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Comparing two psychological interventions in reducing impulsive processes of eating behaviour: Effects on self-selected portion size

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Objective. Palatable food, such as sweets, contains properties that automatically trigger the impulse to consume it even when people have goals or intentions to refrain from consuming such food. We compared the effectiveness of two interventions in reducing the portion size of palatable food that people select for themselves. Specifically, the use of dieting implementation intentions that reduce behaviour towards palatable food via top-down implementation of a dieting goal was pitted against a stop-signal training that changes the impulse-evoking quality of palatable food from bottom-up.

Design. We compared the two interventions using a 2 × 2 factorial design.

Methods. Participants completed a stop-signal training in which they learned to withhold a behavioural response upon presentation of tempting sweets (vs. control condition) and formed implementation intentions to diet (vs. control condition). Selected portion size was measured in a sweet-shop-like environment (Experiment 1) and through a computerized snack dispenser (Experiment 2).

Results. Both interventions reduced the amount of sweets selected in the sweet shop environment (Experiment 1) and the snack dispenser (Experiment 2). On average, participants receiving an intervention selected 36% (Experiment 1) and 51% (Experiment 2) fewer sweets than control participants. In both studies, combining the interventions did not lead to additive effects: Employing one of the interventions appears to successfully eliminate instrumental behaviour towards tempting food, making the other intervention redundant.

Conclusions. Both interventions reduce self-selected portion size, which is considered a major contributor to the current obesity epidemic.

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Statement of contribution

What is already known on this subject? Exposure to temptations, such as unhealthy palatable food, often frustrates people's attainment of long-term health goals. Current approaches to self-control suggest that this is partly because temptations automatically trigger impulsive or hedonic processes that override the influence of more deliberate processes on behaviour. This perspective has stimulated the development of new interventions – which have so far been studied in isolation – aimed at decreasing the influence of impulsive or hedonic processes to decrease unhealthy eating behaviour.

What does this study add?

- Linking sweets to stop signals and diet-prime implementation intentions both reduce self-selected portion size.
- Combining the interventions does not lead to additive effects.
- Each intervention reduces self-selected portion size of sweets, making the other redundant.

Tempting objects often frustrate people's attainment of long-term health goals, even though people can have strong intentions to resist these temptations. Why is it so difficult to control behaviour when encountering temptations? Current approaches to self-control suggest that this is partly because temptations automatically trigger impulsive or hedonic processes that override the influence of deliberate processes on behaviour (e.g., intentions, restraint standards, long-term goals; Hofmann, Friese, & Wiers, 2008; Metcalfe & Mischel, 1999; Strack & Deutsch, 2004; Stroebe, 2008). This perspective has stimulated the development of new methods aimed at decreasing the influence of impulsive processes to help people regain control over behaviour and to decrease unhealthy behaviour (Friese, Hofmann, & Wiers, 2011). The potential of this approach is gaining broad recognition (Marteau, Hollands, & Fletcher, 2012; Sheeran, Gollwitzer, & Bargh, 2013). Interestingly, new methods that target automatic determinants of health behaviour vary greatly in how they reduce the influence of these determinants (e.g., see Sheeran *et al.*, 2013, for a detailed overview).

Specifically, one class of new methods aims to suppress the influence of impulsive processes by strengthening the influence of deliberate processes on behaviour (e.g., long-term health goals). This top-down approach draws on people's motivation and attention within tempting situations to prevent impulsive behaviour. For instance, working memory training aims at increasing people's working memory span and thereby their capability to stick to their long-term health goals (e.g., Houben, Wiers, & Jansen, 2011). Another possibility is to activate mind sets that lead people to judge temptations in relation to their future consequences rather than short-term pleasures (e.g., Fujita & Anna Han, 2009). Likewise, goal-priming strengthens the influence of health goals on behaviour by making them cognitively accessible (e.g., Papies & Hamstra, 2010). Moreover, by forming implementation intentions, people can learn to automatically show healthy responses in situations that usually trigger unhealthy behaviours (e.g., Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011).

Another class of methods focuses on directly changing impulsive reactions to specific stimuli (a bottom-up approach; Hofmann *et al.*, 2008). For instance, attentional bias modification training induces people to disengage attention from unhealthy stimuli (e.g., Fadardi & Cox, 2009), and negative evaluative conditioning aims at changing the positive valence of tempting stimuli (e.g., Hollands, Prestwich, & Marteau, 2011). Other examples are approach/avoidance training where people learn to approach healthy and to avoid unhealthy stimuli (e.g., Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011),

and stop-signal training in which people learn to inhibit behavioural responses to tempting stimuli (e.g., Houben & Jansen, 2011; Veling, Holland, & Van Knippenberg, 2008).

