



Depletion sensitivity predicts unhealthy snack purchases[☆]



Stefanie J. Salmon^{a, c, *}, Marieke A. Adriaanse^c, Bob M. Fennis^a, Emely De Vet^b,
Denise T.D. De Ridder^c

^a Groningen University, The Netherlands

^b Wageningen University, The Netherlands

^c Utrecht University, The Netherlands

ARTICLE INFO

Article history:

Received 23 January 2015

Received in revised form

25 July 2015

Accepted 21 August 2015

Available online 28 August 2015

Keywords:

Self-control

Ego-depletion

Depletion sensitivity

Diary study

Food choice

Eating behavior

ABSTRACT

The aim of the present research is to examine the relation between depletion sensitivity – a novel construct referring to the speed or ease by which one's self-control resources are drained – and snack purchase behavior. In addition, interactions between depletion sensitivity and the goal to lose weight on snack purchase behavior were explored. Participants included in the study were instructed to report every snack they bought over the course of one week. The dependent variables were the number of healthy and unhealthy snacks purchased. The results of the present study demonstrate that depletion sensitivity predicts the amount of unhealthy (but not healthy) snacks bought. The more sensitive people are to depletion, the more unhealthy snacks they buy. Moreover, there was some tentative evidence that this relation is more pronounced for people with a weak as opposed to a strong goal to lose weight, suggesting that a strong goal to lose weight may function as a motivational buffer against self-control failures. All in all, these findings provide evidence for the external validity of depletion sensitivity and the relevance of this construct in the domain of eating behavior.

© 2015 Published by Elsevier Ltd.

Healthy eating starts with healthy food choices made at point-of-purchase settings, such as cafeterias, kiosks, and supermarkets. It has been estimated that individuals make over 200 of these food decisions per day (Wansink & Sobal, 2007). A critical factor determining whether people are able to make the healthy choice in these instances, is self-control. Self-control refers to the ability to alter thoughts, feelings, and actions in the service of attaining long-term goals (Baumeister, Vohs, & Tice, 2007). In terms of food choices, this can be conceived of as the ability to choose a healthy product that aligns with one's long-term health goals instead of a tasty, unhealthy product that – despite being appealing on the short-term – jeopardizes these long-term goals.

Building on the notion that each act of self-control consumes self-control from a limited resource (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven & Baumeister, 2000), we recently demonstrated that the ability to exert self-control may largely depend on the speed by which one's self-control resources

are drained: a phenomenon that we coined depletion sensitivity (Salmon, Adriaanse, De Vet, Fennis, & De Ridder, 2014). Specifically, we found that some people deplete their self-control resources at a faster rate than others, and that these individual differences in depletion sensitivity predict actual self-control exertion under low self-control conditions (Salmon, Adriaanse et al., 2014). To demonstrate this effect we used validated self-control tasks in a restricted lab setting. The aim of the present research is to investigate the external validity of the depletion sensitivity construct by observing how depletion sensitivity relates to real-life food purchase behavior in a community sample.

1. Depletion sensitivity

The construct of depletion sensitivity is based on the ego-depletion paradigm, which refers to the limited human capacity to exert self-control (Baumeister et al., 1998, 2007). After an initial act of self-control, such as inhibiting one's emotional expressions, people are said to be 'depleted', meaning that they lack the capacity (Baumeister et al., 1998; Muraven & Baumeister, 2000; Muraven, Tice, & Baumeister, 1998) or motivation (Inzlicht & Schmeichel, 2012; Inzlicht, Schmeichel, & Macrae, 2014) to exert self-control on a second self-control task, such as resisting tempting

[☆] The work in this article was supported by ZonMW Grant 115100002 from the Netherlands Organization for Health Research and Development.

* Corresponding author. Department of Marketing, Groningen University, PO Box 800, 9700 AV, Groningen, The Netherlands.

E-mail address: s.j.salmon@rug.nl (S.J. Salmon).

chocolates and eating a healthy product instead. Whereas recently the mechanism underlying the ego-depletion effect, and the strength and robustness of the ego-depletion effect have been topic of debate (Carter, Kofler, Forster, & McCullough, 2015; Carter & McCullough, 2014; Hagger & Chatzisarantis, 2014; Kurzban, Duckworth, Kable, & Myers, 2013; Tuk, Zhang, & Sweldens, 2015), most research suggests that people are less likely to exert self-control after exerting self-control in an initial task (e.g. Duckworth & Kern, 2011; Hagger, Wood, Stiff, & Chatzisarantis, 2010; Inzlicht & Schmeichel, 2012). Notwithstanding the large number of studies that found evidence for the ego-depletion effect, we argue that people differ in their sensitivity to ego-depleting tasks and situations and that, consequently, some people will deplete their self-control resource at a faster rate than others (Salmon, Adriaanse et al., 2014). To illustrate, we propose that where one person may already deplete his resources and indulge in a delicious, but unhealthy, chocolate cake after studying for an hour, another person may still have sufficient self-control resources to resist that same chocolate cake after studying the entire morning.

