The effects of glucose on varying levels of ego depletion

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Thank you,

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Abstract

Social psychological studies have highlighted the importance of self-control in facilitating societal progress. In the early 1990s, the *strength model of self-control* was developed by Roy Baumeister. This model posited that acts of self-control draw on a unitary resource which, once depleted, impair subsequent self-control ability. More recent research conducted by Baumeister has looked at the role that glucose plays in counteracting the after-effects of self-regulatory acts – which he has termed ego depletion. The current study attempted to fill a lacuna in the extant literature on ego depletion by testing the attenuating effects of glucose on both mild and severe levels of ego depletion – previous research has focused almost exclusively on mildly depleted states. An experimental study was conducted to examine these effects. The study's results will be useful in elucidating a more precise understanding of how glucose functions in terms of self-regulation. The findings suggest that, in line with Baumeister's *strength model of self-control*, glucose attenuates the after-effects of ego-depletion in both the mild and severe states. This provides important counter-evidence to those who claim that, much like motivational thinking, glucose is only an effective moderator at mild levels of depletion. Implications of these findings are discussed and suggestions for future research are made.

Keywords: ego depletion; self-control; self-regulation; glucose; strength model; Roy Baumeister

Introduction

Self-control denotes an effortful attempt to alter one's cognitive, behavioural and/or affective response to a naturally occurring internal process in order to conform to societal or personal standards. That is to say, self-control occurs when one overrides a natural impulse or habitual response and replaces it with another, less dissonant, response, or no response at all (Baumeister, Heatherton, & Tice, 1994; Baumeister, Vohs, & Tice, 2007). From a neurobiological perspective, self-control involves neural activity in the prefrontal cortex – in particular, executive control is associated with activity in the dorsolateral prefrontal cortex (DL-PFC) and emotion regulation is associated with activity in the ventromedial-orbitofrontal cortex (vmPFC) and the anterior cingulate cortex (ACC; Banfield, Wyland, Macrae, Münte, & Heatherton, 2005; Hare, Camerer, & Rangel, 2009; Heatherton & Wagner, 2011). Self-control and self-regulation (terms which are used interchangeably in the extant literature) are highlighted as important areas of study when considering their empirical ties to an array of societal and individual progress, and indeed, regress. Studies of high levels of self-control have tied it to better academic performance (Duckworth & Seligman, 2005; Zimmerman, 2005), fewer impulse control problems, fewer psychopathological problems, higher levels of self-esteem, better family cohesion, as well as healthier lifestyles (Baumeister & Tierney, 2011; Mischel, Shoda, & Rodriguez, 1989; Tangney, Baumeister, & Boone, 2004). Conversely, an abundance of evidence has linked low levels of self-regulation with an increased propensity for criminality and violent behaviour (DeLisi, & Vaughn, 2008; Gottfredson & Hirschi, 1990; Piquero, Moffitt, & Wright, 2007), bullying (Unnever & Cornell, 2003), substance dependence, financial mismanagement (partly due to compulsive spending, borrowing, and gambling), as well as poorer overall health and academic achievements (even once social class and IQ are controlled for; Baumeister, Heatherton, & Tice, 1994; Baumeister & Tierny, 2011; Moffitt et al., 2011). These findings have led Baumeister, Heatherton, and Tice (1994) to the bold assertion that "[s]elf-regulation failure is *the* [emphasis added] major social pathology of the present time" (p. 3). Moreover, Moffitt and colleagues (2011, p. 2697) claim "their findings imply that innovative policies that put self-control center stage might reduce a panoply of costs that now heavily burden citizens and governments."

Self-regulation

Much of our current understanding of self-regulation stems from the seminal work of Carver and Scheier (1982) in which they outlined the 'feedback-loop theory,' in an attempt to elucidate an understanding of self-awareness. Feedback-loop theory is best explained by means of the acronym 'TOTE,' which stands for Test-Operate-Test-Exit. According to this model, one *tests* a certain aspect of the self in relation to a preconceived norm or aspiration; one then cognitively, behaviourally and/or affectively *operates* in an attempt to bring these two into alignment; one then *tests* again for any dissonance, and if there is none one is able to *exit* the 'loop' (Baumeister, 2000; Baumeister, Heatherton, & Tice, 1994). This theory presupposes that three elements are present: (1) norms, or an understanding of the way things ought to be (these could be societal, personal, or other); (2) monitoring capability, that is to say one must be able to assess any dissonance or lack thereof; and (3) a faculty that is able to bring about these changes by effortfully overriding the automatic processes (i.e. self-regulation; Baumeister & Heatherton, 1996; Baumeister, Heatherton, & Tice, 1994; Carver & Scheier, 2009). While there has been much scholarly work on automatic, that is to say effortless, self-regulation, these discussions go beyond the limits of this paper and thus the terms self-regulation and self-control will be used, interchangeably, solely to denote the effortful conception of self-regulation (for discussions on automatic self-regulation see Fishbach, 2009; Fitzsimons, Friesen, Orehek & Kruglanski, 2009; Sedikides, 2009). While the feedback-loop model goes a long way in outlining the contours of self-regulation, a key element, more specifically the precise way in which the *operate* phase functions, is left in need of a comprehensive explanation (Baumeister, 2000).

The strength model

In an attempt to fill this lacuna in our understanding of self-regulation, Baumeister, Heatherton, and Tice (1994) have spent the last two decades developing what they have termed the *strength model of self-regulation* which focuses precisely on the *operate* phase. The strength model, in its crude form, posits that the faculty for self-regulation draws on a limited resource that is used up by acts of self-regulation and thus becomes depleted, thereby impairing self-regulatory ability on subsequent tasks (Baumeister, Bratslavsky, Muraven & Tice, 1998). The understanding of self-regulation as that which is analogous with energy and the expenditure thereof dates back to Freud's postulation that civilised behaviour became possible once the ego was able to harness energy from the id and convert it into a superego –

the superego then potentiated the restraint of undesirable impulses (Freud, 1923/1927; Gailliot & Baumeister, 2007). Much of the theoretical work which came after Freud disregarded energy models for not being able to provide an intelligible understanding of self-regulation; however this has seen a revised comeback with the work of Baumeister, Heatherton, and Tice (1994). Baumeister, Vohs, & Tice (2007) have made the analogy between self-control and a muscle – much like a muscle, they claim our capacity for self-control can become tired (or diminished), strengthened (through targeted exercise), and indeed replenished. The state wherein the self-regulatory faculty's limited resource becomes diminished has been termed 'ego depletion,' in tribute to Freud (Baumeister, Bratslavsky, Muraven & Tice, 1998). While in its crude form the strength model claimed that ego depletion was a result of a diminishment of the energy resource needed for self-regulation, in light of new evidence this has been revised to assert that ego depletion occurs as a result of the automatic response to conserve available resources once they have been used, which results in subsequent impaired self-regulatory ability (Muraven & Slessareva, 2003; Muraven, Shmueli & Burkley, 2006). Although studies suggest that the resource for self-regulation is potentially limitless, the natural response to conserve this resource produces the effects of ego depletion after self-regulatory activity is performed (Baumeister & Vohs, 2014; Muraven, Shmueli & Burkley, 2006).