The aim of the present research is to test whether two recently developed interventions to reduce impulsive eating behaviour can influence an important health outcome, that is, portion size selection. Portion size is generally considered a major contributor to the obesity epidemic (e.g., Duffey & Popkin, 2011). Moreover, by testing a top-down and bottom-up intervention within one experimental design, we address the question whether it is beneficial to simultaneously attack impulses top-down and bottom-up (e.g., Sheeran *et al.*, 2013).

Using implementation intentions to target impulses top-down

For the top-down intervention, we build on research showing that implementation intentions can be used as a tool to shift the balance to goal-directed dieting behaviour in favour of impulsive behaviour by reminding people about their dieting goal (Kroese, Adriaanse, Evers, & De Ridder, 2011; Van Koningsbruggen, Stroebe, Papies, & Aarts, 2011). A model that stimulated the development of this intervention is the goal conflict model of eating behaviour (e.g., Stroebe, Van Koningsbruggen, Papies, & Aarts, 2013). This model proposes that the eating behaviour of people motivated to restrict their food intake is dominated by two conflicting goals: Eating enjoyment and dieting. According to this model, perception of palatable food automatically triggers a hedonic eating enjoyment goal (Hofmann, Van Koningsbruggen, Stroebe, Ramanathan, & Aarts, 2010; Papies, Stroebe, & Aarts, 2007) that temporarily inhibits the dieting goal (Stroebe, Mensink, Aarts, Schut, & Kruglanski, 2008). As a result, eating behaviour is guided by the hedonic eating enjoyment goal instead of the dieting goal, thereby increasing the likelihood of overconsumption when encountering tempting food. A prediction derived from this model is that diet stimuli that activate the dieting goal in tempting situations should facilitate control over eating behaviour.

Indeed, studies have shown that dieting goal reminders reduce palatable food consumption (e.g., Anschutz, Van Strien, & Engels, 2008; Fishbach, Friedman, & Kruglanski, 2003; Study 5; Papies & Hamstra, 2010). For instance, participants in Papies and Hamstra's study did or did not encounter a poster announcing a low-calorie recipe when entering a butcher's store. Results showed that this diet-prime reduced consumption of palatable meat snacks that were available for tasting among participants motivated to restrict their food intake. Diet-primes thus restore the influence of the dieting goal on eating behaviour and prevent people from processing food cues entirely in hedonic terms.

Recent research on goal-priming interventions showed that implementation intentions can be used as a tool to teach people to automatically activate the dieting goal themselves in tempting situations (Kroese *et al.*, 2011; Van Koningsbruggen *et al.*, 2011). Implementation intentions are behavioural plans that create a strong link between a specified situation and an instrumental response, making people automatically select this response when entering the situation (e.g., Gollwitzer, 1999; Webb & Sheeran, 2007). Studies using diet-prime implementation intentions (e.g., 'The next time that I am tempted to eat chocolate, then I will think of dieting!') have been found to activate the dieting goal in response to food temptations and to decrease consumption of palatable foods for a period of up to 2 weeks (Kroese *et al.*, 2011; Van Koningsbruggen *et al.*, 2011).

Using stop signals to target impulses bottom-up

Tempting stimuli not only trigger hedonic cognitions but also unintentionally elicit approach tendencies because of their reward value (e.g., Seibt, Häfner, & Deutsch, 2007; Veenstra & De Jong, 2010), thereby contributing to difficulties in self-control. Bottom-up approaches weaken or modify the immediate response that is evoked upon perception of specific tempting stimuli. One method uses behavioural stop signals that are presented in close temporal proximity of tempting foods in a short training procedure, with the aim of modifying subsequent impulsive behaviour towards these foods (Houben, 2011; Houben & Jansen, 2011; Houben, Nederkoorn, Wiers, & Jansen, 2011; Veling & Aarts, 2009, 2011; Veling, Aarts, & Papies, 2011; Veling, Aarts, & Stroebe, 2013). Stop signals are cues in the environment that indicate that people should withhold their behaviour (Veling & Aarts, 2011). A stop signal can be experimentally learned (e.g., 'If you see the letter "L", do not respond!'), but can also be intrinsically associated with withholding a response (e.g., red traffic lights).

Research has shown that behavioural stop signals immediately suppress impulsive motor responses towards palatable food (e.g., Veling, Aarts, & Papies, 2011; Veling, Aarts, & Stroebe, 2011). Moreover, repeated association with stop signals decreases both explicit and implicit evaluations of positive or rewarding stimuli (e.g., Ferrey, Frischen, & Fenske, 2012; Houben, Nederkoorn, *et al.*, 2011; Veling *et al.*, 2008). This suggests that the stop-signal training modifies reactions towards palatable food, which may alter consumption.

