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CAN WE CATCH FLIES WITH VINEGAR?

Recurrent issues in ego-depletion studies,
and potential solutions

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8 **Abstract**

9 Psychology suffers from the so-called “replication crisis”, which has led to question
10 many popular psychological phenomena. Ego-depletion is among the most criticized ones,
11 especially since attempts to improve its replicability have failed. We argue though that many
12 replication attempts are based on inaccurate conceptions of ego-depletion. More precisely, we
13 suggest that failures to replicate ego depletion may be due to four common issues and limits.
14 Firstly, we discuss the regular absence of a comprehensive and integrative definition of self-
15 control, as a set of strategies of conflict resolution, which is central to the concept of ego-
16 depletion. Secondly, we debate the lack of distinction between ego-depletion and mental
17 fatigue, two phenomena that induce a decrease in cognitive performance but that do not rely
18 on the same processes. Thirdly, we argue that the tasks chosen to induce ego depletion are
19 often inappropriate. Finally, we argue in favor of more complex and extensive approaches to
20 investigate ego-depletion. We propose some conceptual clarifications and pave the way for
21 studies that adopt more rigorous methodologies.

22 **Keywords** : ego-depletion, self-control, mental fatigue, replicability

Controlling emotions, impulses, or automatic responses that interfere with goal-directed behavior is critical for successful adaptation. A concept that has helped to better understand self-control failure is *ego-depletion*, the exhaustion of resources necessary to regulate behaviors, that results from an initial engagement in a self-control act (Baumeister et al., 1998). This construct has been influential these past two decades before being highly criticized, mostly because of replicability problems. We argue here that many failures to replicate ego depletion effects may be due to inaccurate conceptions and methods. This article discusses four arguments that we consider as key issues common in the literature, that could question the validity of some replication attempts.

1. The absence of a comprehensive and integrative definition of self-control

Originally, ego-depletion is defined as the phenomenon by which exerting self-control in a first task leads to an impaired ability to exert self-control in a second task (Baumeister et al., 1998). Over time, many replication attempts of ego-depletion effects have omitted this original definition. For example, Lin et al., (2020) proposed that ego-depletion refers to feeling tired after exerting a mental effort. Other proposed that ego-depletion corresponds to deficits in persistence and performance on cognitive and motor tasks after a self-regulatory effort (Segerstrom & Nes, 2007), or to impaired performance after any monitoring and modification of behavior (Vohs et al., 2005). Some authors have stressed the need of a clear and operational definition of self-control to better guide ego-depletion research (Lurquin & Miyake, 2017). Since this claim, self-control has benefited from theoretical clarifications (e.g., Gillebaart, 2018; Milyavskaya et al., 2019), and is considered as the self-regulation operationalization by which an individual resolves a conflict through effortless or effortful strategies (also named self-control strategies). Effortless ones are automatic and do not require effort (e.g., asymmetric cognitive associations, Fishbach et al., 2003). Effortful ones

are reflective, and rely on self-control resources availability¹ (e.g., effortful inhibition, Muraven & Baumeister, 2000)².

To summarize, effortful self-control strategies draw from resource(s) that once emptied or reduced, impair subsequent effortful self-control strategies success (Baumeister et al., 1998; Fujita, 2011; Gillebaart, 2018). This temporary self-control impairment is called ego-depletion, and may be characterized by (at least, see point 4) resources and self-control performance's decrements.

According to contemporary definitions, self-control operates only for conflict resolution (Fujita, 2011; Gillebaart, 2018; Milyavskaya et al., 2019), which differentiates it from other regulatory constructs such as self-regulation or conscientiousness. According to these definitions, ego-depletion is the phenomenon by which self-control is impaired by the use of an effortful self-control strategy to resolve a conflict (e.g., originally, choosing a larger delayed reward over a smaller immediate one, through inhibition; Mischel et al., 1989). However, several studies that have failed to replicate ego-depletion effects have investigated them outside this strict definition, for example by manipulating mental/cognitive effort (e.g., Englert et al., 2015; Lin et al., 2020), with tasks unrelated to self-control or to conflict resolution (e.g., Finkel et al., 2006). In fact, these studies did not test ego-depletion (Lurquin & Miyake, 2017), suggesting that the ego-depletion controversy could have been fostered by the omission of the original concept this phenomenon is part of. We recommend future research to stick more strictly to the original ego-depletion definition, and to integrate it

¹ Some authors also proposed that ego-depletion could rely on motivation to exert control (e.g., Inzlicht & Schmeichel, 2012). Because to our knowledge, no empirical study confirmed this assumption, our arguments are based on the resource approach of ego-depletion definition. Motivation role is discussed below.