Ego depletion

Many studies have been conducted which provide evidence to support the concept of ego depletion. Most of these studies have followed a similar design whereby two independent and dissimilar tasks are performed, one after the other (known as the dual-task paradigm). In the experimental group both of these tasks require self-control and in the control group self-control is only required by the second task. The tasks are drawn from a variety of self-regulatory domains such as impulse and attentional control, affect regulation, and performance optimization (Gailliot & Baumeister, 2007). A meta-analysis of 83 ego depletion studies found that participants who completed an initial self-regulatory task performed significantly worse on the second self-regulatory task, when compared to a control group whose initial task did not require self-regulation. Furthermore, the meta-analysis found a moderate to large effect size of d=.62 for dual-task studies of ego-depletion (Haggar, Wood, Stiff, & Chatzisarantis, 2010). These findings provide support for the strength model by

suggesting that self-regulation draws on a unitary resource which, once used, is conserved for future use, thereby impairing subsequent self-regulation (Baumeister & Vohs, 2014).

Ego depletion has also been tied to an overall subdual of executive, top-down mental functioning but has no such impact on automatic, bottom-up mental functioning. In fact, automatic mental functioning has been shown to increase during depleted states as it is subjected to less inhibitory control by the depleted executive function – this goes some way in explaining the self-regulation failure which is typical in states of ego depletion (Heatherton & Wagner, 2011; Hofmann, Raunch, & Gawronski, 2006; Schmeichel, Vohs, & Baumeister, 2003).

Offsetting depletion

There have been a number of laboratory studies which have shown that self-affirmation (Schmeichel & Vohs, 2009), personal prayer (Friese & Wänke, 2014), the belief that willpower is unlimited (Job, Dweck, & Walton, 2010), and inducing positive affect and motivation (Shmueli & Prochaska, 2012) have attenuated the effects of ego depletion in dual-task studies. These findings have provided significant challenges to the strength model by arguing that if the after-effects of depletion can be offset by certain cognitive and affective strategies, then the so-called unitary resource might not actually exist. Defenders of the strength model have appealed to studies (DeWall, Baumeister, Mead, & Vohs, 2012; Vohs, Baumeister, & Schmeichel, 2012) which suggest that rather than counteracting ego depletion (in the sense of replenishing a diminished resource), these strategies merely incentivise the participant to continue to perform *in spite of their depleted state*, thereby causing greater depletion later on (i.e. these strategies postpone and exacerbate ego depletion, rather than counteracting it; Baumeister & Vohs, 2014).

Glucose and ego depletion

In contrast to the aforementioned temporary strategies of overcoming ego depletion, studies have suggested that glucose is capable of actually *counteracting* the after-effects of depletion – suggesting that it constitutes a key element of the unitary resource underlying self-control (Haggar, Wood, Stiff, & Chatzisarantis, 2010). Natural experimental studies have indicated that self-regulation failure is more likely to occur at times of the day when glucose levels are low (Gailliot & Baumeister, 2007). This finding has serious and far-reaching implications – studies have shown that in Israeli parole judgements, “when judges

make repeated rulings, they show an increased tendency to rule in favor of the status quo [i.e. no parole]" and that "[t]his tendency can be overcome by taking a break to eat a meal, consistent with previous research demonstrating the effects of … glucose on mental resource replenishment" (Danziger, Levav, & Avnaim-Pesso, 2011, p. 6892). Furthermore, doctors have been shown to overprescribe antibiotic medication during times of the day when glucose depletion is at its peak (Linder et al., 2014). These findings seem to shift the use of the term 'energy' within the strength model from a metaphor to something more physiologically concrete.

Indeed, there is an ever-expanding evidence base in support of the assertion that glucose constitutes a key substrate of the physiological 'energy source' underlying self-regulation. Three key findings were made through a series of experimental studies conducted by Gailliot and colleagues (2007): (1) that blood-glucose levels are demonstrably reduced following acts which require self-control; (2) that low blood-glucose levels predict poor performance on tasks which require self-control and that higher blood-glucose levels predict better such performance; and (3) that administering glucose to participants mitigated or eliminated the effects of mild ego depletion. These findings have been replicated in a number of subsequent laboratory studies (e.g. Masicampo & Baumeister, 2008; McMahon & Scheel, 2010; Wang & Dvorak, 2010). Moreover, a plethora of multi-method studies have corroborated these findings across a variety of self-control domains (Gailliot & Baumeister, 2007). For example, research has linked low levels of glucose and hypoglycaemia (abnormally low blood-glucose levels) to: poorer concentration (Smid et al., 1987); reduced vigilance (Benton, 1990); emotion regulation failure (Meijer, 1984; Barglow, Hatcher, Edidin, & Sloan-Rossiter, 1984); and increased criminality and delinquency (Matykiewicz, Le Grange, Vance, Wang, & Reyes, 1997; Virkkunen, De Jong, Bartko, Goodwin, & Linnoila, 1989). In sum, there is a significant amount of converging evidence which points to the centrality of glucose in self-control.

However, these findings faced a noteworthy challenge when a study showed that merely swirling glucose around one's mouth and then spitting it out also produced counteracting effects (Molden et al., 2012). An explanation of this finding is that, much like the belief in unlimited willpower, the taste of glucose could signal that more is on the way and thus eliminate the need to conserve energy and consequently postpone and exacerbate the effects of depletion (Baumeister & Vohs, 2014). The question of whether ingesting glucose

merely postpones the effects of ego depletion or whether it actually counteracts it remains an area in the study of the strength model which requires further research. In order to assess the true nature of glucose dynamics in self-control, the effects of glucose on severe levels of ego depletion, which are currently unknown, need to be determined (Baumeister & Vohs, 2014).

Degrees of depletion

It would follow from the presuppositions of the strength model that there exists varying degrees or levels of depletion relative to the amount of resource expended. That is to say, one would expect a task requiring little self-control to produce less subsequent impairment to self-control in comparison to the impairment caused by multiple tasks which require significant self-control (Baumeister & Vohs, 2014). Studies have shown some qualitative and quantitative differences at varying levels of depletion (Choi & Fishbach, 2011). However, the vast majority of studies have focused solely on mildly depleted states, leaving a paucity in the extant literature on severely depleted states. An experiment conducted by Vohs, Baumeister, and Schmeichel (2012) attempted to study the effects of motivational thinking on both mild *and* severe levels of ego depletion (the first study of its kind to include a severely depleted condition). The study found that whilst ego depletion was moderated by motivational thinking in the mildly depleted conditions, the severely depleted condition showed no such moderation. Moreover, it was found that motivational thinking worsened ego depletion in the severely depleted conditions (Vohs, Baumeister, & Schmeichel, 2012). The failure of motivational thinking to attenuate severe ego depletion constitutes further evidence that such cognitive and affective strategies do not address the root of self-control and that, in contradistinction, they merely postpone and exacerbate ego depletion. To date, there have been no published studies which show moderation of severe ego depletion (Baumeister & Vohs, 2014). Thus the question remains: is severe depletion capable of moderation?

Addressing the gap

As highlighted above, both glucose's role in moderating the after-effects of depletion and the possibility for such moderation within severely depleted states remains under-researched in the extant literature on the *strength model of self-regulation*. Research into these issues will be helpful in forwarding our understanding of self-regulation and will both answer and raise important questions (R. Baumeister, personal communication, March 7,

2014). Among these are: Will glucose, much like motivational thinking, only be capable of moderation at mildly depleted states? And, are severely depleted states capable of moderation? The answers to these questions will certainly begin to address the lacuna.

