OPEN

International Journal of Obesity (2014) **38,** 597–602

www.nature.com/ijo

ORIGINAL ARTICLE

Using health primes to reduce unhealthy snack purchases among overweight consumers in a grocery store

EK Papies[1], I Potjes[1], M Keesman[1], S Schwinghammer[2] and GM van Koningsbruggen[3]

OBJECTIVE: Healthy-eating intentions of overweight individuals are often thwarted by the presence of attractive food temptations in grocery stores and the home environment. To support healthy-eating intentions, we tested the effectiveness of a simple health prime to reduce the purchases of energy-dense snack foods in a grocery store among overweight individuals.
DESIGN: This field experiment had a 2 (condition: health prime vs control) × 2 (weight status: overweight vs normal weight) between-participants design.
METHOD: Customers of a grocery store were handed a recipe flyer that either contained a health and diet prime, or not. Participants' weight and height, as well as their attention to and awareness of the prime during shopping, were assessed by means of a questionnaire. The purchase of unhealthy snack foods was assessed by means of the receipt.
RESULTS: Results showed that the health prime reduced snack purchases compared with the control condition among overweight and obese participants. When primed, overweight and obese participants bought almost 75% fewer snacks than when not primed. Additional analyses showed that although the prime worked only when customers paid initial attention to the flyer that contained the health prime, no conscious awareness of the prime *during* grocery shopping was necessary for these effects.
CONCLUSION: These findings suggest that health priming can lead to healthier grocery shopping among overweight consumers, without relying on conscious awareness during shopping. This makes priming a highly viable intervention tool to facilitate healthy food choices. Such tools are especially relevant in the setting of grocery shopping, given that they have direct effects on eating in the home environment and thus for longer-term weight management.

International Journal of Obesity (2014) **38,** 597–602; doi:10.1038/ijo.2013.136

Keywords: priming; food choice; intervention; behavior change; grocery shopping

INTRODUCTION

Our current 'obesogenic' living environment makes healthy, low-calorie food choices difficult by reminding us continuously of the pleasures of eating tasty, high-calorie food, which is easily available, very affordable and experienced as highly rewarding. Indeed, attractive food cues trigger strong hedonic and reward processes, such as activation in reward areas of the brain, salivation, food cravings, increased attention and actual overeating.[1–4] These reactions are especially pronounced in people struggling with their weight, such as overweight and obese individuals, making the pursuit of their weight control intentions especially difficult.[5–7]

Countering hedonic food cues

In response, it has been argued repeatedly that we need effective environmental interventions targeting these processes, to bolster individuals against the impact of such hedonic cues.[8–11] In the current work, we suggest that placing subtle health primes in the environment, reminding individuals of a healthy weight, may provide promising opportunities for such interventions.

Priming refers to activating the mental representation of a goal or other meaningful construct by means of subtle external cues (for example, words, pictures, or behavior of others) that can affect subsequent cognitive processes and behavior.[12] Although priming has rarely been used to affect meaningful health behaviors,[13] some initial evidence suggests that simple health primes can stimulate healthy cognition and behavior. For example, dieters who were primed subliminally with their weight control goal paid reduced attention to hedonic food cues compared with dieters who had not been primed.[14] Similarly, diet cues in a TV commercial reduced snack consumption among dieters,[15] and exposing dieters to the cover of a health and diet magazine led to less hedonic food choices.[16] These findings suggest that health and diet primes can shift attention and preferences away from attractive, high-calorie food items, thus potentially facilitating low-calorie food choices.

In a field study, we examined the effect of health primes on the actual food purchases of normal-weight and overweight consumers in a grocery store. To our knowledge, this is the first work of its kind. A grocery store is a particularly important setting for food decisions because grocery shopping can affect the eating behavior of several people over several days. Within the setting of a grocery store, the current experiment focuses particularly on attractive, energy-dense snacks, because these play a role in the increasing prevalence of being overweight, and because overweight and obese people consume more snacks than normal-weight consumers.[17–20] Although experienced as highly rewarding,[21] energy-dense, nutrient-poor snacks like cake, chips and chocolate can be easily cut from one's diet to control one's

[1]Department of Psychology, Utrecht University, Utrecht, The Netherlands; [2]Crossmedia Communication in the Public Domain, University of Applied Sciences, Utrecht, The Netherlands and [3]Department of Communication Science, VU University Amsterdam, Amsterdam, The Netherlands. Correspondence: Dr EK Papies, Department of Psychology, Utrecht University, Postbus 80140, Utrecht 3508TC, The Netherlands.
E-mail: E.K.Papies@uu.nl
Received 7 May 2013; revised 3 July 2013; accepted 18 July 2013; accepted article preview online 26 July 2013; advance online publication, 20 August 2013

weight. We hypothesize that reminding consumers subtly of health and dieting may motivate them to consume such foods less,[16,22] and thus reduce the purchases of such items. To test this, we assessed the influence of health primes on purchasing unhealthy and energy-dense snacks.