² Although studies that operationalized resources through glucose failed to confirm such hypotheses, other studies using resources perception or cardiovascular markers to operationalize self-control resources (Wright et al., 2019; Wright & Mlynski, 2019) provide support to the assumption that effortful self-control strategies rely on resources availability (e.g., Clarkson et al., 2016; Forestier et al., 2018; Laborde et al., 2019; Tyler & Burns, 2009).

within the updated self-control definition proposed in the contemporary literature (e.g., de Ridder et al., 2018; Fujita, 2011; Gillebaart, 2018; Milyavskaya et al., 2019). We argue that this phenomenon cannot be rejected or reinvented, before rigorous empirical studies based on this definition are conducted.

2. The lack of distinction between ego-depletion and mental fatigue

Several studies derived from the original assumption that effortful self-control acts induce self-control impairment (Baumeister et al., 1998; Lurquin & Miyake, 2017), toward the assumption that “people feel tired or depleted after exerting mental effort” (e.g., Lin et al., 2020, p. 1). This claim, which postulates that any task that requires cognitive effort produces ego-depletion, mixes two concepts: mental/cognitive fatigue and ego-depletion. Some authors proposed that the distinction between ego-depletion and mental fatigue relies on task duration, but found no empirical evidence of such assumption (e.g., Giboin & Wolff, 2019). We propose a more theory-based distinction. On the one hand, mental/cognitive fatigue is “the feeling that people experience after/during prolonged periods of cognitive activity, [...] involves tiredness, exhaustion, aversion to continue the present activity, a decrease in the commitment level, [...] and has been associated with impaired cognitive/behavioral performance” (Boksem & Tops, 2008, p. 126). Mental/cognitive fatigue results from short (e.g., few minutes, O’Keeffe et al., 2020; Roy et al., 2013; Smith et al., 2019; Wright et al., 2013)³ or long (e.g., hours, Marcora et al., 2009; Smith et al., 2019; Van Cutsem et al., 2017) periods of cognitively demanding task. On the other hand, ego-depletion is a temporary self-control impairment induced by the resolution of a cognitive or motivational conflict through a self-control strategy⁴.

³ Importantly, O’Keeffe et al., (2020) concluded, through 5 experimental studies, that individualized, dual-task of short duration are the most effective to induce mental fatigue.

⁴ To this day, no recommendation exists on the optimal duration of the self-control effort to induce ego-depletion. Even if the literature typically adopted depleting task of less than 10 minutes, this duration has not been subject to prior empirical validation.

As such, ego-depletion is a type of mental/cognitive fatigue, which specifically results from an effortful self-control act, but does not refer to all types of mental/cognitive fatigue. Similarly, a decrease in cognitive performance after a demanding task cannot systematically be interpreted as indicating ego-depletion. We recommend to stop using these phenomena interchangeably: although both induce a change in cognitive performance, ego-depletion is consecutive to an effortful self-control act (i.e., a motivational or cognitive conflict resolution), and is captured through a decreased performance related to a self-control strategy (e.g., inhibition, related to the self-control strategy of resisting temptations, Hofmann et al., 2014) and/or self-control resources.

3. The validity of the tasks chosen to deplete/capture ego-depletion

The choice of ego-depleting tasks has also been criticized, often made “regardless of whether tasks could be considered as a valid operationalizations of self-control” (Carter et al., 2015, p. 15). Others stressed the confusion produced by “inappropriate depleting tasks” (Dang, 2018, p. 646), that do not require, or are unrelated to, self-control (Carter et al., 2015). Authors have also criticized the frequent choice of tasks “mentally demanding, requiring effort, or simply being difficult”, but in which we “cannot unambiguously determine whether or not it implicates self-control, and determine whether one should expect a significant ego-depletion effect” (Lurquin & Miyake, 2017, p. 2).

Ego-depletion studies have often used depleting tasks without pre-testing whether they accurately indexed at least one self-control strategy, including high-maintenance social interaction tasks (Finkel et al., 2006), symbol-counting task (Lin et al., 2020), labyrinth task or arithmetic task with auditory interference (Martijn et al., 2007, Study 1 and 2), forced-

choice essay task (Moller et al., 2006, Study 1)⁵. These tasks do not measure a conflict resolution strategy, which represents a major limitation of the literature.

While using a subsequent task unrelated to self-control is relevant to examine ego-depletion effects in different domains, the choice of the depleting task must be related to self-control. For example, some studies proposed that ego-depletion may influence attention (e.g., Englert et al., 2015; Osgood, 2015), decision making (e.g., Furley et al., 2013), response caution (e.g., Lin et al., 2020), or working memory (e.g., Li et al., 2013). We argue that we cannot yet conclude on such effects because “self-control” was manipulated with unvalidated depleting tasks. As such, it is not possible to determine whether these studies are part of the ego-depletion, or the mental/cognitive fatigue literature.

We recommend to use depleting tasks that have been thoroughly validated, by ensuring that they involve processes that are closely related with at least one self-control strategy. Studies could choose well-validated tasks (e.g., Go/No-Go task, Duckworth & Kern, 2011), or novel ones, but in this case, these tasks absolutely need to be pre-tested before being considered as depleting. This validation step seems crucial as it concerns tasks that have frequently been used to induce ego-depletion (e.g., letters tasks “have not been independently validated as effective measures of self-control”, Lurquin & Miyake, 2017, p. 2).