The critical reader might wonder how depletion sensitivity can be distinguished from trait self-control, which has been found to relate to a variety of outcomes such as academic success, eating behavior, and overall well-being (De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Tangney, Baumeister, & Boone, 2004). In the ego-depletion paradigm, the self-control resource is compared to the working of a muscle (Muraven & Baumeister, 2000). Although this metaphor has been criticized as it may not adequately reflect the nature of self-control (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014), it is helpful in illustrating the proposed difference between trait self-control and depletion sensitivity. In terms of this muscle metaphor of ego-depletion, one can compare trait self-control to the *power* of the muscle (Tangney et al., 2004). However, we argue that besides the power of the muscle, which determines the likelihood one will exert self-control in the first place, muscle *endurance*, or depletion sensitivity, determines how fast one's self-control resource gets depleted. So, whereas two individuals may have similar muscle power (e.g. equal levels of trait self-control), one individual may drain his muscle power at a faster rate compared to another (e.g. is more depletion sensitive).

Initial evidence for the relevance of depletion sensitivity was provided by showing that individual differences in depletion sensitivity predict the ability to exert self-control under conditions of ego-depletion in the lab (Salmon, Adriaanse et al., 2014). Compared to individuals low in depletion sensitivity, individuals sensitive to depletion performed worse on a self-control task (i.e., logical reasoning task) after they had already exerted self-control in a first task (i.e. cognitive task in which participants override learned responses, the 'E-erasing task', Baumeister et al., 1998). With the present study we aim to build on and extend our previous findings by demonstrating how depletion sensitivity affects the ability to exert self-control outside the lab, in the context of food choices.

Making food choices is frequently mentioned as a typical self-control dilemma (Baumeister, 2002; Bruyneel, Dewitte, Vohs, & Warlop, 2006; Faber & Vohs, 2004; Hofmann, Strack, & Deutsch, 2008; Salmon, Fennis, De Ridder, Adriaanse, & De Vet, 2014) and therefore makes an ideal context for further investigating the relevance of depletion sensitivity. We chose to focus on snacks as this is a food type that has previously been found to be predicted by self-control and that can be reliably categorized as healthy or unhealthy (e.g., Adriaanse, Kroese, Gillebaart, & De Ridder, 2014; Salmon, Fennis et al., 2014). We expect depletion sensitivity to predict snack purchase behavior in real-life settings where people encounter several depleting circumstances during the day. By

predicting self-control exertion in the field with a community sample, the present study aims to test the external validity of the depletion sensitivity construct.

2. The present study

In the present study, participants' goals to eat healthily and to lose weight will be included as additional predictors for exploratory reasons. That is, by including these predictors, we aim to provide an initial test of two additional, competing hypotheses; On the one hand it can be expected that depletion sensitivity is most likely to affect food choices for individuals with a strong long-term health or weight loss goal as the presence of such a goal is necessary for the experience of a self-control conflict. It makes sense to expect that the presence of a self-control conflict is required for self-control to become of relevance, and thus for depletion sensitivity to predict food purchases. On the other hand, there is also reason to expect that the presence of a strong health or weight loss goal may actually function as a buffer against the effects of depletion sensitivity, resulting in a stronger effect of depletion sensitivity for individuals with a weak long-term health or weight loss goal. This hypothesis is grounded in recent findings that suggest that ego-depletion may (partly) be explained by a lack of motivation (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014).

To reliably assess food purchase behavior, participants kept a food diary in which they were instructed to report every snack they bought. The number of healthy snack purchases and the number of unhealthy snack purchases were aggregated over one week, and analyzed as the two main outcome measures. It was expected that depletion sensitivity predicted the number of healthy and unhealthy snack purchases. Furthermore, in line with previous research that demonstrated effects of self-control on eating behavior (Adriaanse et al., 2014; Tangney et al., 2004; Wills, Isasi, Mendoza, & Ainette, 2007), trait self-control was also expected to predict snack purchases. However, note that stronger effects of depletion sensitivity and trait self-control were expected for unhealthy rather than healthy snacks, as these represent a self-control dilemma between the immediate gratification of enjoying palatable foods and the long term benefits of eating healthily (Adriaanse et al., 2014; Dhar, 1997; Wang, Novemsky, Dhar, & Baumeister, 2010). Lastly, interaction effects of depletion sensitivity with the goal to eat healthily/to lose weight were explored.

3. Method

3.1. Participants and procedure

Participants were recruited via the website of the Netherlands Nutrition Center and could sign up for participation via email. After sign up, participants received a 7 day snack diary (Adriaanse, De Ridder, & De Wit, 2009) and a questionnaire via postal mail. One hundred eighty seven individuals signed up, and one hundred and eight individuals participated and returned their diaries by free postal mail. We excluded 12 participants who did not complete the entire study, as they did not fill out the questionnaire including the measures on depletion sensitivity or trait self-control (11.1%), so final analyses are based on a sample of 96 participants (7.3% men) with a mean age of 36.75 years ($SD = 13.92$) and a mean BMI of 23.84 ($SD = 5.11$). Of these participants, 8.3% completed lower education (primary school or lower general secondary education), 36.5% completed a middle level of education (intermediate vocational education or higher general secondary education), and 55.2% completed higher education (higher vocational education or university).