Indeed, studies have shown that behaviour towards rewarding stimuli can be reduced by inducing participants to withheld responses to tempting stimuli via a go/no-go task (Houben & Jansen, 2011; Houben, Nederkoorn, *et al.*, 2011; Veling, Aarts, & Papies, 2011; Veling *et al.*, 2013). Houben and Jansen (2011), for instance, consistently associated pictures of chocolate with no-go cues for participants in the experimental condition, while no such association was created in the control condition. Results showed that participants in the experimental condition consumed less chocolate in a subsequent taste test, and this effect was particularly pronounced among participants who find palatable food particularly hard to resist (see also Veling, Aarts, & Papies, 2011).

Implementation intentions versus stop signals

The above-discussed top-down and bottom-up interventions both appear to reduce consumption of tempting food by decreasing the influence of automatically triggered impulsive processes. Here, we aim to test whether these interventions can also reduce the portion size of tempting food people select for themselves. Moreover, we will also explore the combined effects of these interventions.

For this purpose, we assessed participants' behavioural responses towards palatable food (i.e., sweets) as a function of a go/no-go and a diet-prime implementation intention intervention in two experiments. Because previous research suggests that both interventions affect people motivated to restrict their food intake (e.g., Houben & Jansen, 2011; Van Koningsbruggen *et al.*, 2011), all participants formed the goal intention to restrict their intake of sweets before the manipulations. We hypothesized that participants receiving both control treatments would serve themselves most of the sweets, while participants in conditions with at least one intervention would serve themselves less. We also tested whether food-serving

behaviour would be lower when both interventions were employed instead of only one of the interventions.

EXPERIMENT 1

Methods

Design and participants

To test our hypothesis, we used an experimental design with two independent variables, each consisting of two levels. The experiment thus followed a 2 (go/no-go task: no-go vs. control) × 2 (implementation intention: diet-prime vs. control) factorial between-subjects design. The computerized laboratory experiment randomly allocated participants to one of the four conditions: control group (C), no-go task only group (NG), diet-prime only group (DP), or no-go task and diet-prime group (NGDP). Figure 1 shows the participant flow chart. Participants were kept unaware that there were different conditions (see cover story below). Also, the experimenter was blind to conditions since participants completed the intervention tasks individually.

Sample size was determined based on a medium-to-large effect of $f = 0.31$ (Van Koningsbruggen *et al.*, 2011; Veling, Aarts, & Papies, 2011) with $\alpha = .05$ and power = .80 using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), resulting in a required total sample size of 82 participants. The final sample included in the analysis consisted of 89 participants (48 women; $M_{age} = 21.76$, $SD_{age} = 3.37$; $range_{age}$ 18–41; one participant had missing data on background variables). Participants received course credit or a small fee. Most of them were psychology students ($n = 41$) or students from

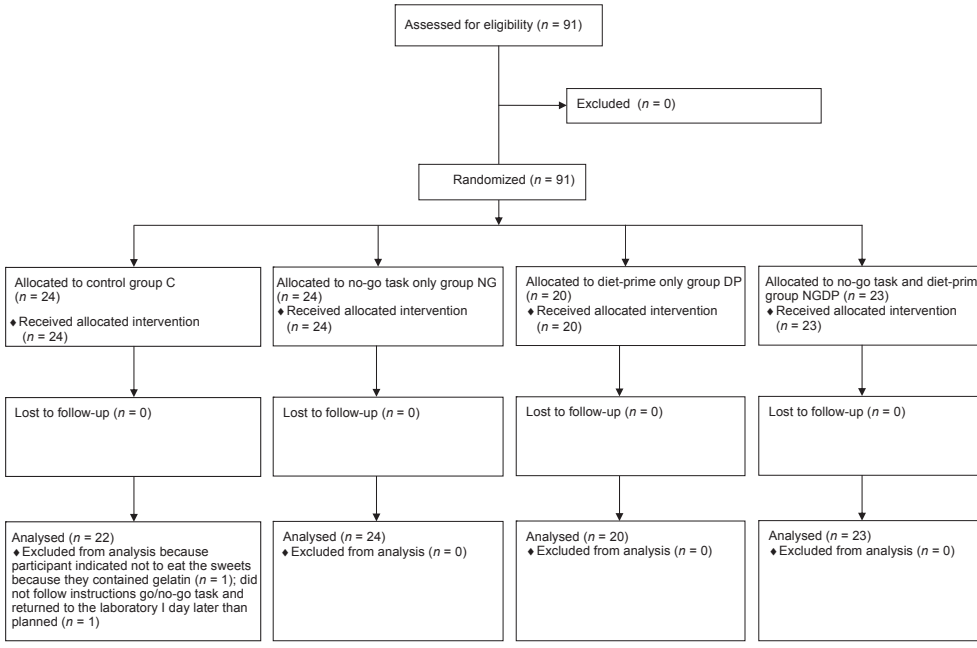

Figure 1. Participant flow chart of Experiment 1.

outside the social sciences (n = 31; other categories n = 16; missing information from n = 1).