Aims and hypotheses

The primary objectives of the present study were to assess the impact of glucose on varying levels of ego depletion. The hypotheses that were tested are as follows:

1) Once ego depleted, a group administered with glucose will perform better than a placebo group on subsequent tests of self-control.
2) Severely depleted participants will perform worse on post-tests of self-control trials than mildly depleted participants.
3) The effects of the administration of the intervention (glucose or placebo) on self-regulation will differ between the mildly and severely depleted groups.

Method

Design

The study used a 2X2 experimental design. The independent variables were level of depletion (mild and severe) and type of intervention (glucose or placebo). The dependant variable was self-regulation measured by how well the participant performed in terms of speed and accuracy on sixty post-test Stroop trials, whilst controlling for their performance on sixty pre-test Stroop trials.

Participants

The study used convenience sampling and acquired participants through the University of Cape Town's Student Research Participant Programme (SRPP; see SRPP invitation in APPENDIX A). Participants received 2 SRPP points for agreeing to take part in the study – a duly performed requirement for undergraduate psychology students. To rule out confounds and to ensure participant safety, potential participants who were diabetic and/or glucose intolerant were excluded from participating in the study. In total 120 students (103 female), with a mean age of 20.43, participated in the study. The sex distribution of participants in the study is typical of undergraduate psychology students. No participants objected to taking part in the study and none withdrew from the study.

Materials/measures

Stroop test. A Stroop test which is available online was used in both the mildly and severely depleted groups as a pre- and post-test of self-control. In the Stroop test, the names of colours appeared on the screen and would either appear in the colour that the word spelt out or another colour. Participants were tasked with typing the first letter of the colour of the word rather than the word itself. The precise word-colour combinations differed between the sixty pre- and post-test trials so as to mitigate pre-test effect. The test measured participants on both average speed to respond (in milliseconds) and accuracy (in percentage of correct trials). Stroop trials have been consistently used as a dependant measure in studies of ego depletion (Gailliot et al., 2007; Haggar, Wood, Stiff, & Chatzisarantis, 2010).

Video clip. A silent video clip of a woman talking was used as a means to deplete participants' self-control (R. Baumeister, personal communication, May 6, 2014). During the 6 minute video, monosyllabic words individually appeared on the bottom left-hand corner of the screen for 10 seconds at a time. Participants were tasked with focusing on the woman's face whilst averting their eyes away from the monosyllabic words. This precise video is a frequently used task in ego depletion studies as it has been shown to require much self-control to constantly redirect one's attention away from the words and to focus solely on the woman (Gailliot et al., 2007; Haggar, Wood, Stiff & Chatzisarantis, 2010). This video clip was shown in both the mildly and severely depleted experimental conditions.

Editing text task. In the severe depletion conditions, a task which requires additional self-regulation was administered. This task is what made the participants in this condition 'severely depleted' (in line with the other study which included a severely depleted condition; Vohs, Baumeister, & Scheicher, 2012). The task required participants to edit a four-page article by crossing out the letter 'e' every time it appeared on the first two pages (APPENDIX B). Once they had completed the first two pages, and a pattern had been established, the participants were required to cross out the letter 'e' on pages three and four in all cases except when a vowel appeared two letters prior to, or immediately after, the 'e.' This task has been used on a number of self-control studies as it has been shown to require substantial self-control to search for each 'e' and to change ones pattern of editing halfway through the exercise (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Haggar, Wood, Stiff & Chatzisarantis, 2010; Vohs, Baumeister, & Schmeichel, 2012).

Lemonade. In line with much of the research focused on studying the interplay between glucose and ego depletion (e.g. Gailliot et al., 2007; Masicampo & Baumeister, 2008), lemonade was administered to the participants so as to manipulate their blood-glucose levels. Two batches of lemonade were made, one sweetened with ordinary white sugar (40 grams per cup; which increases blood-glucose levels) and the other sweetened with a sugar substitute (which has a negligible effect on blood-glucose levels). The former was administered in the experimental condition and the latter in the placebo condition.

Filler questionnaire. A filler questionnaire, which contained thirty extraneous questions and one question pertaining to enjoyment of the lemonade, was administered (APPENDIX C). This questionnaire was important primarily as a time filler to allow for the glucose to be metabolized to the brain, which, as studies have shown, takes approximately ten minutes (Donohoe & Benton, 1999). Additionally, the questionnaire helped to assess any differences in enjoyment of the experimental and placebo drinks. The same questionnaire which was used in McMahon and Scheel's (2010) study on ego depletion was obtained and used in the present study (M. Scheel, personal communication, May 13, 2014). The questionnaire was slightly revised so as make it more applicable to South African participants. Apart from one item ("How pleasant was the beverage you drank?"), none of the items of the questionnaire were analysed.

Ethical considerations

The study was granted ethical approval by the University of Cape Town's Research ethics committee before the study commenced (APPENDIX D). Because there was a chance that glucose would be administered, participants who were diabetic or glucose intolerant were not permitted to take part in the study. So as to ensure anonymity, participants were assigned participant numbers which were used in the data collection – their names were stored separately and used only so as to allocate SRPP points.

Procedure

An advert was sent out to all undergraduate psychology students (APPENDIX A) inviting them to take part in the study. Students who showed further interest were asked to sign up for prearranged timeslots.

Participants arrived at a UCT computer laboratory at their designated timeslots in groups of five to fifteen and sat behind allocated computers where they were assigned

participant numbers. Participants were informed that the study intended to find out more about the interaction between cognitive performance and food. They were then asked to read and sign the informed consent form (APPENDIX E). Participants were then reminded that anyone with diabetes or a glucose intolerance was not permitted to take part in the study.

Next, participants were instructed to complete sixty Stroop trials, and their results were noted. Both the mildly and severely depleted groups were instructed to watch the six minute silent video. The participants were told to focus solely on the woman who was talking and to refrain from looking at the words which appeared in the bottom-left corner of the screen. At the end of the video, the mildly depleted group were instructed to drink the lemonade (which was sweetened with either glucose or a placebo – single-blind).

Before drinking the lemonade, the severely depleted group were instructed to complete the additional 'editing text' task (APPENDIX B). In this task each participant was given four pages of text with clear instruction on the first page. Additionally, the instructions were read out by the experimenter. On the first two pages, the participants were instructed to cross out the letter 'e' each time it appeared. On the third and fourth page, the participants were required to cross out the letter 'e' in all instances except when it appeared one letter before, or two letters after, a vowel. Once completed, they were instructed to drink the lemonade (which was either the glucose or placebo - single-blind).

Once the lemonade was consumed, each participant received the filler questionnaire and completed it.

Once fifteen minutes had passed, participants were instructed to perform sixty more Stroop trials on the computer. The participants' Stroop trial results were recorded. The participants were then debriefed and were given educational feedback on the experiment and its aims. The experiment was then drawn to a close. A flow chart of the experimental procedure is provided in *Figure 1*.