Upon entering the store, half the participants were primed with the goal of healthy eating and dieting by means of health- and diet-related words that were printed on a recipe flyer. Our main hypothesis was that these primes would reduce the subsequent purchase of snack foods, and that they would particularly influence overweight participants, because weight and health concerns are especially prevalent among this group.[23] Research on goal priming shows that primes work best when they activate a goal or behavior that is relevant for participants, and that participants actually try to pursue.[16,24–26] Therefore, as our main hypothesis, we expect that health and weight primes will mostly affect overweight participants.

The potential role of consciously thinking about the primes

An interesting additional question that may have important practical implications for the use of goal priming in field settings concerns the role of attention and conscious awareness. Although almost all research on priming has been done in highly controlled laboratory environments, priming as an intervention method will ultimately have to function effectively in busy, complex real-life settings. However, we know little about how much attention and awareness of the primes are needed in field settings. In other words, how much attention must participants pay to the priming cues to be effective? Do participants need to keep thinking about the primes for them to affect behavior? Such questions seem particularly relevant in busy shopping environments, in which people have to make numerous food decisions while they try to integrate complex financial and nutrition information,[27] often while under time pressure. Given these demands on our attentional resources, a health intervention to stimulate healthy food choices in field settings is particularly promising if it does not require people to continuously think about the prime and monitor their behavior with high levels of conscious awareness.

The literature on priming suggests that attention may be required for goal activation, but that conscious awareness of the primes is not necessary during subsequent goal pursuit; for a review, see Dijksterhuis and Aarts.[28] Numerous laboratory studies show, for example, that goal primes can affect behavior independent of whether they are presented supraliminally or subliminally, that is, above or below the threshold of conscious awareness during initial processing, as long as they receive initial attention.[24,29,30] Once a goal has been activated by goal-relevant cues, motivation and goal-directed behavior are triggered, which do not rely on conscious awareness.[24] In short, these laboratory studies suggest that while initial attention is essential for the primes to be effective, consciously thinking about them during later behavior is not necessary.

In the current field experiment, goal primes were presented supraliminally, but in an unobtrusive way (that is, printed on a recipe flyer). We expected that these primes would only affect behavior when they were initially perceived with some degree of attention.[28,31] We hypothesized, however, that priming effects would occur without thinking about the prime during shopping. To test these hypotheses, we included specific questions in the control questionnaire. These questions assessed whether participants had looked at the recipe flyer containing the prime, and whether they had been thinking about it during grocery shopping. We expected that goal priming effects would occur only when participants had paid attention to the flyer initially, but that they would be independent of whether participants later thought about the prime or not.

MATERIALS AND METHODS

Participants

Ninety-nine customers of a local supermarket agreed to participate and completed the control questionnaire (5 men, 94 women). (This study was conducted in accordance with the institutional guidelines for human experimentation in Psychological Research of Utrecht University. Five additional participants did not answer the questions about weight or for how many people they were doing groceries, and could therefore not be included in the main analyses.) The mean age of participants was 54.18 (s.d. = 11.90). Mean body mass index (BMI) was 24.73 kg m^{-2} (s.d. = 4.69). Participants with a BMI below 25 kg m^{-2} were classified as normal-weight (coded as 0), and participants with a BMI of $\geqslant$25 were classified as overweight or obese (coded as 1; for ease of reading, this group will be referred to as overweight). Most participants had a lower education level ($N = 58$), while some had completed or were receiving higher education ($N = 38$; missing information from $N = 3$). See Table 1 for participant characteristics.

Design

The study had a 2 (condition: health goal prime vs control) $\times$ 2 (weight status: normal weight vs overweight) between-participants design.