Materials

We selected three kinds of sweets (twin cherries, sugared bananas, and English liquorices) with more or less similar shapes that were ranked as most palatable among 45 types of sweets in a pilot study (n = 15). For the go/no-go intervention, we used four different pictures of each of the sweets. One of the pictures contained a close-up of the sweets, the others displayed the sweets in a glass bowl, on a plate, and on a plate with a serving spoon similar to the one used during measurement of actual food-serving behaviour. Furthermore, five pictures of everyday objects (elastic bands, marbles, butterflies, wooden balls, and pencil shavings) were used as filler pictures in the go/no-go task.

Manipulations

Go/no-go task

Participants were informed that we were interested in studying attention processes. They learned that everyday objects would be presented in the middle of the screen for 1,500 ms accompanied by either the letter A or L displayed randomly near one of the four corners of the pictures. After each object–letter combination, a question mark appeared for 1,000 ms, which acted as a sign for participants to respond. In the no-go condition (NG and NGDP groups), participants had to press the space bar when an A (or L counterbalanced across participants) had been presented over the object, and to withhold responding when an L (or A) had been presented. In the no-go condition, the letters thus functioned as go/no-go cues. In the control condition (C and DP groups), participants had to press the A when an A had been presented and an L when the L had been presented. Participants were requested to react as fast and accurately as possible (accuracy feedback was presented after each trial).

The task consisted of 12 blocks of six trials. Within each block, one picture of the sweets was presented, and the five pictures of the filler objects. In the no-go condition, the sweets were always accompanied by a no-go cue, and fillers with either no-go (two trials) or go cues (three trials). Thus, within each block and across the task, the probability of responding in the no-go condition was 50%. In the control condition, the objects were presented with the same letters as in the no-go condition. While in both conditions the task involved, the categorization of letters presented over task-irrelevant objects, only in the no-go condition the task involved withholding a response towards sweets. The procedure was adopted from the study by Veling, Aarts, and Papies (2011, Study 2).

Implementation intentions

Participants learned that we were interested in studying everyday planning and that they were going to make several plans. All participants were first instructed to make a goal intention ('Next week I will…'), followed by an implementation intention. They were asked to adopt the goal intention and implementation intention by silently repeating the plans three times. Participants were also instructed to type in and visualize execution of the implementation intention. All participants first adopted the goal intention 'Next week I will refrain from eating sweets' (C, NG, DP, and NGDP groups). This was done to make

sure that all participants created the intention to restrict their intake of sweets (i.e., a dieting goal). Participants in the diet-prime implementation intention condition (DP and NGDP groups) then supported this intention by making the following if-then plan: 'The next time that I am tempted to have sweets, then I will think of dieting!' (cf. Van Koningsbruggen *et al.*, 2011). Control participants (C and NG groups) made an irrelevant implementation intention: 'The next time my alarm rings, then I will get out of bed immediately!' Next, all participants (C, NG, DP, and NGDP groups) made four filler goal intentions and implementation intentions (e.g., wearing a safety belt, turning off the lights) to strengthen the cover story.

Measures

Food-serving behaviour

Participants were presented with three bowls, each containing one of the sweets. They were given a bag (similar to the ones used in self-serving sweet shop) and were told that they could serve themselves *ad libitum*. Participants learned that after getting the sweets, they would taste one of each type to rate it on a number of taste dimensions and that they could take home the remaining sweets in their bag for further evaluation. While participants completed the next part of the study (see Procedure below), the experimenter weighed the amount of sweets participants served themselves (in grams, separately for each type). Because the three sweets differed in weight and size, we standardized the amount of each type of sweets. We then averaged the *Z*-scores to obtain a mean standardized score of food-serving behaviour (analysing the unstandardized score revealed similar significant results).

Concern for dieting

Motivation to diet was assessed with the Concern for Dieting subscale of the Revised Restraint scale (Herman & Polivy, 1980). The scale assesses the motivation to restrain eating by six items (e.g., 'How often are you dieting?'; $\alpha = .79$).

BMI

Participants reported their body weight and height that we used to calculate their BMI.

Appetite

Participants indicated on a scale how hungry they were at that moment to assess appetite (1 = *not at all*, 7 = *very much*).

Procedure

Day 1

Participants were informed that the research consisted of several unrelated studies and that one was about memory for which they had to return the next day. Participants started with the go/no-go task and then responded to some filler questions with regard to the presented filler objects (e.g., how often did you see a candle) to distract them from the true purpose of the study. Next, participants formed the implementation intentions and ended by responding to other filler questions. These memory-related filler questions were also

asked to strengthen the cover story and to distract participants' attention further from the true purpose of the study.