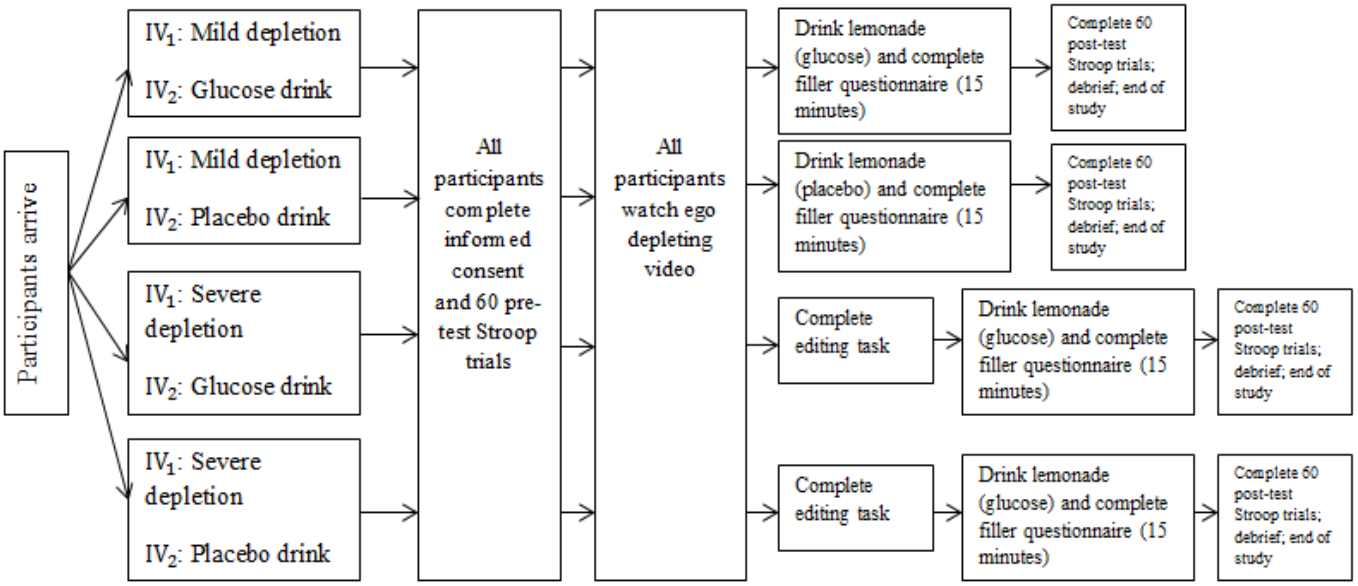

Figure 1. A flow chart depicting the experimental procedures of the four experimental conditions.

Data management and statistical analyses

All data was analysed using the statistical software package IBM SPSS Statistics, version 22. The significance level was set at α=.05.

Accuracy. First, the accuracy results for the pre- and post-Stroop trials were analysed. Participants attained a mean pre-test accuracy of 94.9% (*SD*=9.86) and a mean post-test accuracy of 97.65% (*SD*=6.75; see *Table 1*). It was clear that a ceiling effect was present and the accuracy data for the Stroop trials was thus not useful for the analysis. In line with previous studies which found a ceiling effect for accuracy results in Stroop trials (e.g. Strauss, Allen, Jorgensen, & Cramer, 2005), the post-test response time measure was used as the sole dependant variable. Before discarding the accuracy results it was important to assess if there was any speed-accuracy trade-off which would confound the results. An analysis of covariance, which controlled for accuracy results, was conducted. The main effect of glucose (expanded on in the results section below) remained significant ($F(1, 113)=6.15$, $p=.015$) even after accuracy was included - indicating no speed-accuracy trade-off (Gailliot et al., 2007).

Table 1

Descriptive statistics of accuracy

	N	Minimum	Maximum	Mean	Std. Deviation
accuracypre	120	40.68	100.00	94.9015	9.85828
accuracypost	120	46.57	100.00	97.6541	6.75253
Valid N (listwise)	120				

Pre- and post-test Stroop trial response times. The response times were captured in milliseconds and this data was then winsorised and transformed (logarithmic) so as to encourage normal distribution and homogeneity of variance (Clark-Carter, 2010; Field, 2009; Tabachnick & Fidell, 1989). When its assumptions are met, an analysis of covariance (ANCOVA) is widely regarded as the appropriate methods for analysing the data of pre- and post-test experimental designs as it is capable of determining mean differences between groups based on the independent variables whilst adjusting for differences in pre-test scores (i.e. the covariates; Cardinal & Aitken, 2006; Clark-Carter, 2010; Huck & McLean, 1975; Tabachnick & Fidell, 1989).

Checking the assumptions of ANCOVA. The level of measurement and sample size requirements were satisfied (*Table 2*). All cell sizes were equal and there was no missing data (*Table 2*).

Table 2

Between-Subjects Factors

		Value Label	N
glucose	0	placebo	60
	1	glucose	60
severe	.00	mild	60
	1.00	severe	60

The assumption of normality was tested (*Table 3, Figures 2 & 3*) and all results of the Kolmogorov-Smirnov test (with Lillierfors significance correction) were not significant – indicating normality. However, the results of the pre-test data produced a significant (p=.04) result on the Shapiro-Wilks test of normality. When group sizes are equal, ANCOVA is considered robust to violations of the normality assumption and the power of F has been shown to go largely unaffected by non-normality (Donaldson, 1968; Field, 2009; Lunney,

1970; Tabachnick & Fidell, 1989). Considering that the assumption of normality was not violated when the Kolmogorov-Smirnov test was performed and that the Q-Q plots indicate relatively normal distributions (*Table 3, Figures 2 & 3*), the analysis was continued.

Table 3

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pre_log_pooled	.071	120	.200*	.977	120	.040
post_log_pooled	.073	120	.177	.987	120	.311

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

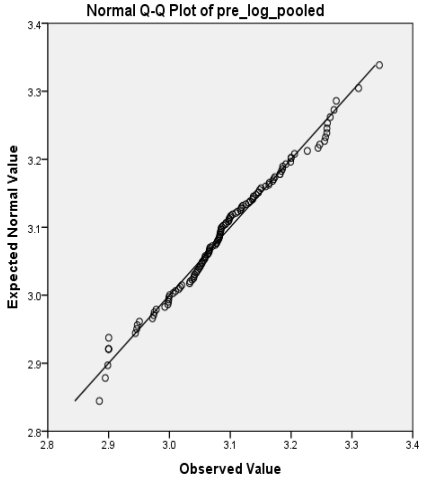

Figure 2. Q-Q plots for pre-test response time data.

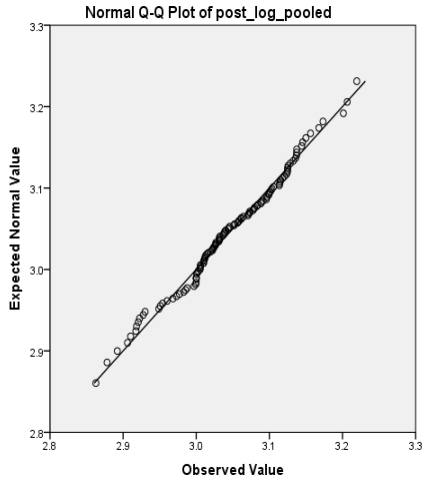

Figure 3. Q-Q plots of post-test response time data.

The assumption of homogeneity of variance was upheld – Levene's test of equality of error variances (*Table 4*) was not significant (p=.065; Field, 2009).

