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Unsuccessful Attempts to Replicate Effects of Self Control Operations and Glucose on Ego-Depletion Pose an Interesting Research Question that Demands Explanation

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Response to Lange, F. (in press). If ego depletion cannot be studied using identical tasks, it is not ego depletion: A commentary on Chatzisarantis and Hagger. *Appetite*.

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### Abstract

The hypothesis that sugar-containing drinks counteract depletion of self-control or ego resources is elegant and provocative because it entails that the origins of ego-energy and self-control operations can be traced to a physiological substrate. However, this hypothesis has not withstood scientific scrutiny. Lange and Eggert (2014) presented two unsuccessful attempts to replicate effects of glucose on ego-depletion. Chatzisarantis and Hagger (this issue) argued that inconsistent findings may be due to experimental designs that expose participants to similar acts of self-control. This methodology may not provide a more rigorous test of the counteracting effects of glucose on ego-depletion because it does not control for factors (i.e., motivation) that interfere with glucose effects. In this article, we address Lange's (in press) comments and explore the possibility that findings reported by Lange and Eggert's (2014) and Hagger and Chatzisarantis' (2013) studies are consistent. In addition, we discuss two factors that researchers may wish to take into consideration when designing experiments that aim to test effects of glucose, or glucose rinsing, on ego-depletion. These factors are related to ego-depleting value of self-control tasks and type of motivation that may drive performance on such tasks.

**Keywords:** Ego-depletion, motivation, dual task-paradigm, glucose

Unsuccessful Attempts to Replicate Effects of Self Control Operations and Glucose on Ego-Depletion Pose an Interesting Research Question that Demands Explanation

When researchers embark on a research project they hope to observe statistically-significant findings that are consistent with their original hypothesis. Observing statistically non-significant results can be disappointing because such findings are difficult to interpret or get published. However, it is possible findings to be statistically non-significant but still consistent with the extant literature (Hunter & Schmidt, 2004). In this article, we respond to Lange's (in press) comments and explore the possibility that findings reported by Lange and Eggert (2014) and Hagger and Chatzisarantis (2013) are consistent. In addition, we discuss two factors that researchers may wish to take into consideration when designing experiments that aim to test effects of glucose on ego-depletion: the ego-depleting value of self-control tasks and the type of motivation that may drive performance on such tasks.

In our previous article (Chatzisarantis & Hagger, in press), we argued that Lange and Eggert (2013) did not detect effects of glucose on ego-depletion because negative feedback and cognitive evaluations developed during the first act of self-control likely undermined willingness to exercise self-control. We also suggested that experimental designs that expose participants to different acts of self-control may provide a more rigorous test of the counteracting effects of glucose on ego-depletion because they may control for factors (e.g., motivation) that interfere with glucose effects. Lange (in press) maintained that experimental designs that expose participants to similar acts of self-control provide rigorous tests of the glucose hypothesis and justified this conclusion on several grounds that we think are sound and with which we concur. Given this, and based on statistical credibility analysis, Lange (this issue) concluded that Hagger and Chatzisarantis' (2013) studies overestimated the effects of glucose on ego depletion. We would, however, like to seize this opportunity to point out some serious problems with Lange's conclusions based on the credibility analysis.

There are two issues that researchers should take into consideration when using Schimmack's (2012) analysis. First, the value of the incredibility index (and average power of studies) is influenced by the effect size used in the analysis. For example, in Hagger and Chatzisarantis (2013) studies, the incredibility index is lower when one is using the average effect size than the meta-analytic effect size. We demonstrated this variability in the incredibility index by providing estimates for meta-analytic and average effect sizes. Lange (in press) favours the use of the meta-analytic effects size but this choice is based on the assumption that the effect size reported in Hagger et al. (2010) meta-analysis is homogenous. However, Hagger et al. (2010) meta-analysis is not sufficiently powerful to detect homogeneity in study results due to the small number of studies included in its estimation. In accordance with this proposition, Huedo-Medina, Sanchez-Meca, Marin-Martinez and Botella (2006) demonstrated that the power of meta-analyses, and indexes such as the  $Q$  or  $I^2$  statistics, in detecting homogeneity in study results is less than .4 in meta-analyses with fewer than 20 studies. Hence, it may be premature to use incredibility index analysis to evaluate average power of studies because incredibility analysis should only be applied to a homogenous set of studies only (Ioanidis & Trikalinos, 2007).

Second, incredibility indexes can detract researchers' attention away from conducting research that aims to explain variability in study results if it is applied on a set of studies that are not homogenous. This is because "homogeneity" means that study results are not influenced by experimental designs or other factors that possibly moderate glucose effects. It is this cautious interpretation of homogeneity tests, alongside Lange and Eggert's (2014) studies, that motivate us to address unsuccessful replications of the glucose hypothesis by looking into methodological factors. If the assumption of homogeneity in a set of studies examining a particular effect, such as those included in Lange and Eggert's analysis of the glucose rinsing effect, is in question and researchers are faced with inconsistent results

among studies included in the set of studies, then a logical step toward resolving the true effect would be to attempt to identify possible moderators that may explain that inconsistency. Resolution cannot be deduced from an analysis, such as the incredibility analysis conducted by Lange and Eggert, where the homogeneity is in question.

