams & DeSteno, 2008). However, other prevalent accounts make the opposite prediction, proposing that positive affect arises when goal states are virtually satisfied, promoting an easing of effort and coasting towards the goal (Carver & Scheier, 1990). Mirroring the apparent paradox that

arises in regard to negative affect, these results lead us to question how positive affect can be both good and bad for self-control?

While this question requires close examination in future research, we think that consideration of the appraisals that underlie self-control might start to provide some answers to this question. More specifically, at the start of goal progress and during goal selection positive affect perhaps has an appetitive effect, where people show preferences for the types of activities that have been associated with pleasant experience, rewards, and competency in the past. These anticipatory emotions putatively increase the desirability of the goal and motivate the actions required to achieve the goal (cf., Bagozzi & Pieters, 1998). However, in line with the law of diminishing marginal utility, the appetite for reward likely decreases with increasing consumption, and this factor might promote different classes of positive emotion, characterised by satisfaction and contentment, to come to the fore. If we are hungry, for example, we might feel extreme excitement and desire when entering a pizzeria, followed by positive feelings of contentment and relaxation after consuming the meal. This latter signal might indicate that performance has met current needs, with emotions only becoming negative (e.g., into fatigue or frustration) if the individual is obliged to continue engage with goal beyond its utility. Thus, in contrast to feelings of fatigue, positive, satiation-related emotions might also signal that the hedonic gains from current goal have reached satisfactory levels, and that it is now time to switch to other goals.

Conclusion

The current review puts forward a novel appraisal framework that can explain why negative affect can be both good *and* bad for self-control. By viewing self-control through the

lens of appraisal, we suggest that these bidirectional effects of negative affect on self-control appear less paradoxical in light of the evaluative and homeostatic principles that unite emotion and goal pursuit.

Our proposal is also generative. Foremost, it is our hope that the cybernetic implementation of our framework might lay some of the groundwork for developing integrated models of self-control and emotion with ever increasing computational precision. While producing a computational model of an emotional process is undoubtedly difficult to realise, the field might move closer to this aim by ever more closely specifying and testing the feedback processes, evaluations, and calculations (e.g., subjective value) that putatively underlie the willingness to engage control.

Our framework also implicates diverse appraisal processes in the generation of goal persistence over time, often despite setbacks along the way (e.g., the hedonic costs of control). Leading from this suggestion, future investigations could assess the effects of encouraging deep and multifaceted appraisals during real-world self-regulation using more ecologically valid measures (e.g., experience sampling) in targeted populations (e.g., dieters, athletes, college students). Unlike personality measures that can predict self-discipline and long-term goal pursuit (e.g., Grit and conscientiousness; Duckworth, Peterson, Matthews & Kelly, 2007; Roberts, Lejuez, Krueger, Richards, & Hill, 2014), appraisal processes are highly malleable and situationally variable (Gross, 2015). As such, understanding the appraisals that underlie self-control persistence might generate targeted interventions with the power change every day self-regulation for the better. For example, it can be tested if encouraging participants to

engage a broad range of appraisals during goal setting will result in greater persistence and less self-control failure.

Only by considering self-control as an emotional process have we been able to reconcile competing perspectives on the relationship between willpower and emotion. It is our hope that this framework will be generative, advancing the field towards both more computationally precise accounts of motivation and self-control, and, in more applied settings, aiding the development of targeted interventions to improve self-control in groups that need it most.

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