Day 2

When participants returned the next day, they were told that a short additional study was added to the session that they would start with before continuing the second part of the original study. Participants went to a different room and learned that we needed their judgements about various aspects of sweets for a future study. In this room, participants completed the food-serving behaviour measure. When participants were ready, they went to a different room to finish the 'original study on memory'.

Finally, participants completed the same filler questions concerning their memory of stimuli in the go/no-go task as on Day 1 (to strengthen the cover story), some questionnaires and demographic questions, and were probed for awareness with regard to the purpose of the study. They were asked what they thought the goal of the research was. None of the participants guessed the exact purpose of the experiment. Finally, participants were debriefed and thanked for their participation.

Statistical analyses

Our primary analysis was an ANOVA that tested the main and interaction effects of go/no-go and planning tasks on food-serving behaviour. Interaction effects were further examined by testing the simple main effects of each of the independent variables within each of the levels of the other independent variable (i.e., simple effects analysis; Field, 2013). In addition, and to corroborate the main analysis, we conducted planned pairwise comparisons to further investigate the differences between conditions (C, NG, DP, and NGDP groups).

Results

Participants' age (M = 21.76, SD = 3.37), percentage of women (53.9%), BMI (M = 22.08, SD = 2.87), concern for dieting (M = 6.73, SD = 3.77), appetite (M = 2.78, SD = 1.64), and number of correct responses in the go/no-go training (M = 70.78, SD = 1.51) did not differ between conditions, Fs < 1–1.88, ps = .95–.14, all η_p^2s < .07.

While the ANOVA revealed no main effects of the go/no-go, $F(1, 85) = 3.54$, $p = .063$, $\eta_p^2 = .04$, and planning tasks, $F(1, 85) = 1.43$, $p = .24$, $\eta_p^2 = .02$, the interaction effect between the two tasks was significant, $F(1, 85) = 4.32$, $p = .041$, $\eta_p^2 = .05$ (see Figure 2).[1] Simple effects analyses showed that for participants who received the control version of the go/no-go task, the formation of diet-prime implementation intentions significantly decreased their serving behaviour, $F(1, 85) = 5.06$, $p = .027$, $\eta_p^2 = .06$. The planning task had no effect among participants who had received the

[1] *Including gender in the analysis revealed a main effect of gender,* $F(1, 80) = 14.99$, $p < .001$, $\eta_p^2 = .16$. *Men served themselves more sweets (*$M = 0.33$, $SE = 0.11$*) than women (*$M = -0.26$, $SE = 0.10$*). The effects of go/no-go,* $F(1, 80) = 2.65$, $p = .11$, $\eta_p^2 = .03$, *and planning,* $F(1, 80) = 1.74$, $p = .19$, $\eta_p^2 = .02$, *were not significant, while their interaction remained significant,* $F(1, 80) = 4.47$, $p = .038$, $\eta_p^2 = .05$. *No other effects were significant (gender × go/no-go,* $F(1, 80) = 1.02$, $p = .32$, $\eta_p^2 = .01$; *gender × planning,* $F < 1$; *gender × go/no-go × planning,* $F < 1$).

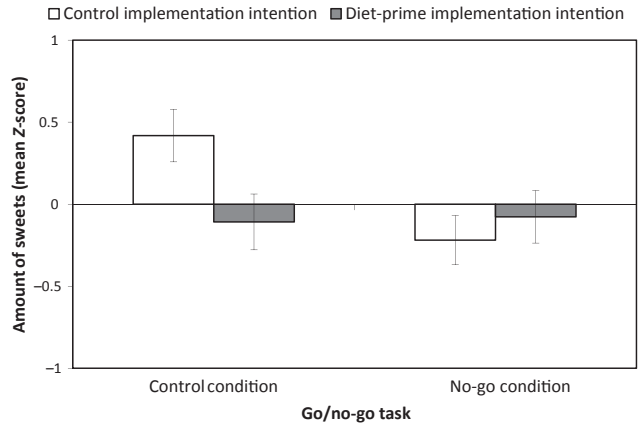

Figure 2. Mean amount of sweets participants served themselves (in sweet-shop-like environment; *Z*-score) as a function of go/no-go task and planning task. Error bars = *SE*.

no-go manipulation, $F < 1$. This shows that diet-prime implementation intentions reduced food-serving behaviour in the absence of the no-go manipulation (C vs. DP groups), but did not further influence behaviour when participants received the no-go manipulation (NG vs. NGDP groups). Approaching this interaction from a different angle (i.e., testing the simple effects of the go/no-go task) revealed that the no-go manipulation decreased serving behaviour among participants who received the control implementation intention, $F(1, 85) = 8.12$, $p = .005$, $\eta_p^2 = .09$, but not among participants who received the diet-prime implementation intention, $F < 1$. This shows that the no-go manipulation reduced food-serving behaviour in the absence of diet-prime implementation intentions (C vs. NG groups), but did not further influence behaviour when participants also received the diet-prime implementation intention (DP vs. NGDP groups).