Health goal priming

Participants were handed a recipe flyer that presented a low-calorie recipe (a gratinated pasta dish) retrieved from the website of The Netherlands Nutrition Center, accompanied by a color picture of the dish (see Supplementary Figure 1). Around the main text, we included words

Table 1. Distribution of participants over conditions, and participant characteristics

Control condition	*Health prime condition*	*Difference between conditions*
Weight status		
$N_{normalweight} = 27$	$N_{normalweight} = 30$	$\chi^2 = 0.53$, $P = 0.54$
$N_{overweight} = 23$	$N_{overweight} = 19$	
Mean concern for dieting scores		
$M = 0.95$ (s.e. = 0.06)	$M = 0.98$ (s.e. = 0.06)	F = 0.17, $P = 0.68$
Mean number of persons doing groceries for		
$M = 2.92$ (s.e. = 0.18)	$M = 2.90$ (s.e. = 0.18)	F = 0.007, $P = 0.92$
Current level of experienced hunger		
$M = 2.10$ (s.e. = 0.22)	$M = 1.91$ (s.e. = 0.22)	F = 0.39, $P = 0.54$
Time spent in store (min)		
$M = 15.38$ (s.e. = 1.20)	$M = 15.06$ (s.e. = 1.22)	F = 0.04, $P = 0.85$
Age		
$M = 53.83$ (s.e. = 1.71)	$M = 54.50$ (s.e. = 1.69)	F = 0.08, $P = 0.78$
Number of children		
$M = 0.88$ (s.e. = 0.15)	$M = 0.82$ (s.e. = 0.15)	F = 0.09, $P = 0.76$
Education level		
$N_{low} = 32$	$N_{low} = 26$	$\chi^2 = 1.57$, $P = 0.30$
$N_{high} = 16$	$N_{high} = 22$	

Note: we categorized education level as 'low' if participants had completed primary school, pre-vocational training or vocational training, and as 'high' if they had completed an (applied) university education, or the type of high school preparing for this.

either related to the health consciousness of the recipe in the health prime condition (for example, healthy, 'good for your figure', and the amount of calories), or unrelated to health and weight in the control condition ('new recipe' and 'try it out').

Procedure and measures

Participants were approached before entering the supermarket and asked if they wanted to participate in a study on the way people do their grocery shopping. If they agreed to participate, they were told that they would be approached by another experimenter after they paid their groceries. In addition, they were handed the recipe flyer. Importantly, at that point, we did not tell them that we would later ask for their grocery receipts. Participants then did their grocery shopping as usual. The experimenters noted the time participants spent in the store ($M = 15.22$ min, s.d. $= 8.46$). The experiment was conducted on five afternoons between 1300 and 1700 hours. Participants on one half of the afternoons were handed the health prime flyer, and participants on the other half received the control flyer, and the order of conditions was reversed over the days of the experiment. Day of the experiment did not affect the results (all $P > 0.39$).

After paying, participants were approached by a second experimenter and were first asked to provide written informed consent. Then, participants completed a brief questionnaire assessing Concern for Dieting,[32] weight and height to calculate BMI, hunger (1 = not at all hungry to 7 = very hungry), for how many people in their household they were purchasing groceries, and whether they were in a hurry (1 = not at all to 7 = very much). Three questions assessed attention to the recipe flyer ('Did you look at the recipe, and if so, how extensively did you look at it?' 1 = not at all to 7 = very extensively), as well as conscious awareness of the prime during shopping ('Did you think back or look back at the recipe flyer during grocery shopping? 1 = *no;* 2 = *yes*, I thought about it; 3 = *yes*, I looked at it; and 4 = yes, I thought about and looked at it'), and continued visibility of the flyer ('What did you do with the recipe flyer during grocery shopping? (a) I put it away right away, (b) I put it in the cart/basket and (c) I held it in my hand'). (Unfortunately, some participants failed to complete all of these control questions. Three participants failed to answer the question regarding initial attention to the flyer, one failed to answer what they had done with the flyer during shopping, and five did not indicate whether they were in a hurry.). Demographic questions included gender, age, and education level. Finally, as suspicion checks, we asked the participants if they had noticed something special about the recipe, and what they thought the purpose of the study was. In the meantime, with the participants' consent, a digital photograph of their receipt was taken. Participants received a small snack as a reward for participation.

From participants' grocery receipts, we coded the category of 'unhealthy snacks' as the sum of units of cake and cookies, sweets and chocolate, and chips and other savory and nut snacks that the participants purchased. We also registered the costs of the snacks purchased from each category (see Table 2 and Supplementary Table 1).

Data analysis

Our main analysis was an ANOVA that assessed the effects of condition and weight status on the number of unhealthy snacks purchased, while controlling for the number of persons in the household that the participants were doing groceries for. We corroborated this by analyzing the costs of participants' snack purchases in the same way. Interaction effects were examined by performing specific contrast analyses.