Table 4

Levene's Test of Equality of Error Variances [a]

Dependent Variable: post_log_pooled

F	df1	df2	Sig.
2.480	3	116	.065

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + pre_log_pooled + glucose + severe + glucose * severe

The test of linearity (*Table 5*) confirmed that the assumption of linearity was upheld, $F(1, 113)=42.56$, $p<.001$. Finally, the ANCOVA assumption of homogeneity of regression slope was upheld – the interaction term (glucose*severe*pre_log_pooled) was not significant, $F(3,113)=.384$, $p=.765$ (*Table 6*). It was decided that an ANCOVA was appropriate and the analysis, reported below, was run.

Table 5

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
post_log_pooled * pre_log_pooled	Between Groups	(Combined)	.602	114	.005	3.219	.094
		Linearity	.070	1	.070	42.559	.001
		Deviation from Linearity	.532	113	.005	2.870	.118
	Within Groups		.008	5	.002		
	Total		.610	119			

Table 6

Tests of Between-Subjects Effects

Dependent Variable: post_log_pooled

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	.402	1	.	.	.
	Error	.	.[a]	.		
glucose	Hypothesis	.004	1	.004	.819	.367
	Error	.503	113	.004[b]		
severe	Hypothesis	.001	1	.001	.283	.596
	Error	.503	113	.004[b]		
pre_log_pooled	Hypothesis	.092	1	.092	20.665	.000
	Error	.503	113	.004[b]		
glucose * severe * pre_log_pooled	Hypothesis	.005	3	.002	.384	.765
	Error	.503	113	.004[b]		

a. Cannot compute the error degrees of freedom using Satterthwaite's method.

b. MS(Error)

Pleasantness of the lemonade. Additionally, the means of the pleasantness of lemonade scores were run through a one-way ANOVA, all assumptions were met (APPENDIX F: *Tables 7, 8, & 9*).

Results

Stroop trial response times

A 2x2 ANCOVA was performed on post-test Stroop trial response times. Independent variables consisted of intervention (placebo and glucose) and level of depletion (mild and severe). The covariate was pre-test Stroop trial response time.

The results of the ANCOVA showed that the covariate was significantly related to the post-test Stroop trial response time, $F(1, 115)=22.05$, $p<.001$, $\eta_p^2 = .16$ (*Table 10*). There was also a significant main effect of intervention (glucose vs. placebo) on the post-test results, $F(1, 4.3)=18.89$, $p<.01$, $\eta_p^2 = .82$, after controlling for the effects of the pre-test. Neither the main effect of level of depletion (mild vs severe) nor the interaction effect was statistically significant.

By looking at the estimated marginal means (*Table 11*) it is evident that, when comparing the two intervention groups (glucose vs. placebo) and after controlling for the

differences in pre-test response time, the glucose group performed significantly better (that is to say they had faster response times) than the placebo group at the post-test, regardless of their state of depletion (mild or severe). The partial eta squared indicated that the intervention accounted for approximately 82% of the total variance in the post-test result (Field, 2009). However, it produced a relatively small effect size of *r*=.15 (Field, 2009).

Table 10

Tests of Between-Subjects Effects

Dependent Variable: post_log_pooled

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	Hypothesis	.402	1	.402	90.533	.000	.438
	Error	.516	116.152	.004[a]			
pre_log_pooled	Hypothesis	.097	1	.097	22.049	.000	.161
	Error	.508	115	.004[b]			
glucose	Hypothesis	.026	1	.026	18.894	.010	.815
	Error	.006	4.301	.001[c]			
severe	Hypothesis	.008	1	.008	10.923	.253	.937
	Error	.001	.739	.001[d]			
glucose * severe	Hypothesis	.001	1	.001	.178	.674	.002
	Error	.508	115	.004[b]			

a. .001 MS(glucose) + .001 MS(severe) - .001 MS(glucose * severe) + .999 MS(Error)

b. MS(Error)

c. .838 MS(glucose * severe) + .162 MS(Error)

d. 1.026 MS(glucose * severe) - .026 MS(Error)

Table 11

Estimates

Dependent Variable: post_log_pooled

glucose	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
placebo	3.062[a]	.009	3.044	3.080
glucose	3.030[a]	.009	3.012	3.048

a. Covariates appearing in the model are evaluated at the following values: pre_log_pooled = 3.0915.

Pleasantness of the lemonade

The results of a one-way ANOVA (*Table 12*) on the participants' pleasantness of the lemonade ratings (1=pleasant, 7=unpleasant) indicated that the placebo (M=3.54, SD=1.72) and glucose (M=3.12, SD=1.63) groups did not differ significantly on their ratings, $F(1,118)=1.86$, $p=.176$. This indicates that the participants did not prefer one drink over another.

Table 12

ANOVA

pleasantness

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.208	1	5.208	1.856	.176
Within Groups	331.117	118	2.806		
Total	336.325	119			

Discussion

The present study set out to explore the effects of glucose administration on both mild and severe levels of ego depletion. This was done so as to further our understanding of severely depleted states and to determine glucose's efficacy in counteracting them - an area which had gone significantly under-researched in previous studies. This study has confirmed its first hypothesis by showing that participants who received glucose, in both the mild and severe conditions, performed significantly better than the placebo group in post-tests of self-control. These findings provide corroborating evidence for the basic claim that glucose plays an important role in self-control. Moreover, the findings suggest that, unlike cognitive and affective strategies such as motivational thinking, glucose is capable of moderating the after-effects of self-regulation (ego depletion) at both mild *and* severe levels – a novel finding. This finding is an important contribution to the ever-expanding empirical basis for Baumeister's *strength model of self-regulation* which posits that effortful self-regulation and decision-making draw on a unitary resource. Once acts of self-regulation are performed, the unitary resource is conserved, thereby hampering subsequent self-regulatory ability (i.e. ego depletion); however, a dose of glucose can moderate these after-effects. Although it may seem attractive to declare glucose to itself be this unitary resource, this would be premature. For example, studies have suggested other physiological factors, such as heart rate variability, to be important in self-regulation (Baumeister & Vohs, 2014; Segerstrom & Nes, 2007).

Nonetheless, it is clear that glucose is capable of moderating ego depletion and it thus constitutes a key element of self-control. Further research is required to delineate glucose's precise workings in the brain and other organs such as the liver, and their interaction with self-control (Baumeister & Vohs, 2014).

The study's second hypothesis - that the severely depleted group would perform worse than the mildly depleted group - was not confirmed. Participants in the mildly and severely depleted conditions showed similar patterns of performance on the post-test within both the placebo and glucose conditions. The failure to find a statistically significant 'severely depleted' group constitutes a limitation of the present study. It follows that the additional editing task, which was given to the 'severely depleted' participants so as to further deplete them, was insufficient. Given that experimental research into severe ego depletion is relatively unchartered territory, methodological shortcomings are to be expected. Nonetheless, this study constitutes an important guide for future research aimed at furthering our understanding of severe ego depletion. These future studies ought to include more than one additional task requiring self-control so as to ensure that participants in the severely depleted condition are quantitatively more depleted than those in the mildly depleted condition.