Participants were instructed to report every snack they bought

for one week in the snack diary and to fill out the questionnaire after completion of the diary. The measures in this questionnaire included depletion sensitivity, trait self-control, healthy eating goals and some demographic variables. Finally, participants were asked four questions about their accuracy in reporting the snacks in the snack diary. After completion of the study, participants were thanked and debriefed. By participation, participants could win a small prize (a book).

3.2. Snack diary

The first pages of the snack diary included instructions for filling out the diary and an example of a diary entry. Participants were instructed to fill out one entry for every moment they bought (a) snack(s) during a period of one week. In this entry participants indicated which snack they bought, as well as the amount they bought. Participants were instructed to fill out an entry immediately after they bought (a) snack(s). Snacks were categorized per type of snack (e.g. fruits, vegetables, sweet snacks and salty snacks) and every category included an 'other' option that participants could fill out when the snack did not match any of the categories specified in the list. The amount of snacks was standardized per package or single product (for example one bag of crisps or one apple). Participants could fill out a maximum of 5 diary entries per day, resulting in a total of 35 diary entries.

3.2.1. Descriptives purchase moment

Participants indicated per purchase moment where they bought the snack (e.g. at a supermarket, restaurant, kiosk, canteen, or somewhere else) and reported for whom they bought the snack (e.g. for themselves and/or others). In case participants bought the snack only for others the diary entry was excluded from the analyses, as buying a food product for someone else should not consume self-control resources (5.9% of all snacks were bought exclusively for someone else).

3.2.2. Categorization of healthy versus unhealthy snacks

As the dependent variables were the number of healthy and unhealthy products, snack categories had been coded as healthy or unhealthy prior to the start of the study. This categorization was based on previous experience with snack diaries (Adriaanse et al., 2009; Verhoeven, Adriaanse, Evers, & De Ridder, 2012) and discussions with nutritional experts. In addition, we conducted a pilot study to further corroborate this categorization.

This pilot study included 385 participants (9% men) drawn from the online participant pool Amazon's Mechanical Turk with a mean age of 36.38 years ($SD = 12.13$) and a mean BMI of 24.24 ($SD = 5.15$). Participants rated the healthiness of each of the 35 products on a 7-point scale, ranging from 1 (*not healthy at all*) to 7 (*very healthy*). There was a significant difference between the products we coded as healthy ($M = 5.64, SD = .57$) and the products we coded as unhealthy ($M = 2.44, SD = .63; t(388) = 89.48, p < .001$), matching our prior categorization.

Besides these 35 products, participants in the main study also mentioned new products in the 'other' categories. These remaining products (8.5% of all purchases) were categorized as healthy or unhealthy post-data collection based on discussions with nutritional experts.

3.3. Data analysis

The total number of healthy snacks and the total number of unhealthy snacks bought over one week were calculated.

3.4. Questionnaire

All items were rated on a 7 point scale ranging from 1 (*totally disagree*) to 7 (*totally agree*).

3.4.1. Depletion sensitivity

The 11-item Depletion Sensitivity Scale (Salmon, Adriaanse et al., 2014) measures individual differences in sensitivity to ego-depletion, an example item being 'After I have worked very hard at something, I am not good at reloading to start a new task' (Cronbach's $\alpha = .87$). An index was created by averaging the scores on the items.

3.4.2. Trait self-control

The 36-item version of the Trait Self-Control Scale (Tangney et al., 2004) measures individual differences in self-control, an example item being 'I am good at resisting temptation' (Cronbach's $\alpha = .84$). An index was created by averaging the scores on the items.

3.4.3. Healthy eating goals

The goal to eat healthily and the goal to lose weight were measured by two separate items: 'I have the goal to eat healthily' and 'I have the goal to lose weight'.

3.4.4. Snack diary accuracy

Accuracy in reporting the snacks in the snack diary was measured by 4 items: 1) whether participants took the diary with them every day, 2) whether participants filled out the diary immediately after buying the snack, 3) whether participants filled out the snack diary honestly, and 4) whether participants forgot to report one or more snacks.

4. Results

4.1. Descriptives and correlations

Participants on average bought 7.49 snacks over the entire week ($SD = 6.39$), including 3.97 ($SD = 3.89$) healthy products and 3.52 ($SD = 3.98$) unhealthy products. Of all reported purchase moments (580 purchase moments in total), most of these products were bought in the supermarket (72.8%), and 27.2% were bought at other places, such as restaurants, kiosks and canteens.

Participants were moderately sensitive to ego-depletion ($M = 3.72, SD = 1.12$) and had a moderately high level of trait self-control ($M = 4.95, SD = .63$). Moreover, participants had a strong goal to eat healthily ($M = 6.25, SD = .78$) and a moderately strong goal to lose weight ($M = 3.92, SD = 1.97$). The goal to eat healthily was highly skewed and therefore not normally distributed. Almost all participants ($n = 94, 97.8%$) had a (moderately) strong goal to eat healthily (score of 5 or higher on a 7 point scale). Because of this lack of variance, this variable is not included in the remaining analyses.