We then conducted additional analyses to assess whether initial attention to the prime and awareness of the prime during shopping were necessary for the prime to affect behavior. To this end, we first conducted two separate ANOVAs testing whether initial attention to the flyer and consciously thinking about the flyer during shopping were affected by weight status and condition. We then included attention and awareness separately in the analysis of the number of snacks purchased, to assess whether they would moderate the priming effect.

In additional regression analyses, we also assessed the possible moderating effects of whether the flyer was visible to the participants during shopping, of experienced hunger and of whether participants were in a hurry during shopping, given that this may have reduced the impact of the prime and thus led to more habitual shopping behavior.[33]

In all analyses reported here, we included all main and interaction effects.

Table 2. Range and mean number of purchases of units of snacks from three different categories, and the associated costs

	Cake and cookies	*Sweets and chocolate*	*Chips and other savory snacks*	*Total*
Units of snacks				
Range	0–4	0–5	0–10	0–11
M	0.57	0.52	0.66	1.71
s.d.	1.05	1.03	1.59	2.75
Costs of snacks (in €)				
Range	0–7.21	0–6.22	0–9.50	0–15.53
M	0.83	0.66	0.81	2.30
s.d.	1.59	1.33	1.91	3.47

RESULTS

Effects of primes and weight on snack purchases

The critical ANOVA revealed the predicted interaction of condition and weight status on the number of snack purchases, $F(1, 94) = 5.87$, $P = 0.02$ and $\eta^2 = 0.06$, displayed in Figure 1. Contrast analyses showed that in the control condition, overweight participants bought somewhat more unhealthy snacks than normal-weight participants, $F(1, 94) = 3.53$, $P = 0.06$ and $\eta^2 = 0.04$. Importantly, among the overweight individuals, the health prime reduced unhealthy snack purchases compared with the control condition, $F(1, 94) = 6.59$, $P = 0.01$ and $\eta^2 = 0.07$. Overweight participants in the control condition bought 2.79 (s.e. = 0.55) units of snacks, whereas overweight participants in the health prime condition bought only 0.72 (s.e. = 0.60) units. This is a reduction of 74.2%.

Among normal-weight participants, the goal prime had no effect, as they bought equal numbers of snacks in the health prime as in the control condition, $F(1, 94) = 0.53$, $P = 0.47$. Thus, the health goal prime reduced the purchases of unhealthy energy-dense snacks, but only among overweight/obese participants.

Not surprisingly, this analysis also revealed a main effect of number of people, such that participants bought more unhealthy snacks if they purchased groceries for more people, $F(1, 94) = 8.55$, $P = 0.004$, and $\eta^2 = 0.08$.

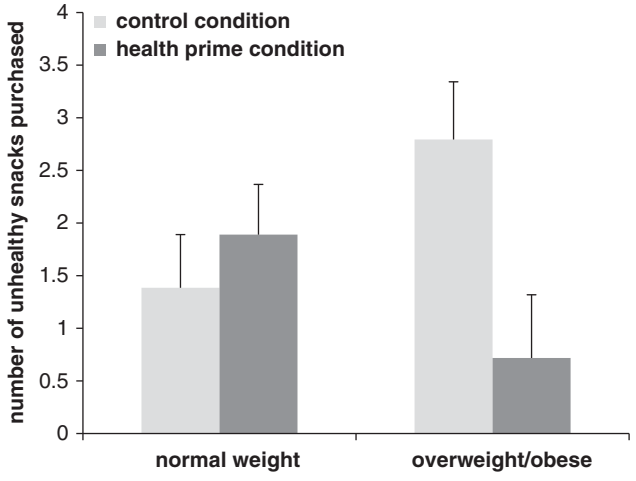

Figure 1. Number of unhealthy snack purchases among normal-weight and overweight/obese participants in the control condition, and when primed with the goal of healthy eating when entering the supermarket (controlling for the number of people in the household). Error bars represent the standard error.

To corroborate these findings, we conducted the same analysis with the cost of unhealthy snacks purchased as the dependent variable. This revealed the same critical interaction of condition and weight status, $F(1, 90) = 4.70$, $P = 0.03$ and $\eta^2 = 0.05$. In the control condition, overweight participants spent somewhat more money on unhealthy snacks than normal-weight participants, $F(1, 90) = 3.05$, $P = 0.08$ and $\eta^2 = 0.03$. Importantly, overweight individuals spent less on unhealthy snacks in the health prime condition ($M = €1.05$, s.e. $= 0.80$) than in the control condition ($M = €3.65$, s.e. $= 0.72$), $F(1, 90) = 5.87$, $P = 0.02$ and $\eta^2 = 0.06$. Again, among normal-weight participants, the goal prime had no effect, $F < 1$. There was a main effect of number of people participants did groceries for on the cost of unhealthy snacks purchased, $F(1, 90) = 3.91$, $P = 0.05$ and $\eta^2 = 0.04$. The total value of the groceries participants bought ($M = €29.62$, s.e. $= 2.31$) was not affected by weight status and condition, all $P > 0.17$.