Moreover, the use of almost exclusively female undergraduate psychology students as participants constitutes another limitation of the present research. Sears (1986) commented on the "narrow data base" (p. 515) which is common among many social psychological experimental studies. In these studies, university "student subjects [are] tested in the academic laboratory with academiclike [sic] materials" (Sears, 1986, p. 515). Indeed, the use of a fairly homogenous, relatively affluent, and educated group of participants poses a threat to the external validity of the study's findings (Gordon, Slade, & Schmitt, 1986; Lucas, 2003). Future research into self-control and glucose dynamics should avoid this problem by ensuring demographic diversity among participants.

Conclusions

Self-control is central to overall individual and social well-being. High levels of self-control have been linked to increased health, wealth, and overall prosperity (Tangney, Baumeister, & Boone, 2004). In contradistinction, the propensity for self-control failure – which occurs in states of ego depletion – has been tied to increased criminality, violence, impulsivity, as well as substance abuse and eating disorders (Baumeister, Heatherton, & Tice,

1994; Baumeister, Vohs, & Tice, 2007; Tangney, Baumeister, & Boone, 2004). These findings serve to highlight the importance of studying self-control and discovering its inner workings. The strength model of self-control - which posits that a unitary resource underlies all self-control and that expending this resource leads to ego depletion - is by far the most comprehensive and promising account of human volition to date. Only fairly recently, since Gailliot and colleagues (2007) published their study on glucose dynamics, has glucose been demonstrated as a key substrate of the unitary resource underlying self-control. The findings of subsequent studies have supported this proposition. Whilst these studies made the astonishing finding that levels of self-control were linked to blood-glucose levels and that mild ego depletion was capable of moderation by administering glucose, the potential for moderation at severe levels remained unknown. The present study attempted to address this heretofore neglected area of ego depletion research by assessing the impact of glucose on severe ego depletion. In sum, its contribution lies in its incorporation of a severe level of ego depletion to test the moderating effects of glucose. Only one other study (Vohs, Baumeister, & Schmeichel, 2012) has attempted to include a severely depleted condition – however, this study did not examine glucose dynamics. By further establishing the hypothesis that glucose is capable of counteracting ego depletion, this study serves to improve our understanding of self-control more generally. In turn, the application of this enriched understanding will contribute to ongoing efforts - from within the *strength model of self-control* - aimed at enhancing the remediation and prevention of criminal and antisocial behaviours (Baumeister, 2013), strengthening dieting programmes (Hofmann, Adriaanse, Vohs, & Baumeister, 2014), ensuring more objective parole judgements (Danziger, Levav, & Avnaim-Pesso, 2011), reducing the overprescription of medication (Linder et al., 2014), and improving the treatment of addiction (Baumeister & Vonasch, 2014). To date, the strength model has proven its utility in enhancing our understanding of a wide array of both positive and negative social phenomena. This enhanced understanding has facilitated much-needed improvement in our intervention strategies. Continued research into self-control will undoubtedly produce further significant advancements in both theory and praxis.

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APPENDIX A

SRPP invitation

Dear Psychology students

My name is Gary Ganz and I am currently running a study on the interaction between food and performance. You are invited to take part in my study in exchange for 2 SRPP points which form part of your DP requirements for Psychology undergraduate courses.

The study will entail consuming a beverage and performing a few cognitive tasks.

There is a chance that you will have to consume a beverage with glucose in it. Because of this, all potential participants who are diabetic or glucose intolerant are not allowed to take part in the study.

The entire experiment will take approximately 35 minutes to complete.

If you have any questions, or would like to take part in the study please email me on garyganz@gmail.com

Thanking you in advance

Gary Ganz

Psychology Honours student

UCT

APPENDIX B

Editing task

INSTRUCTIONS:

On the first two pages cross out the letter ‘e’ every time it appears. On the third and fourth page cross out the letter ‘e’ every time it appears **except** when it comes right before a vowel or when it appears two letters before a vowel.

Can Civilization Survive Capitalism?

Noam Chomsky

Alternet, March 5, 2013

The term "capitalism" is commonly used to refer to the U.S. economic system, with substantial state intervention ranging from subsidies for creative innovation to the "too-big-to-fail" government insurance policy for banks.

The system is highly monopolized, further limiting reliance on the market, and increasingly so: In the past 20 years the share of profits of the 200 largest enterprises has risen sharply, reports scholar Robert W. McChesney in his new book "Digital Disconnect."

"Capitalism" is a term now commonly used to describe systems in which there are no capitalists: for example, the worker-owned Mondragon conglomerate in the Basque region of Spain, or the worker-owned enterprises expanding in northern Ohio, often with conservative support -- both are discussed in important work by the scholar Gar Alperovitz.

Some might even use the term "capitalism" to refer to the industrial democracy advocated by John Dewey, America's leading social philosopher, in the late 19th century and early 20th century.

Dewey called for workers to be "masters of their own industrial fate" and for all institutions to be brought under public control, including the means of production, exchange, publicity, transportation and communication. Short of this, Dewey argued, politics will remain "the shadow cast on society by big business."

The truncated democracy that Dewey condemned has been left in tatters in recent years. Now control of government is narrowly concentrated at the peak of the income scale, while the large majority "down below" has been virtually disenfranchised. The current political-economic system is a form of plutocracy, diverging sharply from democracy, if by that concept we mean political arrangements in which policy is significantly influenced by the public will.

There have been serious debates over the years about whether capitalism is compatible with democracy. If we keep to really existing capitalist democracy -- RECD for short -- the question is effectively answered: They are radically incompatible.

It seems to me unlikely that civilization can survive RECD and the sharply attenuated democracy that goes along with

it. But could functioning democracy make a difference?

Let's keep to the most critical immediate problem that civilization faces: environmental catastrophe. Policies and public attitudes diverge sharply, as is often the case under RECD. The nature of the gap is examined in several articles in the current issue of Daedalus, the journal of the American Academy of Arts and Sciences.

Researcher Kelly Sims Gallagher finds that "One hundred and nine countries have enacted some form of policy regarding renewable power, and 118 countries have set targets for renewable energy. In contrast, the United States has not adopted any consistent and stable set of policies at the national level to foster the use of renewable energy."

It is not public opinion that drives American policy off the international spectrum. Quite the opposite. Opinion is much closer to the global norm than the U.S. government's policies reflect, and much more supportive of actions needed to confront the likely environmental disaster predicted by an overwhelming scientific consensus -- and one that's not too far off; affecting the lives of our grandchildren, very likely.

As Jon A. Krosnick and Bo MacInnis report in Daedalus: "Huge majorities have favored steps by the federal government to reduce the amount of greenhouse gas emissions generated when utilities produce electricity. In 2006, 86 percent of respondents favored requiring utilities, or encouraging them with tax breaks, to reduce the amount of greenhouse gases they emit. Also in that year, 87 percent favored tax breaks for utilities that produce more electricity from water, wind or sunlight [These majorities were maintained between 2006 and 2010 and shrank somewhat after that.

The fact that the public is influenced by science is deeply troubling to those who dominate the economy and state policy.

One current illustration of their concern is the "Environmental Literacy Improvement Act" proposed to state legislatures by ALEC, the American Legislative Exchange Council, a corporate-funded lobby that designs legislation to serve the needs of the corporate sector and extreme wealth.