Participants did not take the snack diary with them every day, $M = 3.36, SD = 2.21$, filled out the diary immediately after buying the snack, $M = 4.89, SD = 2.02$, reported to have filled out the snack diary honestly, $M = 6.59, SD = .92$, and did not often forget to report one or more snacks, $M = 1.72, SD = 1.39$. Therefore, we can be quite confident that most of the snacks participants bought were included in the snack diary.

Depletion sensitivity was positively related to unhealthy snack purchases ($r = .27, p = .008$), but was not related to healthy snack purchases ($r = -.02, p = .83$). Furthermore, depletion sensitivity was negatively related to trait self-control ($r = -.57, p < .001$) and positively related to the goal to lose weight ($r = .33, p = .001$). Trait

Table 1
Means, standard deviations and correlations between study variables.

	1	2	3	4	5	6	7	8
Gender (1 = men, 0 = women) (1)	–							
Age (2)	–.03	–						
BMI (3)	.06	.34**	–					
Goal to lose weight (4)	.04	.15	.44**	–				
Depletion sensitivity (5)	–.13	–.16	–.04	.33**	–			
Trait self-control (6)	.16	.25*	.07	–.28**	–.57**	–		
Unhealthy snack purchases (7)	.15	–.04	.13	.15	.27**	–.11	–	
Healthy snack purchases (8)	.18 ^b	–.10	–.04	.03	.02	.19 ^b	.32**	–
<i>M</i>	92.7 ^a	36.75	23.84	3.92	3.72	4.95	3.52	3.97
<i>SD</i>	–	13.92	5.11	1.97	1.12	.63	3.98	3.89

* correlation significant at $p < .05$; ** correlation significant at $p < .01$.

^a Percentage female.

^b correlation marginally significant at $p < .10$.

self-control was negatively related to the goal to lose weight ($r = -.28, p = .006$), and marginally significantly related to healthy snack purchases ($r = .19, p = .067$), but not to unhealthy snack purchases ($p = .30$; see Table 1 for all means and correlations).

4.2. Predicting purchasing of unhealthy snacks

A negative binomial regression analysis was conducted to test (a) whether depletion sensitivity predicts unhealthy snack purchases, and (b) whether there is an interaction effect between depletion sensitivity and the goal to lose weight on the amount of unhealthy snack purchases. In the first model, the control variables gender, age, education level and BMI were entered into the regression analysis as predictors. The goal to lose weight, trait self-control and depletion sensitivity were entered in model 2. In the final model, the interaction between depletion sensitivity and the goal to lose weight was entered.¹ All continuous independent variables were mean centered before being entered in the regression analyses (Aiken & West, 1991).

The result of this analysis is shown in Table 2. The first model was marginally significant ($\chi^2(df = 5) = 9.76, p = .082$) with gender ($B = .97, p = .024$) significantly predicting unhealthy snack purchases. Model 2 was also marginally significant ($\chi^2(df = 8) = 14.88, p = .062$), with gender ($B = .90, p = .040$) and depletion sensitivity ($B = .29, p = .034$) significantly predicting unhealthy snack purchases. The final model was significant ($\chi^2(df = 9) = 18.07, p = .034$). Again gender ($B = 1.00, p = .022$) and depletion sensitivity ($B = .36, p = .013$) were significant predictors. Moreover, the interaction term between depletion sensitivity and goal to lose weight (marginally) significantly predicted the amount of

unhealthy snacks bought ($B = -.10, p = .075$). Simple slope analyses to further disentangle the interaction effect demonstrated that for participants with a weak goal to lose weight ($-1 SD$; Aiken & West, 1991), depletion sensitivity had a positive effect on the amount of unhealthy snacks bought, such that the more depletion sensitive participants were, the more unhealthy snacks they bought ($B = .56, SE_B = .21, \text{Wald } \chi^2(1.86) = 7.28, p = .007$). However, for participants with a strong goal to lose weight ($+1 SD$), no significant effect of depletion sensitivity could be observed ($B = .16, SE_B = .16, \text{Wald } \chi^2(1.86) = 1.03, p = .31$; see Fig. 1 for the plotted interaction).

4.3. Predicting purchasing of healthy snacks

Similar regression analyses (see above) performed with healthy purchases as the dependent variable did not yield a significant model (all models p 's $> .11$). For more details see Table 3.