Initial attention to the prime

An ANOVA with condition and weight status on initial attention paid to the flyer revealed a main effect of condition, $F(1, 92) = 10.08$, $P = 0.002$ and $\eta^2 = 0.099$, such that participants looked at the flyer more extensively in the health prime ($M = 3.82$, s.e. $= 0.27$) compared with the control condition ($M = 2.61$, s.e. $= 0.27$). This was not affected by weight status.

We then repeated the ANOVA on the number of snacks purchased, now including attention to the flyer as an additional factor. (Because the variable attention was not normally distributed (30 participants reported that they paid no attention at all), we performed a median split (median = 3). However, essentially the same pattern of means emerges when taking attention scores into account as a continuous predictor in a regression analysis, instead of as a categorical variable with a median split.) In addition to the main effect of number of people, $F(1, 87) = 11.27$, $P = 0.001$ and $\eta^2 = 0.12$, this analysis revealed the interaction of weight status and condition described above, $F(1, 87) = 9.89$, $P = 0.002$ and $\eta^2 = 0.10$. However, this was qualified by a three-way interaction with attention, $F(1, 87) = 4.88$, $P = 0.03$ and $\eta^2 = 0.05$.

To further examine this interaction, we tested the effects of prime and weight status separately for the participants below and above the median of initial attention to the prime. With little or no attention to the recipe flyer, there was no interaction of condition and weight status, $F(1, 45) = 0.49$, $P = 0.49$. However, when participants paid more extensive attention, there was a strong interaction of prime and weight status, $F(1, 41) = 11.85$, $P = 0.001$ and $\eta^2 = 0.22$. Contrast effects showed that normal-weight participants were not affected by the health prime, $F < 1$, and bought similar amounts of snacks in the control condition ($M = 0.82$, s.e. $= 0.78$) as in the health prime condition ($M = 1.77$, s.e. $= 0.62$). However, overweight participants bought much fewer snacks after the health prime ($M = 0.34$, s.e. $= 0.80$) than in the control condition ($M = 5.14$, s.e. $= 0.31$), $F(1, 41) = 13.86$, $P = 0.001$ and $\eta^2 = 0.25$ (see also Supplementary Figure 2). Thus, the prime only reduced snack purchases of overweight consumers if it had been processed with some degree of initial attention.

Conscious awareness of the prime during shopping

An ANOVA revealed a main effect of condition on conscious awareness of the prime during shopping, $F(1, 95) = 5.69$, $P = 0.02$ and $\eta^2 = 0.06$, which was qualified by an interaction with weight status, $F(1, 95) = 8.72$, $P = 0.004$ and $\eta^2 = 0.08$. Normal-weight participants' awareness of the flyer was not affected by condition, $F(1, 95) = 0.19$, $P = 0.66$, but overweight participants thought about the flyer during shopping more often when it contained diet- and health-related words ($M = 2.21$, s.e. $= 0.19$) compared with the control condition ($M = 1.30$, s.e. $= 0.17$), $F(1, 95) = 12.34$, $P = 0.001$ and $\eta^2 = 0.12$ (see also Supplementary Figure 3).

We repeated the ANOVA of purchases of unhealthy snacks, now including awareness as an additional factor. (Participants' answers to the question whether they had thought or looked back at the recipe flyer during shopping were coded as 0 ('no conscious awareness', $N = 59$) when they had answered 'no', and as 1 ('conscious awareness', $N = 40$) when they had either thought about the recipe flyer, looked at it or both.) This showed that the critical interaction of weight status and condition was not affected by thinking about the flyer, $F < 1.90$, NS. Thus, the prime reduced the snack purchases of overweight participants but not of normal-weight participants, regardless of whether they had been thinking about the flyer during shopping. No other significant effects of thinking about the flyer emerged either. This finding shows that the effects of the health prime on purchasing behavior were independent of whether participants consciously thought about it during shopping.