Lange (in press) also argued that our proposition that negative feedback explained their findings is not sound because negative feedback can actually increase motivation such as when it is mildly negative and not humiliating (Ryan, Koestner, & Deci, 1991). We agree with this argument but we clarify that our original suggestion is not necessarily restricted to negative effects of negative feedback, we also implied that our argument was also applicable to positive effects of negative feedback. To be more specific, if negative feedback enhanced motivation then ego-depletion effects should not be present in Lange and Eggert's (2014) experiments. This is because motivation counteracts ego-depletion effects (Baumeister & Vohs, 2007). As a consequence, Lange and Eggert's (2014) experimental design would not provide a rigorous test of whether glucose counteracted ego-depletion but whether it augmented effects of motivation on ego-depletion. Further, if motivation counteracted ego-depletion effects then the control condition (i.e., the no-glucose condition) in Lange and Eggert experiments would be equivalent to a condition that does not induce ego depletion effects in typical ego-depletion experiments. As a result, Lange and Eggert's (2013) findings would be consistent with Hagger and Chatzisarantis (2013) results because Hagger and Chatzisarantis did not observe glucose effects over and above a condition that did not induce ego-depletion. In accordance with this reasoning, a closer look at Lange and Eggert's (2014) findings reveals that ego-depletion effects were not consistently present in their experiments. Specifically, reductions in self-control performance were observed only on measures of interference-suppression and not on measures of inhibition in Study 2. In addition, in Study 1, in which Lange and Eggert used a delayed discounting paradigm, there is no evidence to

support ego-depletion effects. Given these findings, it seems plausible that task-related factors such as negative feedback masked the glucose effects by counteracting ego-depletion.

The observation that Lange and Eggert (2014) did not observe ego-depletion effects consistently across studies is not news in the literature on ego-depletion (Hagger & Chatzisarantis, 2014). Hence, our suggestion that factors inherent to self-control tasks (i.e., negative feedback, boredom) mask ego-depletion or glucose effects may not be restricted to Lange and Eggert's (2013) experiments but it may apply to other published or unpublished studies as well. As a case in point, consider the delayed discounting paradigm that Lange and Eggert (2013) used in their experiments. This paradigm, at least on the surface, appears to facilitate self-control exertion because it involves choice. In addition, as Lange (in press) contends, the delayed discounting paradigm produces similar discounting rates regardless of whether real payoffs or hypothetical rewards are used during choice. However, the fact that choice yields similar discounting rates does not necessarily mean that it does so via self-control processes. As Frederick et al. (2003) pointed out, decisions made during the delayed discounting experiments may be rule-based and not necessarily function of the intentional system that we assume to induce ego-depletion (Solman et al., 2005). This is consistent with Baumeister et al.'s (1998) contention in the original experiments that tested the ego-depletion effect that tasks requiring the application of rules on a rote basis would not be depleting, and tasks require an element of response inhibition or impulse control. This issue was also raised in Hagger et al. (2010) in their meta-analysis who raised the question as to what, exactly, constitutes a self-control task. Hence, researchers should not take the capacity for a task to be ego-depleting for granted, there may be a need to reconsider the ego-depleting value of self-control tasks when these tasks are performed in laboratory settings. Our suggestion to use real pay-offs in delayed discounting paradigms aimed to emphasise that detection of ego-depletion (and glucose or 'rinsing' effects) may require that participants exert some minimal

levels of effort or involvement during self-control operations and that monetary rewards can increase task involvement by making choices more consequential.

Apart from paying acute attention to ego-depleting value of self-control tasks, it may also be important to consider type of motivation that experimental manipulations induce during experimentation. There is a trend in the literature to think of motivation, and aversive experiences, as being part of ego-depletion processes. Lange (in press) for example argued that if the study of ego-depletion excluded tasks that induced negative affective experiences then many studies included in Hagger et al.'s (2010) meta-analysis would have to be regarded as methodologically inappropriate. Broadly speaking, we agree with Lange's suggestion that negative affective experiences and motivation are part of self-control processes. On the other hand, however, it may be an overgeneralisation to suggest that all types of motivation are indicators of ego-depletion.

To be more precise, an aversive state that involves feelings of being fatigued or worn out may be considered to be a "marker" of what we call an ego-depleted state (Baumeister et al., 1998; Hagger et al., 2010). However, in our opinion, we should not consider other states, such as amotivation, as indicators (or causes) of ego-depletion. This is because amotivation entails a de-evaluation of the task at hand whereas ego-depletion states do not necessarily imply negative task evaluation (Deci & Ryan, 1985). As another illustration, assume for a moment that a researcher uses an interesting puzzle as a self-control task. Puzzles can induce self-control operations because their solutions are not algorithmic but they require individuals to consider and suppress alternative solutions. Assume also that the researcher asks participants to engage in the puzzle twice as a means of inducing ego-depletion. According to Deci and Ryan's (1985) cognitive evaluation theory, this procedure is likely to motivate participants to exert equivalent levels of effort during their first and second attempts. Most relevant, such pattern of findings would be inconsistent with the strength model of self-



control which suggest that repeated exposure to self-control tasks diminishes self-control performance. However, should it be concluded that this pattern of findings does not support the strength model of self-control? We think not. Although a cognitive analysis of inherently interesting tasks may lead researchers to conclude that puzzles induce self-control operations, an organismic analysis would question such a conclusion on grounds that inherently interesting puzzles facilitate intrinsic motivation (c.f. Moller et al., 2006). Hence, in addition to thinking in terms of whether (or how) amount of motivation is implicated in ego-depletion, we should also start thinking in terms of what type of motivation should we consider a marker of ego-depletion.

In conclusion, we maintain that unsuccessful attempts to replicate effects of glucose on ego-depletion may be due to insufficient control of effects that factors inherent to self-control tasks exert on ego-depletion. We also suggested that researchers may wish to pay attention to ego-depleting value of self-control tasks and the type of motivation when designing experiments that aim to examine effects of glucose on ego-depletion. Regardless of different opinions, approaches, or interpretations of existing findings, we propose that the inconsistent findings related to effects of glucose on ego-depletion raise fascinating research questions that demand further explanation.

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