the OCM account is that task value is compared to the value of a competing task also requiring executive functions; the authors focus specifically on the competing "task" of daydreaming. However, to our knowledge, there is no convincing evidence that daydreaming requires executive functions, and therefore it is not likely that this assumption is satisfied. A third assumption of the OCM account is that task value is defined only in terms of its positive aspects, and not by its negative ones, as, for example, task difficulty. This would imply that tasks differing in difficulty can have equal value and, thus, should lead to an equal experience of effort. As this corollary of assumption 3 is to our knowledge not supported by empirical evidence (Morsella et al. 2009), we conclude that assumption 3 is not likely to be satisfied.

We therefore argue that a model of the effects of sequential usage of executive functions is needed that does include motivation, yet does not rely on the aforementioned unlikely assumptions. A recently proposed simple formal model satisfies these requirements (Huizenga et al. 2012). In this model, motivation determines the fraction of required resources that will be allocated to tasks, in which required resources depend on task difficulty. It is assumed that motivation decreases with repeated usage of executive functions, and as a result, performance will decrease also. This model does not require the unlikely second assumption, as there is no comparison of motivation ("value") associated with current and alternative tasks. In addition, it does not require the unlikely third assumption, as task difficulty is explicitly incorporated into the model.

The model, however, does require the first assumption, as it is assumed that motivation decreases with repeated usage of executive functions. This assumption certainly needs further investigation, at a behavioral as well as at a neurophysiological level. At a behavioral level, it needs to be investigated whether indices of experienced motivation (e.g., Carlson & Tamm 2000) mediate the effects of sequential use of executive functions. At the neurophysiological level, the effect of repeated use of executive functions on dopamine, a "motivational" neurotransmitter (Salamone & Correa 2012) that improves executive functions (Pessoa 2009), needs further consideration. For example, in simple learning tasks, phasic dopamine releases decrease with repeated exposure to stimuli that are associated with expected reward (Schultz et al. 1993). An intriguing possibility is that these dopamine levels would also decrease with repeated performance on executive function tasks (Boksem & Tops 2008; Lorist et al. 2005).

To conclude, an advantage of the OCM account of "resource depletion" is that it includes motivation (value). A disadvantage, however, is that the OCM account relies on two unlikely assumptions. Therefore, an alternative model, relying only on the assumption that motivation decreases with repeated usage of executive functions, requires further investigation, both at a behavioral and at a neurophysiological level.

Beyond simple utility in predicting self-control fatigue: A proximate alternative to the opportunity cost model

doi:10.1017/S0140525X13001076

Michael Inzlicht[a] and Brandon J. Schmeichel[b]

[a]*Department of Psychology, University of Toronto, Scarborough, Toronto, Ontario M1C 1A4, Canada;* [b]*Department of Psychology, Texas A & M University, College Station, TX 77843-4235.*

michael.inzlicht@utoronto.ca schmeichel@tamu.edu
www.michaelinzlicht.com
https://sites.google.com/site/bjschmeichel/

Abstract: The opportunity cost model offers an ultimate explanation of ego depletion that helps to move the field beyond biologically improbable resource accounts. The model's more proximate explanation, however, falls short of accounting for much data and is based on an outdated view of human rationality. We suggest that our own process model offers a better proximate account of self-control fatigue.

The opportunity cost model proposed by Kurzban et al. is thought provoking, and we agree with much of it. It offers an ultimate explanation for why self-control *seems* limited, and it has the potential to move the field beyond simple and biologically improbable resource accounts of fatigue. However, we found the more proximal account of the limits of self-control to be lacking (see Scott-Phillips et al. 2011). Specifically, the notion that opportunity costs drive self-control fatigue does not account for a number of relevant findings as they relate to the proximate processes underlying self-control and its failure. Most critically, the model's proximate account is based on a modern *homo economicus* that risks being just as inscrutable as the limited-resource model it is trying to replace. We discuss the strengths of the proposed model and its shortcomings, contrasting it with our own mechanistic revision of the limited-resource model of self-control (Inzlicht & Schmeichel 2012).