5. Discussion

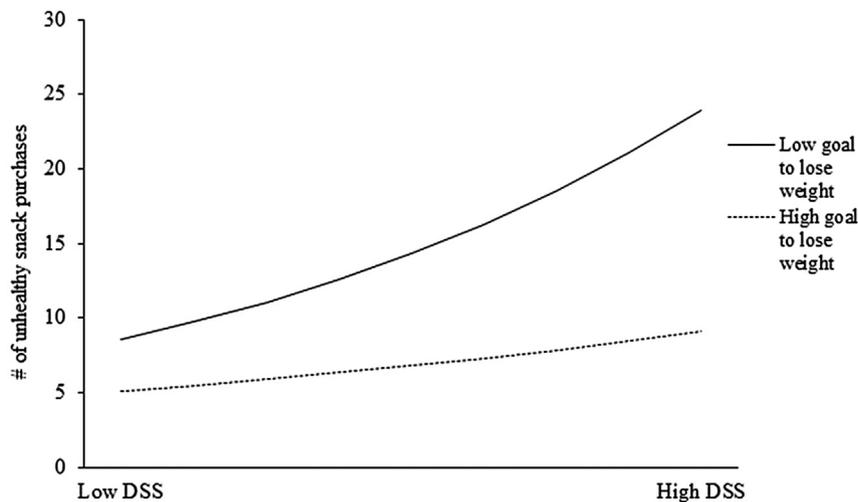
The present research investigated the effect of depletion sensitivity on unhealthy and healthy food purchases using a one-week daily registration of real-life snack purchase behavior. Findings showed that the more sensitive people are to ego-depletion, the more unhealthy snacks they bought. These findings are in line with a previous lab study, in which we demonstrated that depletion sensitivity moderates the ego-depletion effect, such that the ego-depletion effect was stronger for individuals who are sensitive to ego-depletion, compared to individuals who are less depletion sensitive (Salmon, Adriaanse et al., 2014). By demonstrating the effect of depletion sensitivity on unhealthy snack purchases in the field with a community sample, we provide evidence for the external validity of the construct of depletion sensitivity and demonstrate its relevance for unhealthy snacking behavior. No evidence was found for the predictive validity of depletion sensitivity on healthy snack purchases. However, this finding is in line with previous work that demonstrated effects of trait self-control on unhealthy, but not healthy snack intake (Adriaanse et al., 2014) and with the notion that unhealthy snacks are – more so than healthy snacks – representative of a self-control dilemma between the immediate gratification of enjoying palatable foods and the long term benefits of eating healthily (Adriaanse et al., 2014; Dhar, 1997; Wang et al., 2010).

Important to the theoretical implications of the present findings, the strength and robustness of the ego-depletion phenomenon have recently been topic of debate. Recent research suggests that the ego-depletion effect may be less strong than has been previously assumed, or that the ego-depletion effect as such may not even exist at all (Carter et al., 2015; Carter & McCullough, 2014; Tuk

¹ Because gender is skewedly distributed (only 7 males versus 89 females), and males bought more unhealthy snacks ($M = 8.71, SD = 9.50$) compared to females ($M = 3.11, SD = 2.94; t(1.94) = 3.84, p < .001$), we ran a similar negative binomial regression analysis for unhealthy snack purchases, excluding males from the analysis. The results of the analyses remain similar, except that the overall model now becomes insignificant, ($\chi^2(df = 8) = 8.52, p = .39$), and the main effect of depletion sensitivity on unhealthy snack purchases now becomes marginally significant, $B(SE) = .30(.16)$, $\text{Wald } \chi^2(1.80) = 3.56, p = .059$. This may be due to a decreased power, resulting from excluding 7 participants (Cohen, 1992). Moreover, the interaction term between depletion sensitivity and goal to lose weight (marginally) significantly predicted the amount of unhealthy snacks bought ($B = -.11, SE_B = .06, \text{Wald } \chi^2(1.80) = 3.45, p = .063$). Simple slope analyses to further disentangle the interaction effect demonstrated that for participants with a weak goal to lose weight ($-1 SD$; Aiken & West, 1991), depletion sensitivity had a positive effect on the amount of unhealthy snacks bought, such that the more depletion sensitive participants were, the more unhealthy snacks they bought ($B = .52, SE_B = .21, \text{Wald } \chi^2(1.80) = 5.91, p = .015$). However, for participants with a strong goal to lose weight ($+1 SD$), no significant effect of depletion sensitivity could be observed ($B = .07, SE_B = .18, \text{Wald } \chi^2(1.80) = .17, p = .68$).

Table 2
Negative binomial regression analyses for unhealthy snack purchases.

	Model 1			Model 2			Model 3		
	<i>B</i> (<i>SE</i>)	Wald χ^2	<i>p</i>	<i>B</i> (<i>SE</i>)	Wald χ^2	<i>p</i>	<i>B</i> (<i>SE</i>)	Wald χ^2	<i>p</i>
Gender	.97(.43)	5.07	.024	.90(.44)	4.23	.040	1.00(.44)	5.22	.022
Age	-.01(.01)	1.44	.230	-.01(.01)	.54	.462	-.01(.01)	.88	.348
Low education	.01(.44)	.00	.996	-.04(.45)	.01	.922	-.01(.45)	.00	.986
Middle education	-.17(.26)	.41	.521	-.21(.27)	.65	.422	-.29(.27)	1.15	.283
BMI	.03(.03)	1.22	.269	.03(.03)	.94	.333	.04(.03)	1.24	.266
Goal to lose weight				-.01(.08)	.01	.913	.00(.08)	.00	.995
Trait self-control				.13(.25)	.27	.603	.18(.25)	.52	.470
Depletion sensitivity				.29(.14)	4.49	.034	.36(.15)	6.13	.013
Depletion sensitivity \times Goal to lose weight							-.10(.06)	3.17	.075

**Fig. 1.** The interaction between depletion sensitivity and goal to lose weight on the amount of unhealthy snack purchases.

et al., 2015). Rather than being a consequence of a limited self-control resource, other mechanisms underlying the ego-depletion effect have been proposed, such as motivation or attention (e.g. Inzlicht & Schmeichel, 2012; Kurzban et al., 2013). Notwithstanding the importance of these recent insights for understanding the ego-depletion phenomenon, the present findings suggest that the extent to which a person is sensitive to ego-depletion predicts actual self-control behavior.