Pairwise comparisons further showed that food-serving behaviour among participants who received both control treatments (C group) was significantly higher compared with participants in the other conditions (NG, DP, and NGDP groups; *p*s = .031–.005). Moreover, the conditions in which participants received one of the intervention tasks (NG and DP groups) or both (NGDP group) did not differ from each other (*p*s = .89–.52).

Discussion

Results suggest that participants who received one or both of the interventions served themselves a smaller amount of sweets than participants who received both control treatments. Participants who received both interventions did not further decrease their serving behaviour. Notably, in terms of absolute amount of sweets, participants served themselves more than 1.5 times the amount of sweets (in grams) when they received both control treatments ($M = 188.14$; $SD = 126.00$) compared with participants in the other conditions ($M = 119.49$; $SD = 81.84$).

EXPERIMENT 2

Experiment 2 was designed to replicate the findings of Experiment 1, but with an alternative and novel dependent measure of the amount of sweets wanted. Specifically, participants were presented with a computerized snack dispenser and were told that they could earn sweets by continuously pressing a button and that the longer they would hold it the more sweets they would receive at the end of the experiment. We expected that participants receiving both control treatments would serve themselves most of the sweets (i.e., that they would hold down the button the longest), while participants in the other conditions would serve themselves less. Moreover, and based on Experiment 1's findings that combining a go/no-go task with diet-prime implementation intentions does not boost the effectiveness of the interventions, we expected that button holding would not be further decreased by presenting participants both interventions.

Methods

Design and participants

The design was similar to Experiment 1, and participants were also assigned randomly to conditions. Figure 3 shows the participant's flow chart. The participants and experimenter were blind to conditions. The final sample included in the analysis consisted of 88 participants (55 females; M_{age} = 21.17, SD_{age} = 2.21; range 18–30). Participants received course credit or a small fee (the experimenter only allowed participants who did not participate in Experiment 1). Most of them were psychology students (n = 28) or students from outside the social sciences (n = 34; other categories n = 26).

Materials, measures, and procedure

Experiment 2 was identical to Experiment 1 except for the following changes. Whereas Experiment 1 was spread out over 2 days, Experiment 2 consisted of one session in which

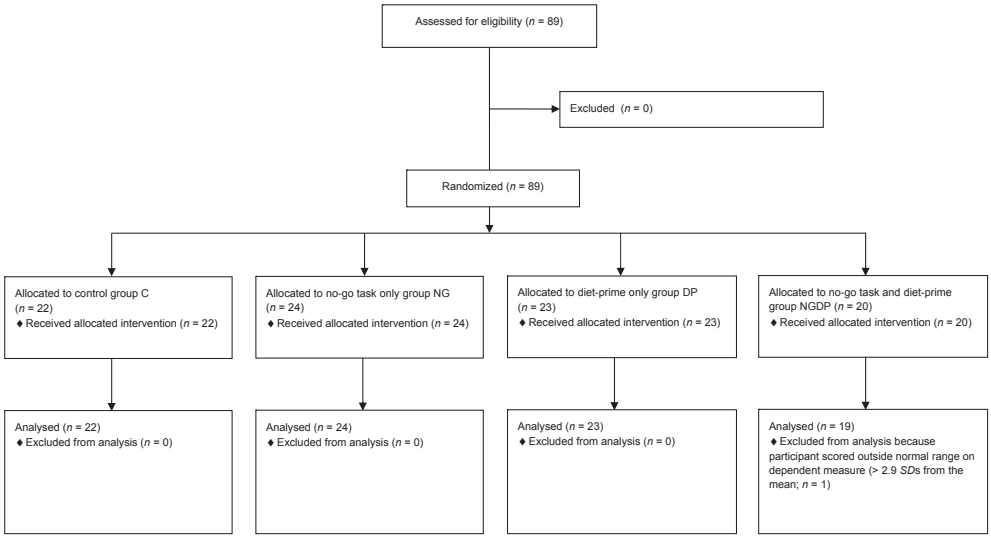

Figure 3. Participant flow chart of Experiment 2.

we measured behaviour towards palatable food following the manipulations (using similar cover stories as in Experiment 1). Between the manipulations and collecting the dependent measure, participants filled in a word completion task.[2] Most important, the main dependent measure was now collected via a computerized snack dispenser. Specifically, participants learned that they could obtain sweets that were left over from previous research. They read that they would see two snack dispensers on the next two screens (one displaying sugared bananas and the other twin cherries; presented in random order) and that they could obtain the sweets by pressing the space bar.[3] They were informed that they were free to press the space bar as long or as short as they liked to get sweets. The longer they would press the space bar, the more sweets they would receive at the end of the study. When participants started pressing the space bar, a grey band scrolled over the sweets visualizing that the snack dispenser dispensed the sweets. The computer unobtrusively recorded the size of the grey area (i.e., total amount dispensed) that resulted in a score between 0 and 500. To obtain the maximum score, participants had to press the space bar for approximately 54 s. The scores of the snack dispensers were averaged and served as our dependent measure.