We start by clarifying what we are and are not debating. We are not debating the consistent finding that engaging in self-control at Time 1 leads to declines in performance at Time 2. This basic effect has been replicated more than 100 times in independent laboratories across the world (Hagger et al. 2010a). It also maps onto the commonsense view that mental fatigue can lead to decrements in performance over time (Hockey 1983). We are also not debating the role of blood glucose as the physical resource underlying self-control and its depletion (Gailliot et al. 2007). The mounting evidence points to the conclusion that blood glucose is not the proximate mechanism of depletion, even if the presence of glucose in the oral cavity can moderate the depletion effect (Hagger & Chatzisarantis 2013; Kurzban 2010a; Molden et al. 2012). What is debatable is the *how* of depletion. The dominant account of ego depletion (Muraven & Baumeister 2000) suggests that performance on self-control tasks decreases over time because it recruits and depletes a limited inner resource. Although results of many and varied experiments using the sequential-task paradigm are consistent with a limited-resource view, the resource in these studies is inferred, but never measured (Hagger et al. 2010a). So how does ego depletion work?

Kurzban and colleagues suggest that people engage in some complex, mostly unconscious calculation of the costs and benefits of continuing to pursue the current task versus the costs and benefits of pursuing some competing task. Some version of this view seems likely to be correct, but this account does not help us to understand or anticipate changes in the cost-benefit ratio. Nor does it explain why people sometimes engage in seemingly costly and effortful behavior following periods of high subjective effort; for example, going to lengths to aggress against others or to find and consume drugs (e.g., Muraven et al. 2002; Stucke & Baumeister 2006). The proposed model also implies that people who monitor and who are generally aware of their phenomenological states should be especially likely to withdraw effort as subjective effort increases. But research has found the opposite: with people who are more self-aware being *less* influenced by previous acts of control (Alberts et al. 2011; Wan & Sternthal 2008); with people more aware and accepting of their emotions particularly good at executive control (Teper & Inzlicht 2013); and with self-control fatigue being mediated by deficits in what can be construed as a form of self-awareness (Inzlicht & Gutsell 2007). These results are not easily explained by the opportunity cost model, but they can be explained by our own process model (Inzlicht & Schmeichel 2012).

Like others (Botvinick et al. 2001; Strack & Deutsch 2004), we construe self-control as being initiated by the competition between two opposing forces: the force that motivates the expression of an impulse versus the countervailing force that

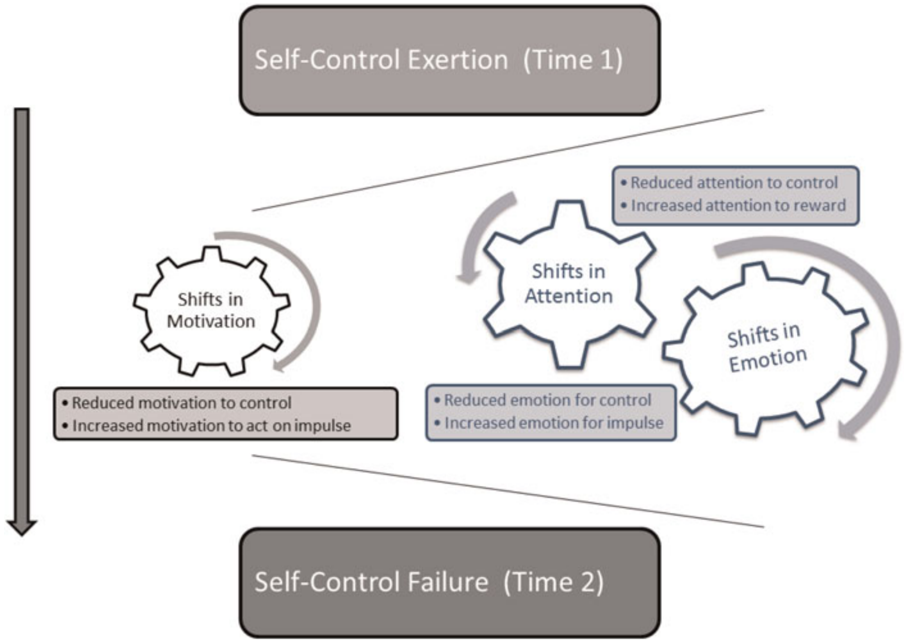

Figure 1 (Inzlicht & Schmeichel). The process model of self-control fatigue. Self-control failure tends to occur after initial self-control exertions because of shifts in motivation away from control and toward impulses and gratification. This shift in motivation consists of shifts in attention and shifts in emotional responding.