Trait self-control did not predict unhealthy food purchases in the present study. This may be explained by the conceptual differences between depletion sensitivity and trait self-control. In terms of the well-known muscle metaphor, trait self-control may represent the strength of the muscle whereas depletion sensitivity relates to how fast the muscle gets tired. The relation between trait self-control and ego-depletion has not been well understood up to

now. However, with depletion sensitivity we may provide more insight into the contradictory findings surrounding the ego-depletion phenomenon. Some individuals are more sensitive to ego-depleting tasks and situations compared to others, and this cannot be explained by individual differences in trait self-control, but by differences in depletion sensitivity.

Since the absence of an effect of trait self-control on food choices is at odds with previous studies on self-control and eating (e.g., Adriaanse et al., 2014; Tangney et al., 2004; Wills et al., 2007), it should be noted that these studies generally looked at unhealthy food intake (e.g., kilocalories consumed) rather than food purchases, which is likely to have more variance and thus more likely to show effects. In addition, and in stark contrast with the prevailing belief that eating is a prototype of a behavior that is highly influenced by the ability to exert self-control (e.g., Bauer &

Table 3
Negative binomial regression analyses for healthy snack purchases.

	Model 1			Model 2			Model 3		
	<i>B</i> (<i>SE</i>)	Wald χ^2	<i>p</i>	<i>B</i> (<i>SE</i>)	Wald χ^2	<i>p</i>	<i>B</i> (<i>SE</i>)	Wald χ^2	<i>p</i>
Gender	.79(.43)	3.39	.065	.64(.44)	2.12	.145	.56(.44)	1.60	.205
Age	-.01(.01)	.28	.596	-.01(.01)	2.06	.152	-.01(.01)	1.66	.198
Low education	.40(.42)	.89	.346	.52(.44)	1.41	.235	.51(.44)	1.36	.244
Middle education	-.03(.26)	.01	.920	-.15(.26)	.33	.566	-.10(.27)	.15	.701
BMI	-.01(.03)	.17	.679	-.01(.03)	.15	.698	-.01(.03)	.14	.714
Goal to lose weight				.06(.08)	.62	.433	.06(.08)	.59	.443
Trait self-control				.66(.26)	6.56	.010	.64(.26)	6.04	.014
Depletion sensitivity				.09(.13)	.49	.484	.08(.13)	.36	.550
Depletion sensitivity \times Goal to lose weight							.05(.05)	1.16	.283

Baumeister, 2011; Hofmann, Rauch, & Gawronski, 2007; Kuijer, De Ridder, Ouwehand, Houx, & van den Bos, 2008; Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010; Vohs & Heatherton, 2000), a recent meta-analysis on the role of trait self-control (De Ridder et al., 2012) showed that, of all behavioral domains, the effect size of self-control was actually the smallest in the domain of “eating behavior and weight control” ($r = .17$). Finally, it should be noted that the participants in our sample generally had a strong goal to eat healthily, which may have limited the effect of trait self-control.

In addition to the main effects of depletion sensitivity and trait self-control, the present paper aimed to explore the interaction effect of depletion sensitivity with the goal to lose weight (the goal to eat healthily could not be included due to a lack of variance) on healthy and unhealthy snack purchases. In an exploratory test of two competing hypotheses, we found a (marginally significant) interaction effect between depletion sensitivity and the goal to lose weight on unhealthy food purchases. People with a weak goal to lose weight were found to purchase more unhealthy snacks when they were higher rather than lower in depletion sensitivity, but for people with a strong goal to lose weight, there was no effect of depletion sensitivity. This finding – which was only marginally significant and should thus be interpreted with care – may suggest that a strong goal to lose weight functions as a motivational buffer against self-control failures. This suggestion is in line with the recently proposed hypothesis that ego-depletion effects are driven by a lack of motivation and are not so much a consequence of a limited cognitive resource (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014) and with research demonstrating that strong motivation may prevent ego-depletion effects (Muraven & Slessareva, 2003; Sato, Harman, Donohoe, Weaver, & Hall, 2010). More insight into the mechanisms underlying the ego-depletion effect and into the factors that may moderate the ego-depletion effect may yield valuable tools to decrease individuals' sensitivity to ego-depletion. By for instance finding ways to improve cognitive capacity or motivation, people may become less depletion sensitive, which in turn may have positive effects on eating and other health behaviors.