4. The need to investigate the complexity of ego-depletion

Past studies have mostly investigated ego-depletion in between-group experimental designs, which constitutes another limit. First, such design prevents to understand the dynamics of the emergence of the phenomenon within an individual. Does self-control performance linearly decreases with time passed at exerting a self-control effort? Or with self-control resources? Is there a non-linear relation (e.g., inverted U-shape) where self-control

⁵ To appreciate the diversity of tasks used to induce or capture ego-depletion, see the meta-analysis of Hagger et al., 2010, Supplementary Materials 2

performance increases until a certain threshold and then breaks, similarly to the relation between effort and fatigue (e.g., Wright & Mlynski, 2019)? Does self-control performance firstly decrease, then increase before a final decrease, similarly to what has been observed elsewhere (e.g., Deschamps et al., 2013)? To our knowledge, only one study has investigated the ego-depletion dynamics (Arber et al., 2017). A within-individual dynamic of ego-depletion during the depleting task was observed, and characterized by a linear performance decrease. Such result corroborates a recent article that recommended to focus on state of self-control evolution during self-control act (de Ridder et al., 2018). However, this innovative approach needs direct, as well as conceptual, replications, and could be supported by an interest for within-person ego-depletion dynamics.

Secondly, investigation of correlates of ego-depletion has often been omitted, despite the insightful information this could provide. A few studies have examined *antecedents* (e.g., perceived energy, Forestier et al., 2018; Hirt, Clarkson, Egan, et al., 2016), *moderators* (e.g., trait of self-control, Imhoff et al., 2014; perceived success attainability, Wright & Mlynski, 2019) and *explanatory mechanisms* of ego-depletion (e.g., motivation, attention, Inzlicht & Schmeichel, 2012; effort cost-related decisions, Kool & Botvinick, 2014; cardiac related markers, Laborde et al., 2019; Wright et al., 2019), but these studies remain rare. Similarly, studies from cognitive neurosciences proposed explanatory mechanisms (e.g., lateral prefrontal cortex deactivation, increased evoked related potential when facing conflict triggering stimuli, on brain region associated with affects; see Wagner & Heatherton, 2016 for a review)⁶. Because these possibilities have already been discussed elsewhere (Hirt, Clarkson, & Jia, 2016; Masicampo et al., 2014), we will not provide further details about boundary

⁶ However “there is much more work to be done to elucidate the mechanisms of ego depletion [...] and we have no doubt that a neuroscience approach will continue to play an important if not decisive role in our understanding of the phenomena” (Wagner & Heatherton, 2016, p. 294)

conditions and explanatory mechanisms. However, we add that empirical investigation of these hypotheses is still lacking, and with a consideration of the issues discussed above.

Thirdly, we argue in favor of a broader operationalization of the markers of ego-depletion. As discussed above, this phenomenon has mainly been indexed through performance decrement. This is problematic because task performance is multifactorial. For example, the mental fatigue literature has identified that fatigued individuals may maintain a similar level of performance compared to not fatigued ones, by investing extra effort on a demanding task to compensate fatigue effects (Wright et al., 2019; Wright & Mlynski, 2019, for recent reviews). Accordingly, if ego-depletion is a particular type of mental fatigue, a compensatory self-control effort investment could help to maintain task performance, leading investigators to erroneously conclude to the absence of ego depletion when focusing only on task performance. Similarly, considering the intraindividual variability change in performance on a demanding task (e.g., response inhibition accuracy) could provide enhanced information about mental fatigue, compared to the tradition of single pre-post or inter-group comparisons (Wang et al., 2014).

Accordingly, we concur with recent recommendations (e.g., de Ridder et al., 2018; Wright et al., 2019) and encourage future research on ego-depletion to use more complex research designs and approaches (e.g., within-person designs; investigation of antecedents, boundary conditions and explanatory mediators; use of broader ego-depletion markers) to provide empirical results that are informative to the ego-depletion literature.

Conclusion

The nature of scientific theories is to be falsified and updated (Lakatos, 1976; Popper, 1935), and ego-depletion cannot pass through. This phenomenon has been highly criticized these past years, mostly because of replicability problems, and difficulties to capture in which circumstances it occurs or not. We argue here that there are at least four issues that do not

allow to conclude yet about the absence or existence of ego depletion. We highlighted (1) the lack of a strict inclusion of ego-depletion within self-control concept, (2) the lack of distinction between ego-depletion and mental fatigue, (3) the choice of depleting tasks seemingly inappropriate to induce ego-depletion, and (4) the lack of investigation of the complexity of the phenomenon. We insist that this article does not argue in favor of the existence of ego depletion, but that it is yet too early for its funeral. It aims to serve as a starting point for a more rigorous line of research, which is necessary before concluding if ego-depletion phenomenon truly exists or not.

Conflict of interest.

None

Authors contributions

Cyril Forestier established the first draft of the manuscript and Aïna Chalabaev provided critical insightful comments to improve it.

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