Next, participants completed the same questions as in Experiment 1 and were probed for awareness with regard to the aim of the study. None of the participants guessed the exact purpose. Finally, participants were debriefed and thanked for their participation.

Results

Participants' age (M = 21.17, SD = 2.21), percentage of women (62.5%), BMI (M = 21.63, SD = 2.32), concern for dieting (M = 6.64, SD = 3.06; α of the scale = .71), appetite (M = 3.84, SD = 1.88), and number of correct responses in the go/no-go training (M = 69.99, SD = 7.71) did not differ between conditions, Fs < 1–1.33, ps = .98–.27, all η_p^2s < .06.

While the ANOVA revealed no main effects of the go/no-go, $F(1, 84) = 2.42$, $p = .12$, $\eta_p^2 = .03$, and planning tasks, $F(1, 84) = 2.28$, $p = .14$, $\eta_p^2 = .03$, the interaction effect between the two tasks was significant, $F(1, 84) = 5.72$, $p = .019$, $\eta_p^2 = .06$ (see Figure 4).[4] Simple effects analyses showed that for participants who received the control version of the go/no-go task, the formation of diet-prime implementation intentions significantly decreased button-holding behaviour, $F(1, 84) = 7.84$, $p = .006$, $\eta_p^2 = .09$. The planning task had no effect among participants who had received the no-go manipulation, $F < 1$. This shows that diet-prime implementation intentions reduced food-serving behaviour in the absence of the no-go manipulation (C vs. DP groups), but did not further influence behaviour when participants received the no-go manipulation (NG

[2] *This was a word completion task originally intended to assess activation of the dieting goal. Eight (of the 16) words could be completed as diet related. Analyses revealed no significant effects and participants only completed 1.26 words on average as diet related; therefore, this task will not be discussed further.*

[3] *We selected bananas and cherries because these two types of sweets were rated quite similar in terms of palatability in Experiment 1.*

[4] *Including gender in the analysis revealed a main effect of gender,* $F(1, 80) = 5.59$, $p = .021$, $\eta_p^2 = .07$. *Men pushed the button down longer (*$M = 129.92$, $SE = 17.58$*) than women (*$M = 77.27$, $SE = 13.67$*). The effect of go/no-go was not significant,* $F(1, 80) = 2.22$, $p = .14$, $\eta_p^2 = .03$, *but planning was,* $F(1, 80) = 4.50$, $p = .037$, $\eta_p^2 = .05$. *Participants in the diet-prime condition served themselves less (*$M = 79.98$, $SE = 15.45$*) than those in the control-prime condition (*$M = 127.20$, $SE = 16.05$*). The go/no-go × planning interaction remained significant,* $F(1, 80) = 5.33$, $p = .024$, $\eta_p^2 = .06$. *No other effects were significant (gender × go/no-go,* $F < 1$; *gender × planning,* $F = 2.09$, $p = .15$, $\eta_p^2 = .03$; *gender × go/no-go × planning,* $F < 1$*).*

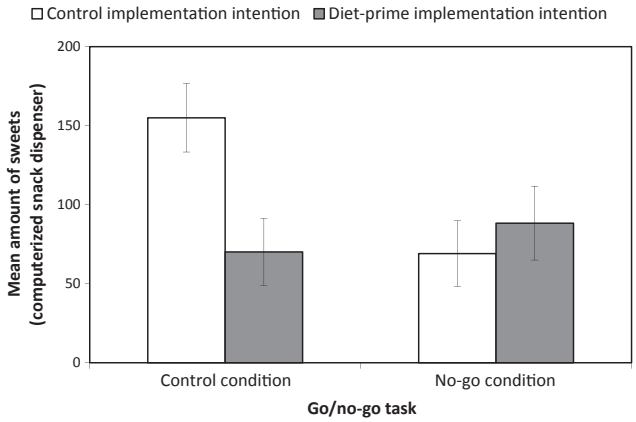

Figure 4. Mean amount of sweets participants served themselves (computerized snack dispenser) as a function of go/no-go task and planning task. Error bars = *SE*.

vs. NGDP groups). Approaching this interaction from a different angle (i.e., testing the simple effects of the go/no-go task) revealed that the no-go manipulation decreased button-holding behaviour among participants who received the control implementation intention, $F(1, 84) = 8.20$, $p = .005$, $\eta_p^2 = .09$, but not among participants who received the diet-prime implementation intention, $F < 1$. This shows that the no-go manipulation reduced food-serving behaviour in the absence of diet-prime implementation intentions (C vs. NG groups), but did not further influence behaviour when participants also received the diet-prime implementation intention (DP vs. NGDP groups).