Several limitations of the present research must be noted. First, the present study has a correlational design, and therefore we cannot draw conclusions about the causality of the effect of depletion sensitivity on snack purchases. However, as the present study builds on a previous experimental study in a controlled lab setting (Salmon, Adriaanse et al., 2014), we can be relatively confident that depletion sensitivity affects unhealthy snack purchases rather than vice versa. A second limitation concerns the fact that whereas the present study was conducted in a community sample, the majority of participants from this sample were female, and all participants aimed to eat healthily. In order to increase the external validity of our results, future research should examine the extent to which the findings of this study hold in a more mixed, and less motivated sample. Third, the data of unhealthy and healthy snack purchases are self-reported, which is prone to retrospective bias. Although asking participants to report their snack purchases not only on a daily basis, but for each purchase moment separately minimizes the chance of underreporting, still the results should be interpreted with care. Lastly, it is important to note that in the present research we analyzed an aggregated number of several acts of self-control, by accumulating all snacks participants bought during one week without having information about whether participants were depleted prior to making the purchase. However, because a one week period was employed, it can be assumed that several situations in which people had drained their self-control prior to making the purchase are incorporated in this measure. Still, since this ability to repeatedly exert self-control concerns

exactly what the concept of depletion sensitivity entails, future studies should investigate the predictive value of depletion sensitivity in predicting sequential acts of self-control exertion.

Notwithstanding the aforementioned limitations, the results of the present study demonstrate that depletion sensitivity predicts the amount of unhealthy (but not healthy) snacks bought in daily life. This demonstrates that depletion sensitivity is a valuable factor in predicting naturalistic observations of food choice. Moreover, the results provided some tentative evidence for the suggestion that strong long term goals, such as the goal to lose weight, may provide a buffer against the negative effect of depletion sensitivity on health outcomes, such as unhealthy snack purchases.

References

- Adriaanse, M. A., De Ridder, D. T. D., & De Wit, J. B. F. (2009). Finding the critical cue: implementation intentions to change one's diet work best when tailored to personally relevant reasons for unhealthy eating. *Personality and Social Psychology Bulletin*, 35, 60–71. <http://dx.doi.org/10.1177/0146167208325612>.
- Adriaanse, M. A., Kroese, F. M., Gillebaart, M., & De Ridder, D. T. D. (2014). Effortless inhibition: habit mediates the relation between self-control and unhealthy snack consumption. *Frontiers in Psychology*, 5, 444. <http://dx.doi.org/10.3389/fpsyg.2014.00444>.
- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, London: Sage.
- Bauer, I. M., & Baumeister, R. F. (2011). Self-regulatory strength. In K. D. Vohs, & R. F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (pp. 64–82). New York, NY: Guilford Press.
- Baumeister, R. F. (2002). Yielding to temptation: self-control failure, impulsive purchasing, and consumer behavior. *Journal of Consumer Research*, 4, 670–676. <http://dx.doi.org/10.1086/338209>.
- Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: is the active self a limited resource? *Journal of Personality and Social Psychology*, 74, 1252–1265. <http://dx.doi.org/10.1037/0022-3514.74.5.1252>.
- Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science*, 16, 351–355. <http://dx.doi.org/10.1111/j.1467-8721.2007.00534.x>.
- Bruyneel, S., Dewitte, S., Vohs, K. D., & Warlop, L. (2006). Repeated choosing increases susceptibility to affective product features. *International Journal of Research in Marketing*, 23, 215–225. <http://dx.doi.org/10.1016/j.ijresmar.2005.12.002>.
- Carter, E. C., Kofler, L. M., Forster, D. E., & McCullough, M. E. (2015). A series of meta-analytic tests of the depletion effect: self-control does not seem to rely on a limited resource. *Journal of Experimental Psychology: General*. <http://dx.doi.org/10.1037/xge0000083>.
- Carter, E. C., & McCullough, M. E. (2014). Publication bias and the limited strength model of self-control: has the evidence for ego depletion been overestimated? *Frontiers in Psychology*, 5, 823. <http://dx.doi.org/10.3389/fpsyg.2014.00823>.
- Cohen, J. (1992). Statistical power analysis. *Current Directions in Psychological Science*, 1, 98–101.
- De Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: a meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review*, 16, 76–99. <http://dx.doi.org/10.1177/1088868311418749>.
- Dhar, R. (1997). Consumer preference for a no-choice option. *Journal of Consumer Research*, 24, 215–231. <http://dx.doi.org/10.1086/209506>.
- Duckworth, A. L., & Kern, M. L. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality*, 45, 259–269. <http://dx.doi.org/10.1016/j.jrjp.2011.02.004>.
- Faber, R. J., & Vohs, K. D. (2004). To buy or not to buy?: self-control and self-regulatory failure in purchase behavior. In R. F. Baumeister, & K. D. Vohs (Eds.), *Handbook of self-regulation: Research, theory, and applications* (pp. 509–524). New York, NY: Guilford Press.
- Hagger, M. S., & Chatzisarantis, N. L. D. (2014). It is premature to regard the ego-depletion effect as “Too incredible”. *Frontiers in Psychology*, 5, 298. <http://dx.doi.org/10.3389/fpsyg.2014.00298>.
- Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: a meta-analysis. *Psychological Bulletin*, 136, 495–525. <http://dx.doi.org/10.1037/a0019486>.
- Hofmann, W., Rauch, W., & Gawronski, B. (2007). And deplete us not into temptation: automatic attitudes, dietary restraint, and self-regulatory resources as determinants of eating behavior. *Journal of Experimental and Social Psychology*, 43, 497–504. <http://dx.doi.org/10.1016/j.jesp.2006.05.004>.
- Hofmann, W., Strack, F., & Deutsch, R. (2008). Free to buy? Explaining self-control and impulse in consumer behavior. *Journal of Consumer Psychology*, 18, 22–26. <http://dx.doi.org/10.1016/j.jcps.2007.10.005>.
- Inzlicht, M., & Schmeichel, B. J. (2012). What is ego-depletion? Toward a mechanistic revision of the resource model of self-control. *Perspectives on Psychological Science*, 7, 450–463. <http://dx.doi.org/10.1177/1745691612454134>.
- Inzlicht, M., Schmeichel, B. J., & Macrae, C. N. (2014). Why self-control seems (but