The ALEC Act mandates "balanced teaching" of climate science in K-12 classrooms. "Balanced teaching" is a code phrase that refers to teaching climate-change denial, to "balance" mainstream climate science. It is analogous to the "balanced teaching" advocated by creationists to enable the teaching of "creation science" in public schools. Legislation based on ALEC models has already been introduced in several states.

Of course, all of this is dressed up in rhetoric about teaching critical thinking -- a fine idea, no doubt, but it's easy to think up far better examples than an issue that threatens our survival and has been selected because of its importance in terms of corporate profits.

Media reports commonly present a controversy between two sides on climate change.

One side consists of the overwhelming majority of scientists, the world's major national academies of science, the

professional science journals and the Intergovernmental Panel on Climate Change.

They agree that global warming is taking place, that there is a substantial human component, that the situation is serious and perhaps dire, and that very soon, maybe within decades, the world might reach a tipping point where the process will escalate sharply and will be irreversible, with severe social and economic effects. It is rare to find such consensus on complex scientific issues.

The other side consists of skeptics, including a few respected scientists who caution that much is unknown -- which means that things might not be as bad as thought, or they might be worse.

Omitted from the contrived debate is a much larger group of skeptics: highly regarded climate scientists who see the IPCC's regular reports as much too conservative. And these scientists have repeatedly been proven correct, unfortunately.

The propaganda campaign has apparently had some effect on U.S. public opinion, which is more skeptical than the global norm. But the effect is not significant enough to satisfy the masters. That is presumably why sectors of the corporate world are launching their attack on the educational system, in an effort to counter the public's dangerous tendency to pay attention to the conclusions of scientific research.

At the Republican National Committee's Winter Meeting a few weeks ago, Louisiana Gov. Bobby Jindal warned the leadership that "We must stop being the stupid party ... We must stop insulting the intelligence of voters."

Within the RECD system it is of extreme importance that we become the stupid nation, not misled by science and rationality, in the interests of the short-term gains of the masters of the economy and political system, and damn the consequences.

These commitments are deeply rooted in the fundamentalist market doctrines that are preached within RECD, though observed in a highly selective manner, so as to sustain a powerful state that serves wealth and power.

The official doctrines suffer from a number of familiar "market inefficiencies," among them the failure to take into account the effects on others in market transactions. The consequences of these "externalities" can be substantial. The current financial crisis is an illustration. It is partly traceable to the major banks and investment firms' ignoring "systemic risk" -- the possibility that the whole system would collapse -- when they undertook risky transactions.

Environmental catastrophe is far more serious: The externality that is being ignored is the fate of the species. And there is nowhere to run, cap in hand, for a bailout.

In future, historians (if there are any) will look back on this curious spectacle taking shape in the early 21st century. For the first time in human history, humans are facing the significant prospect of severe calamity as a result of their actions -- actions that are battering our prospects of decent survival.

Those historians will observe that the richest and most powerful country in history, which enjoys incomparable advantages, is leading the effort to intensify the likely disaster. Leading the effort to preserve conditions in which our immediate descendants might have a decent life are the so-called "primitive" societies: First Nations, tribal, indigenous, aboriginal.

The countries with large and influential indigenous populations are well in the lead in seeking to preserve the planet. The countries that have driven indigenous populations to extinction or extreme marginalization are racing toward destruction.

Thus Ecuador, with its large indigenous population, is seeking aid from the rich countries to allow it to keep its substantial oil reserves underground, where they should be.

Meanwhile the U.S. and Canada are seeking to burn fossil fuels, including the extremely dangerous Canadian tar sands, and to do so as quickly and fully as possible, while they hail the wonders of a century of (largely meaningless) energy independence without a side glance at what the world might look like after this extravagant commitment to self-destruction.

This observation generalizes: Throughout the world, indigenous societies are struggling to protect what they sometimes call "the rights of nature," while the civilized and sophisticated scoff at this silliness.

This is all exactly the opposite of what rationality would predict -- unless it is the skewed form of reason that passes through the filter of RECD.

APPENDIX C

Filler questionnaire

Participant #_____

How many snacks did you have today containing high amounts of sugar?

0 1 2 3 4 5 6+

How many times a week do you eat snacks with high amounts of sugar?

0 1 2 3 4 5 6+

How many cans of soft-drinks did you have today?

0 1 2 3 4 5 6+

How many times a week do you drink a can of soft-drink?

0 1 2 3 4 5 6+

Did you have breakfast? Yes No

If yes

My breakfast contained a lot of sugar

Agree Neutral Disagree

0 1 2 3 4 5 6

Did you have lunch? Yes No

If yes

My lunch contained a lot of sugar

Agree Neutral Disagree

0 1 2 3 4 5 6

How many times a week do you have a dessert?

0 1 2 3 4 5 6+

How many desserts did you have with your meals today?

0 1 2 3 4 5 6+

How many hours of class did you have today?

0 1 2 3 4 5 6+

Do you smoke tobacco? Yes No

If so, how often (times/day)

1 2 3 4 5 6 7+

Do you consume alcohol on a weekly basis? Yes No

If so, how often (times/week)

1 2 3 4 5 6 7+

Check the food in each line that you think is better for your health.

___cookies OR ___an apple

___buttered popcorn OR ___unbuttered popcorn

___chocolate cake OR ___an orange

___ice cream OR ___fresh fruit popsicle

___whole milk OR ___low-fat or skim milk

___frozen yogurt OR ___ice cream

___french toast OR ___whole wheat toast

___grilled chicken sandwich OR ___hamburger

___baked potato OR ___french fries

___fruit juice OR ___soda

___donut OR ___bread

___cold or ready-to-eat cereal OR ___eggs and bacon

___whole milk OR ___low-fat or skim milk

___green salad OR ___french fries

___raisins OR ___candy bar

If you want to eat more fruit, which of the following would you choose?

___Orange soda
___grape jelly
___Strawberry ice cream

___A banana
___Don't know

Reading the nutrition facts food labels makes it easier to choose healthier foods.

A - I strongly agree
B - I agree
C - I disagree
D - I strongly disagree

When I use Nutrition Facts food Labels, I make healthier food choices.

A - I strongly agree
B - I agree
C - I disagree
D - I strongly disagree

I use the Nutrition Fact labels to help me choose what to buy or eat.

___always
___often
___sometimes
___almost never
___never

In the last 2 weeks, did you ever eat fruits or vegetables when you went out to eat?

Yes No Didn't go out to eat

Mark the number below that best describes your opinion of the campus dining options. The numbers mean:

1 - I strongly agree
2 - I agree
3 - I disagree
4 - I strongly disagree

It offers food that I like.

1 2 3 4

It offers food that is good for my health.

1 2 3 4

It offers new foods to try.

1 2 3 4

It offers foods that taste good.

1 2 3 4

It offers a variety of foods that I will eat.

1 2 3 4

It offers fruits that I will eat.

1 2 3 4

It offers vegetables that I will eat.

1 2 3 4

I like to taste new foods.

1 2 3 4

It is bad for me to eat bread, cereal, and other grains many times per day.

1 2 3 4

I like having fruits around for snacks.

1 2 3 4

Trying new foods is good for me.

1 2 3 4

I like to ask someone in my family to buy more fruits and vegetables.

1 2 3 4

I don't like the taste of foods that are good for me.

1 2 3 4

I like to choose snacks lower in fat.

