Illusionary Delusions: Willingness to Exercise Self-Control Can Mask Effects of Glucose on Self-Control Performance in Experimental Paradigms that Use Identical Self-Control Tasks

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Abstract

The purpose of the present article is to highlight limitations of Lange and Eggert's (2014) methodology of using identical self-control tasks in testing effects of glucose on depletion of self-control resources and self-control performance. We suggest that when participants engage in two identical self-control tasks, cognitions developed during initial act of self-control may mask the effects of glucose on self-control performance by undermining willingness to exert effort during the second act of self-control. As a consequence, glucose may increase ability to exercise self-control but participants may not want to capitalize on this "ability advantage" because they are unwilling to exercise self-control. The present article concludes that researchers who test the glucose hypothesis in the context of a depletion paradigm should employ dissimilar acts of self-control and ensure that depleted participants are sufficiently motivated to exercise self-control.

Keywords: ego-depletion, glucose, willingness to exercise self-control, incredibility index

Illusionary Delusions: Willingness to Exercise Self-Control Can Mask Effects of Glucose on Self Control Performance in Experimental Paradigms that Use Identical Acts of Self-Control

Self-control is the capacity to supress thoughts, inhibit impulses, overcome temptations or change habits. Baumeister, Bratslavsky, Muraven and Tice (1998) proposed the ‘strength’ or ‘limited resource’ model of self-control in which self-control is conceptualized as a limited resource. A large number of laboratory studies (N > 200) have supported this hypothesis by demonstrating that participants whose self-control resources have been depleted by an initial act of self-control performed worse on a second act of self-control relative to participants whose self-control resources were not depleted by an initial act of self-control (Hagger et al., 2010). Tests of the model have typically adopted a dual-task paradigm in which participants engage in two consecutive tasks with an experimental group of participants receiving an initial (first) task that requires self-control while a control group receives a task that does not require self-control. Both groups then receive a second task requiring self-control exertion. Performance at the second act of self-control constitutes the dependent measure of self-control capacity. Critically, the two tasks are from different ‘domains’ of self-control consistent with the need to test a key property of self-control from the perspective of the strength model: that it is a generalised, universal resource that applies to multiple domains of self-control (Baumeister et al., 1998; Hagger, Wood, Stiff, & Chatzisarantis, 2010).

One important question related to the strength or limited resource model concerns the nature of the energy resource. Several researchers have proposed that glucose in the brain is the resource that supports self-control operations because mental effort, that is expended on a moment-by-moment basis during self-control operations, relies on adequate supply and availability of glucose in the brain (DeWall, Baumeister, Gailliot, & Maner, 2008; Gailliot et al., 2007). Consistent with this hypothesis, initial tests showed that engaging in self-control tasks coincided with reductions in blood glucose levels and that ingesting a glucose solution improved self-control performance among participants whose self-control resources have been depleted by a previous act of self-control (Gailiot et al., 2007; Masicampo & Baumeister, 2008; Wang and Dvorak, 2010). However, the glucose results were criticised for a number of reasons: glucose levels in the brain do not correlate well with blood glucose, the demand of self-control tasks on brain glucose is relatively modest, and brain glucose levels remain relatively stable (Beedie & Lane, 2011; Kurzban, 2010). In addition, there is evidence that the effect of ingesting glucose on self-control is statistically incredible. Schimmack (2012) pointed out that the probability of failing to obtain the pattern of results reported by Galliot et al. (2007) in a replication was greater than 99%. An alternative perspective has been promulgated by researchers who have demonstrated that the effects of glucose on self-control may be perceptual. Experiments demonstrated that rinsing the oral cavity with a glucose solution moderated the ego-depletion effect (Hagger & Chatzisarantis, 2013; Molden et al., 2012; Sanders et al., 2012). Hagger & Chatzisarantis (2013) argued that the effects were due to carbohydrate-sensitive receptor cells in the oral cavity sending afferent signals to the regions of the brain associated with motivation and the need for cognitive control, two areas likely to be implicated in successful self-control.

Recently, Lange and Eggert (2014) attempted to replicate glucose effects, both ingestion and rinsing, without success. In addition, using Schimmack's (2012) incredibility index, Lange and Eggert (2014) suggested that Hagger and Chatzisarantis' (2013) glucose rinsing findings may be due to 'luck' or selective reporting of positive results. Lange and Eggert (2014) also questioned the validity of the glucose model of self-control on the basis that there is strong evidence that contradicts this belief. The aim of the present article is to point out some limitations of Lange and Eggert's research design and incredibility index analysis.