- may not be) limited. *Trends in Cognitive Sciences*, 18, 127–133. <http://dx.doi.org/10.1016/j.tics.2013.12.009>.
- Kuijjer, R., De Ridder, D. T. D., Ouweland, C., Houx, B., & van den Bos, R. (2008). Dieting as a case of behavioural decision making. Does self-control matter? *Appetite*, 51, 506–511. <http://dx.doi.org/10.1016/j.appet.2008.03.014>.
- Kurzban, R., Duckworth, A., Kable, J. W., & Myers, J. (2013). An opportunity cost model of subjective effort and task performance. *The Behavioral and Brain Sciences*, 36, 661–679. <http://dx.doi.org/10.1017/S0140525X12003196>.
- Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: does self-control resemble a muscle? *Psychological Bulletin*, 126, 247–259. <http://dx.doi.org/10.1037/0033-2909.126.2.247>.
- Muraven, M., & Slessareva, E. (2003). Mechanisms of self-control failure: motivation and limited resources. *Personality and Social Psychology Bulletin*, 29, 894–906. <http://dx.doi.org/10.1177/0146167203029007008>.
- Muraven, M., Tice, D. M., & Baumeister, R. F. (1998). Self-control as limited resource: regulatory depletion patterns. *Journal of Personality and Social Psychology*, 74, <http://dx.doi.org/10.1037/0022-3514.74.3.774>, 774–489.
- Nederkoorn, C., Houben, K., Hofmann, W., Roefs, A., & Jansen, A. (2010). Control yourself or just eat what you like? Weight gain over a year is predicted by an interactive effect of response inhibition and implicit preference for snack foods. *Health Psychology*, 29, 389–393. <http://dx.doi.org/10.1037/a0019921>.
- Salmon, S. J., Adriaanse, M. A., De Vet, E., Fennis, B. M., & De Ridder, D. T. D. (2014a). 'When the going gets tough, who keeps going?' Depletion sensitivity moderates the ego-depletion effect. *Frontiers in Psychology*, 5, 647. <http://dx.doi.org/10.3389/fpsyg.2014.00647>.
- Salmon, S. J., Fennis, B. M., De Ridder, D. T. D., Adriaanse, M. A., & De Vet, E. (2014b). Health on impulse: when low self-control promotes healthy food choices. *Health Psychology*, 33, 103–109. <http://dx.doi.org/10.1037/a0031785>.
- Sato, T., Harman, B. A., Donohoe, W. M., Weaver, A., & Hall, W. A. (2010). Individual differences in ego-depletion: the role of sociotropy-autonomy. *Motivation and Emotion*, 34, 205–213. <http://dx.doi.org/10.1007/s11031-010-9166-9>.
- Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality*, 72, 271–322. <http://dx.doi.org/10.1111/j.0022-3506.2004.00263.x>.
- Tuk, M. A., Zhang, K., & Sweldens, S. (2015). The propagation of self-control: self-control in one domain simultaneously improves self-control in other domains. *Journal of Experimental Psychology: General*, 144, 639–654. <http://dx.doi.org/10.1037/xge0000065>.
- Verhoeven, A. A. C., Adriaanse, M. A., Evers, C., & De Ridder, D. T. D. (2012). The power of habits: unhealthy snacking behaviour is primarily predicted by habit strength. *British Journal of Health Psychology*, 17, 758–770. <http://dx.doi.org/10.1111/j.2044-8287.2012.02070.x>.
- Vohs, K. D., & Heatherton, T. F. (2000). Self-regulatory failure: a resource-depletion approach. *Psychological Science*, 11, 249–254. <http://dx.doi.org/10.1111/1467-9280.00250>.
- Wang, J., Novemsky, N., Dhar, R., & Baumeister, R. F. (2010). Trade-offs and depletion in choice. *Journal of Marketing Research*, 47, 910–919. <http://dx.doi.org/10.1509/jmkr.47.5.910>.
- Wansink, B., & Sobal, J. (2007). Mindless eating: the 200 daily food decisions we overlook. *Environment and Behavior*, 39, 106–123. <http://dx.doi.org/10.1177/0013916506295573>.
- Wills, T. A., Isasi, C. R., Mendoza, D., & Ainette, M. G. (2007). Self-control constructs related to measures of dietary intake and physical activity in adolescents. *Journal of Adolescent Health*, 41, 551–558. <http://dx.doi.org/10.1016/j.jadohealth.2007.06.013>.