overrides the impulse. In this view, self-control fails after initial task exertions when impulses are relatively strong, when control is relatively weak, or through some combination of both of these factors. According to our process model (Fig. 1), self-control at Time 1 leads to shifts in motivation away from restraint and toward gratification, such that people become less motivated to control themselves and more motivated to self-gratify at Time 2. As part of this motivational shift, people pay less attention to self-control cues and more attention to reward cues. We also suspect as part of this motivational shift that people become less aroused by the prospect of goal failure or success and more aroused by the prospect of reward and immediate gratification.

Our model is still preliminary, but it can accommodate data that give the resource model fits (e.g., Job et al. 2010; Muraven & Slessareva 2003); it can also accommodate data that are left unexplained by the current opportunity cost model (e.g., Schmeichel et al. 2010). Whereas Kurzban et al.'s model is vague about how the calculation of utility changes over time, our model better specifies directions in the dynamics of "processing allocations," by suggesting that it moves toward reward/gratification and away from conflict and further control. Most important, our model makes novel and testable predictions that run counter to the current model. Our model predicts, for example, that self-control at Time 2 can be maintained when people are given veridical negative feedback on their performance; it also predicts that increases in emotional acuity will increase, not decrease, control at Time 2.

More generally, we worry that the opportunity cost model makes a fundamental error: It assumes that people calculate costs and benefits in an objective, dispassionate manner. This hyper-rational view discounts seminal work in psychology on the follies of human decision-making (Kahneman & Tversky 1979) and modern economic takes on utility theory that allow for non-rational, hyperbolic discounting of the future (Ainslie 1991).

We admire the authors' ultimate explanation for self-control fatigue, but we find that their proximate explanation falls short of accounting for observed patterns of data and is based on an outdated view of human rationality.

Opportunity prioritization, biofunctional simultaneity, and psychological mutual exclusion

doi:10.1017/S0140525X13001088

Asghar Iran-Nejad[a] and Sally Ann Zengaro[b]
[a]*Educational Studies in Psychology, Research Methodology, and Counseling, University of Alabama, Tuscaloosa, AL 35487;* [b]*Counselor Education and Psychology, Delta State University, Cleveland, MS 38732.*
airannej@bamaed.ua.edu **szengaro@deltastate.edu**

Abstract: We argue that prioritization, simultaneity, and mutual exclusion are mind-body integration functions that can't be addressed meaningfully at the psychological (computational) level alone. We describe the outlook for an integration between Kurzban et al.'s profound discussion of opportunity cost/benefit prioritization and decades of related development in biofunctional science.

The central argument of this target article – that *opportunity cost/benefit prioritization* (OC/BP) is why human behavior consumes mental effort – is supported by two compelling themes. One is intuitive, has to do with the phenomenology of mental effort, and enables reflective psychological engagement/disengagement. The other is utilitarian and pertains to the idea that "phenomenological experiences are reasonably easy to understand from a [bio]functional perspective" (sect. 5, para. 1; cf. Iran-Nejad et al. 1984). Kurzban et al. use these and related ideas skillfully to dislodge the standard resource theory of human endeavor in favor of their promising OC/BP alternative, a feat long overdue. In this commentary, we assume that the computation metaphor, if used for other than a mathematical tool of science, is an Achilles heel; it confines the OC/BP theory to the psychological level; and the theory can survive without it. The purpose of this commentary is to show how OC/BP theory relates to the biofunctional theory of human understanding, including consideration given to the role of biological and computational metaphors in prioritizing opportunities, simultaneity, and mutual exclusion as used in the target article.