1 2 3 4

In the last month, have you taste tested new foods?

___YES ___NO

In the last month, have you done nutrition activities in your community, such as a nutrition fair or a fruit and vegetable taste-test?

___YES ___NO

In the last month, have you talked about good nutrition with your family?

___YES ___NO

In the last month, did you participate in any diets?

___YES ___NO

Mark the box that best describes your opinion of the following vegetables:

	I have never tasted this	**I don't like this**	**I like this a little**	**I like this a lot**
a) Carrots				
b) Celery				
c) Greens (collard, turnip, mustard, etc.)				
d) Potatoes, baked				
e) Corn				
f) Peas (green, sweet or english)				
g) Tomatoes				
h) Broccoli				
i) Lettuce				
j) Beans (green, string, or snap)				

k) Radishes				
l) Cauliflower				
m) Cucumber				
n) Spinach				
o) Bean sprouts				

Mark the box that best describes your opinion of the following fruits:

	I have never tasted this	**I don't like this**	**I like this a little**	**I like this a lot**
a) Peaches				
b) Apple juice				
c) Bananas				
d) Apples				
e) Cantaloupe				
f) Grapes				
g) Orange juice				
h) Oranges				
i) Fruit salad				
j) Applesauce				
k) Blueberries				
l) Apricots				
m) Kiwi				
n) Pears				
o) Plums				
p) Mango				
q) Pineapple				
r) Honeydew melon				

Mark the box that best describes your opinion of the following foods:

	I have never tasted this	**I don't like this**	**I like this a little**	**I like this a lot**
a) Bagels				
b) Spaghetti and other noodles				
c) Couscous				
d) Rice				
e) Cold or ready-to-eat cereal				
f) Hot cereal (oatmeal, cream of wheat)				
g) Rice cakes				
h) Rolls				
i) Grits				
j) English muffins				
k) Tortillas				
l) Unbuttered popcorn				
m) Pretzels				
n) Bread or toast				
o) Granola				
p) Corn bread				
q) Pita bread				
r) Low-fat cookies				

What do you drink most often during the day? _____

What kind of meat do you usually buy (please circle)?

Hamburger steaks pork chops chicken fish

What type of meal or meals do you prepare most often(please circle)?
fry bake broil slow cook grill

How many times a day do you eat? _____

How many times do you eat out during the week? _____

What restaurant do you go to most often? _____

List any vitamins or dietary supplements you take here. How many of each do you take? How often?

_____
_____
_____

If you eat any special foods for health or personal reasons, list what kind and how much.

_____
_____
_____

Do you add salt to your food at the table?
___ Yes ___ No

Do you add salt to foods when you cook?
___ Yes ___ No

The next few questions are in relation to beverage that you just ingested in the experiment:

How pleasant was it for you while drinking the beverage?

Pleasant			**Neutral**			**Unpleasant**
0	1	2	3	4	5	6

Rate the following based on the following scale:

Agree			**Neutral**			**Disagree**
0	1	2	3	4	5	6

I am generally a happy person

0	1	2	3	4	5	6

I feel stressed out or frustrated most of the day

0	1	2	3	4	5	6

Since I came to university, my appetite has decreased

0 1 2 3 4 5 6

Since I came to university, my appetite has increased

0 1 2 3 4 5 6

Now that I am in university, I go out to eat more frequently than I did in high school

0 1 2 3 4 5 6

I eat more when I am sad than when I am happy

0 1 2 3 4 5 6

I eat more when I am happy than when I am sad

0 1 2 3 4 5 6

Overall, I am happy about how my body looks

0 1 2 3 4 5 6

Please notify the experimenter when you have completed the survey

APPENDIX D

Ethics approval

The effects of glucose on varying levels of ego depletion

Gary Ganz

GNZGAR001

University of Cape Town, South Africa

Ethics Approved – no finger prick introduced

27/5/14

Supervisor: Professor Johann Louw

Word count: ~~3774~~ 3,656

APPENDIX E

Informed consent form

Informed consent form

University of Cape Town

Consent to participant in a research study:

A study of tasks and food

Study purpose

You are invited to participate in a research study being conducted by a researcher from the Department of Psychology at the University of Cape Town. The purpose of this study is to determine the interaction that certain foods have on performing tasks.

Study procedure

If you decide to participate in this study, you will be required to watch a six-minute video clip, consume a beverage, and perform cognitive tasks by hand and on a computer. The entire experiment will take about 30-40 minutes to complete.

Possible risks and benefits

The beverage you are required to consume may contain sugar. Therefore, if you are a diabetic or are glucose intolerant you are not permitted to take part in this study. There are no other potential risks of taking part in this study. For participating in this experiment you will be awarded with 2 SRPP points.

Voluntary participation

Participation in this study is entirely voluntary. You are free to withdraw from the study at any time. Withdrawing prematurely from the study will not impact the allocation of SRPP points.

Confidentiality

All your performance data will be kept entirely confidential and will not be traceable back to your personal data. Your personal data is recorded in order to allocate SRPP points.

Questions

Any questions or problems related to this study can be addressed to the following researchers:

Gary Ganz
garyganz@gmail.com

Prof. Johann Louw
Johann.Louw@uct.ac.za

Should you still wish to participate in this study please read the following and sign below:

- I agree to participate in this research project.
- I have read this consent form and the information it contains and had the opportunity to ask questions about them.
- I agree to my responses being used for education and research on condition my privacy is respected.
- I understand that I am under no obligation to take part in this project.
- I understand I have the right to withdraw from this project at any stage.
- I understand that this research might be published in a research journal or book. In the case of dissertation research, the document will be available to readers in a university library in printed form, and possibly in electronic form as well.

Participant name: _____

Participant signature: _____

Age: _____

Sex: M / F

Date: _____

APPENDIX F

Checking assumption of ANOVA

Table 7

Descriptives

	glucose			Statistic	Std. Error
pleasantness	placebo	Mean		3.5333	.22230
		95% Confidence Interval for Mean	Lower Bound	3.0885	
			Upper Bound	3.9781	
		5% Trimmed Mean		3.4815	
		Median		3.0000	
		Variance		2.965	
		Std. Deviation		1.72191	
		Minimum		1.00	
		Maximum		7.00	
		Range		6.00	
		Interquartile Range		3.00	
		Skewness		.539	.309
		Kurtosis		-.602	.608
	glucose	Mean		3.1167	.21005
		95% Confidence Interval for Mean	Lower Bound	2.6964	
			Upper Bound	3.5370	
		5% Trimmed Mean		3.0185	
		Median		3.0000	
		Variance		2.647	
		Std. Deviation		1.62701	
		Minimum		1.00	
		Maximum		7.00	
		Range		6.00	
		Interquartile Range		2.00	
		Skewness		1.222	.309
		Kurtosis		1.094	.608

Table 8

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	glucose	Statistic	df	Sig.	Statistic	df	Sig.
pleasantness	placebo	.188	60	.000	.918	60	.001
	glucose	.245	60	.000	.829	60	.000

a. Lilliefors Significance Correction

Table 9

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
pleasantness	Based on Mean	2.067	1	118	.153
	Based on Median	1.365	1	118	.245
	Based on Median and with adjusted df	1.365	1	117.977	.245
	Based on trimmed mean	2.493	1	118	.117