A possible mechanism by which glucose increases ability for self-control is through activating brain regions that support self-control operations. However, glucose is only likely to improve self-control performance if people exert effort on a moment-to-moment basis, during self-control tasks. If individuals are unwilling to exercise self-control consistently when performing the task, then insufficient motivation may mask glucose effects – thus creating to experimenters the "illusion" that glucose does not influence self-control performance. Glucose may, therefore, increase an individuals' capacity to exercise self-control but this 'glucose advantage' may not be manifested in the results of empirical studies if depleted participants, who ingest or rinse their mouths with glucose, do not use this advantage because they are unwilling to exercise self-control.

The dual-task paradigm used to detect depletion requires that participants engage in two acts that belong to different spheres of self-control (Baumeister et al., 1998). For example, if the initial act of self-control involves thought control (trying to not think of a target word) the second act may involve impulse control (trying to not eat a delicious snack). Other than permitting researchers to test whether different acts of self-control consume energy from a common resource, this paradigm also allows researchers to eliminate the impact of cognitions or affective experiences, that develop during initial exposure to self-control tasks (i.e., boredom, low levels of self-efficacy), in affecting willingness to exert effort on the second self-control task (Fischer, Greitemeyer, & Frey, 2007; Wallace & Baumeister, 2002).

Considering the design features of this paradigm, Lange and Eggert's (2014) experiment exposed participants to the same act of self-control twice. As a consequence, their design failed to control for the impact of cognitions or affective experiences that develop during self-control operations, on willingness to exercise self-control. This methodology might have 'masked' the proposed glucose effects in their studies for a number of reasons.

The reasons include (i) development of response strategies that diminish the need to rely on self-control resources and, as a result, the need for glucose (Study 1); (ii) enhanced levels of boredom that participants might have experienced as a result of engaging in the same self-control task twice (Study 1); and (iii) low levels of optimism and self-efficacy that might have been developed as a result of receiving negative feedback (Study 2). These factors may have introduced confounds which masked the glucose effect on self-control in their experiments. Importantly, the experiments are inconsistent with the widely-used dual-task paradigm rife in the depletion literature. For their study to make a viable and robust test of the glucose effect, a high-powered, precise replication of an experiment using two separate tasks that have been previously adopted in the depletion literature seems to be the minimum criterion.

In addition, in Study 2, the task that Lange and Eggert (2014) used to induce depletion and measure self-control performance provided participants with negative feedback. However, negative feedback reduces effort by undermining confidence in ability to control task demands (Bandura, 1977). For example, negative feedback received during the first act of self-control might have undermined willingness to subsequently exercise self-control for the second act by undermining self-efficacy beliefs. It is important to note that negative feedback might have undermined willingness to exercise self-control by altering the subjective value of the self-control task (Muraven & Slessareva, 2003) and not necessarily by changing expectations related to whether or not people believe that self-control capacity is a limited (versus unlimited) resource (Job, Dweck, & Walton, 2010; Job Walton, Bernederk, & Dweck, 2013). This alternative hypothesis is plausible because cognitions and self-efficacy beliefs are more likely to generalise across similar than dissimilar tasks (Hattie & Timperley, 2007). Interestingly, Fischer, Greitemayer, and Frey (2007) showed that depleted participants reported lower levels of self-efficacy than non-depleted participants even when participants engaged in tasks that did not provide direct feedback.

Moreover, Lange and Eggert’s (2014) findings in Study 1 were inconsistent with Wang and Dvorak’s (2010) study concerning the effects of glucose ingestion on ego-depletion. However, there was one notable difference between these two studies that is worth mentioning because it often goes unnoticed in the ego-depletion literature. Specifically, both Lange and Eggert (2014) and Wang and Dvorak (2010) used a decision task which forced participants to choose between a large delayed reward or a smaller immediate reward. However, Wang and Dvorak’s (2010) participants were presented with rewards. This procedure facilitates a real “acquisition experience” which is ego-depleting (Hsee, Yang, Li, & Shen, 2009). That is, in Wang and Dvorak’s experiment the decision to discount monetary rewards was consequential as participants expected to receive a reward. In contrast, in Lange and Eggert’s (Study 1) participants *hypothetically* chose between a large delayed reward and a smaller immediate reward. Hence, participants’ decision to choose a delayed reward was less consequential (if at all) and hence ego depleting (see also Lange et al., 2014). Unfortunately, Lange and Eggert (2014) did not include a control group to examine whether their tasks were ego-depleting. This distinction between hypothetical decisions and real decisions is equivalent to Kahneman’s (1994) distinction between experienced utility and predicted utility and consistent with studies showing substantive inconsistencies between predicted experiences and real experiences (Hsee, Yang, Li, & Shen, 2008).