Pairwise comparisons further showed that participants who received both control treatments (C group) held down the button longer compared with participants in the other conditions (NG, DP, and NGDP groups; ps = .039–.005). Moreover, the conditions in which participants received one of the tasks (NG and DP groups) or both (NGDP group) did not differ from each other (ps = .97–.54).

Discussion

As in Experiment 1, participants who received one or both interventions served themselves less palatable food compared with participants who received both control interventions. These results confirm that presenting participants with one of the interventions makes the other redundant as both seem to successfully target the hedonic or impulsive aspect of palatable food to the same extent.

GENERAL DISCUSSION

Two experiments yielded consistent results: Both dieting implementation intentions and a stop-signal treatment were effective in reducing the amount of sweets that people selected for themselves. Moreover, in both experiments, we did not observe any beneficial effects of combining the two different interventions. This is quite surprising in the light of the fact that these interventions share few features in terms of the methods employed. However, conceptually, these interventions appear similar in that they are both expected to modify behaviour by diminishing the influence of the impulse-evoking

properties of palatable food on behaviour (e.g., Hofmann *et al.*, 2008; Sheeran *et al.*, 2013). Employing one of the interventions appears to successfully eliminate instrumental behaviour towards tempting food, making the other intervention redundant.

Implementation intentions are a well-studied tool to facilitate health behaviour (Gollwitzer, 1999), and most studies to date have focused on activating concrete behaviours in specific situations to facilitate health behaviour (for a review in the domain of eating behaviour, see Adriaanse *et al.*, 2011). The present research adds to this large field of research the insight that implementation intentions can be used to implement a health goal (i.e., dieting) that reduces instrumental behaviour to obtain means that would undermine successful goal pursuit (see also Kroese *et al.*, 2011; Van Koningsbruggen *et al.*, 2011). Furthermore, the experiments add to the literature on using stop signals and implementation intentions to change eating behaviour by revealing that these manipulations not only reduce consumption of fixed portions (e.g., Houben & Jansen, 2011; Kroese *et al.*, 2011; Veling, Aarts, & Papies, 2011), but reduce selected portion size as well. People generally eat more than 80% of the food they select (e.g., Van Kleef, Shimizu, & Wansink, 2012; Wansink & Cheney, 2005), and the present findings thus underscore the value of the interventions to reduce calorie consumption (Duffey & Popkin, 2011).

The important question raised by the present research is whether there is something to gain by the recent focus on developing tasks that target immediate reactions to tempting stimuli to change unhealthy behaviour in general (e.g., Hofmann *et al.*, 2008; Sheeran *et al.*, 2013; Wiers *et al.*, 2011), and unhealthy eating behaviour in particular. That is, the no-go intervention does not seem to add to the effectiveness of the implementation intention intervention, questioning the merits of using a (less-easier to implement) no-go intervention to alter eating behaviour. Although this question cannot yet be answered empirically, there is one theoretical difference between the interventions that may be relevant to consider in future research. Specifically, one potential advantage of an intervention that changes people's immediate responses to rewarding stimuli is that it may depend less on people's goal motivation (e.g., dieting) compared with a top-down intervention such as the current implementation intention intervention (Sheeran, Webb, & Gollwitzer, 2005). Indeed, previous work suggests that a go/no-go task can reduce people's immediate responses to rewarding stimuli even when people are not motivated to control these responses (Veling & Aarts, 2009). In contrast, effects of implementation intentions depend on people's goal motivation (Sheeran *et al.*, 2005). However, additional research is required to examine whether stop-signal training has value in changing health behaviours that cannot be accomplished more straightforward via implementation intentions.

Several limitations to this research need to be acknowledged. First, we used healthy student samples, including many psychology students who may have increased the risk of social desirability responding. The extent to which the present results generalize to other (non-student) populations thus remains open. Second, although the observed reduction in self-selected portion size following the interventions is promising, an important limitation is that we only assessed behaviour in the short term. An important direction for future work is thus to test the long-term effects of the interventions and to investigate how they influence long-term eating behaviours. Another limitation is that BMI was based on participants' self-reported height and weight.

To conclude, theory-based interventions are being developed to reduce unhealthy behaviour by targeting proximal causes of behaviour, such as by preventing the hedonic or impulse-evoking properties of palatable foods to guide behaviour. Although such interventions may be methodologically quite different, here we showed that effects on

behaviour might be quite similar. This insight may help researchers and practitioners interested in testing these interventions in the field to decide which interventions can best be used for a specific purpose. We thus encourage further studies that compare different interventions.

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