Lange and Eggert (2014) also criticised Hagger and Chatzisarantis’s (2013) findings on the basis of an ‘incredibility index’ analysis that contrasts number of statistically significant findings in reported studies against total power of the reported studies. Their analysis showed that the probability of not obtaining a pattern of results as reported by Hagger and Chatzisarantis (2013) was 98%. However, Lange and Eggert (2014) used a weighted average effect size (meta-analytic effect size; Hagger et al., 2010) to calculate the incredibility index. They omitted to report incredibility indexes that were calculated on the basis of observed or averaged effect sizes (see Schimmack, 2012). We re-ran the incredibility index analysis using the observed and averaged effect sizes from the individual studies in Hagger and Chatzisarantis' (2013) article and found the incredibility index to be as low as 78% (see Table 1). The reason for this difference is that the average power of studies that is calculated on the basis of individual effect sizes or averaged effect size is larger than the average power that is calculated on the basis of the weighted average effect size. These incredibility indexes are lower than those reported by Lange and Eggert (2014) and suggest that their dismissal of glucose effects on self-control performance is an overstatement.

In addition, a more relevant analysis would be to analyze the data to evaluate whether the effects were due to a 'small study' bias, which reflects the tendency for smaller studies to report larger effect sizes. One possible reason for the 'small study effects' may be publication bias, that is, the tendency for journals to favour and publish small, statistically significant but likely underpowered studies (see Hagger & Chatzisarantis, 2014). As Lange and Eggert (2014) claim that the glucose effect on depletion may be biased upward and the chances of finding so many significant effects improbable, it would make sense to test our analysis against this claim. We therefore applied two techniques based on funnel plots i.e. plotting the effect size against study precision: Egger and Sterne's (2005) regression technique and Duval and Tweedie's (2000) trim and fill. Egger and Sterne's regression analysis indicated little evidence of bias with a non-significant regression slope and Duval and Tweedie's trim and fill identified no 'missing' studies from the funnel plot. Both the analyses provide some evidence that the sample was not affected by bias. However, we must reiterate our claim in the meta-analysis that this is a very small sample of studies and that the tests alone do not provide definitive evidence for the presence or absence of bias. These caveats notwithstanding, these analyses do not support the claim that the effect of glucose supplementation on self-control is overestimated.

Despite the limitations we have outlined, we still think that Lange and Eggert's (2014) studies have made an important contribution to the literature. Their findings indicate that the methodology of using the same self-control task twice should be interpreted with caution when researchers test the ego-depletion effect and the glucose hypothesis. Although there are published studies that used the same self-control task (see Hagger et al., 2010), we think that researchers should use different tasks when testing novel hypothesis. To conclude that glucose drinks fail to counteract depletion of self-control resources, one has to make sure that depleted participants are sufficiently motivated to tap on self-control resources and hence capitalize on the glucose advantage. Unfortunately, the methodology of using identical tasks does not guarantee that depleted participants are sufficiently motivated to exercise self-control. Hence, Lange and Eggert's (2014) conclusion that the 'glucose effect' is delusionary is an overstatement because they adopted an experimental paradigm does not produce strong evidence that contradicts this belief. Our suggestion is that researchers who test the glucose hypothesis should employ dissimilar acts of self-control and make sure that depleted participants are sufficiently motivated to exercise self-control (Baumeister et al., 1998).

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Table 1. Incredibility index analysis for Hagger et al.'s (2012) experiments

				Power		
Study	N	*d*	Sig	WAVG	Individual	AVG
1	27	1.19 Means, d = .88 F-ratio, d = 1.12 F-RATIO V. CLOSE	1	.47	.84	.75
2	32	.91 Means d = 0.87 F-ratio, d = .87 V. CLOSE	1	.54	.70	.82
3	34	.70 Means = 0.69 F-ratio, d = .69 V. CLOSE	1	.56	.51	.84
4	23	1.67 Means, d = 0.71, F-ratio, d = 1.88 F-RATIO CLOSEST	1	.40	.97	.67
5	20	.77 Means, d = .79, F-ratio, d = .71 V. CLOSE	1	.36	.37	.60
Average	27.2	1.05	1	.47	.68	.78
Total power				.02	.15	.22
IC-index				.98	.85	.78

Note. *d* = individual effect sizes. WAVG = power calculated on the basis of weight average effect size (*d* = .75). Individual = power calculate on the basis of individual effect sizes. AVG = power calculated on the basis of average effect size (*d* = 1.05)