A further, additional analysis supported this result. Specifically, we examined the effect of the flyer's visibility during shopping. Participants' answers to what they had done with the flyer during shopping were coded as 0 if they indicated that they put the flyer away directly, and as 1 if they held in their hand or put in the cart. An ANOVA showed that this variable did not affect the results, as the interaction of weight status and condition was not qualified by a three-way interaction with visibility, $F < 0.70$, NS.

Similarly, the degree of hurry that participants reported, as well as the time spent grocery shopping, and participants' experienced hunger did not affect this result, all $F < 0.60$, NS. (There was only a two-way interaction of standardized hunger scores with weight status, $F(1, 85) = 4.24$, $P = 0.043$ and $\eta^2 = 0.047$, such that when relatively hungry (at 1 s.d. above the mean of the hunger scale) overweight participants bought slightly more unhealthy snacks than normal-weight participants, $F(1, 85) = 2.29$, $P = 0.09$ and $\eta^2 = 0.03$, but not when they were relatively less hungry, $P = 0.22$.) Thus, even when participants were presumably making quick, impulsive decisions about their groceries, the prime appeared to be effective, with its effectiveness not being reduced by spending more time in the store.

Suspicion probes

Only six participants (all in the health prime condition) mentioned either that the recipe was low in calories or contained diet-related words. None of the participants correctly guessed the hypothesis of the experiment, and only one participant (in the prime condition) hypothesized that we might examine buying behavior related to the recipe that we distributed. Thus, participants did not seem to be aware of the goals of the research. This suggests that demand effects and social pressure were unlikely to contribute to the reported pattern of results.

DISCUSSION

This field experiment showed that health priming strongly reduced the purchases of high-calorie snacks among overweight consumers. Overweight and obese participants who received a simple recipe flyer featuring health- and diet-related words bought almost 75% fewer unhealthy snacks than overweight and obese participants who received the same flyer without the health- and diet-related words. Additional analyses revealed that these priming effects on purchasing behavior were independent of whether or not participants thought about the prime while shopping. This is an important finding given that many food decisions are made in very busy, demanding situations. In sum, this study identified health primes as an intervention tool that is low in costs, works particularly for overweight consumers and is effective even in busy environments.

These results are in line with studies showing that diet primes reduced unhealthy consumption only among dieters.[26,34]

No earlier studies, however, have tested goal priming in the highly relevant, dynamic field setting of grocery shopping. Thus, to our knowledge, this study is the first to show that subtle health primes can affect the grocery shopping of overweight consumers. This is especially relevant since for overweight and obese customers monitoring their snack intake is particularly important and difficult.[17,20] The fact that the prime reduced the amount of snacks overweight people bought is particularly promising, as such primes could affect eating behavior in the home and may also have long-term implications for the snack consumption of multiple people, including children. This result was corroborated by the finding that overweight participants also spent less money on unhealthy snacks. This suggests that the health prime did not simply change purchases, for example, such that overweight individuals bought fewer, but more expensive snacks. Rather, they truly reduced their snack purchases.

One important limitation of the current work is that we had to rely on participants' self-reported height and weight, which may lead to underestimations of BMI.[35] However, in the current field setting, objective assessments of height and weight would have been too disruptive. In addition, overweight participants were equally distributed over conditions, reducing the potential effect of underreporting on our results. Another limitation is that we could only assess participants' attention to the flyer and their later awareness of the prime by explicit questions, rather than manipulating these variables. Future studies may develop more fine-grained procedures to manipulate participants' exposure to the priming cues, even in field settings. Finally, although grocery stores are an important setting to investigate the use of intervention tools, an important limitation is that we only assessed snack purchases, rather than calories ingested. Future work may attempt to include follow-up measures of actual eating behavior. So-called 'small changes', such as reducing intake by 100 kcal a day, have been suggested to be sufficient to prevent weight gain over time.[10,36] We suggest that reducing access to high-calorie snacks by not buying them in the first place[36] may facilitate such small, but significant changes, and future research could show this.

Despite these limitations, the current study advances our insights into the workings of health primes in field settings in important ways. We found that participants' memory about the flyer was affected in meaningful ways by its motivational relevance, as overweight participants thought about it more during shopping when it contained health- and diet-related words. Thus, this measure seems to capture relevant variation in the degree of awareness. Interestingly, however, the degree of awareness of the prime during shopping did not affect its effectiveness, which suggests that once the health goal was triggered its pursuit was regulated by nonconscious processes, rather than by consciously keeping the goal in mind.[24] This suggests that goal primes can facilitate healthy behavior even in dynamic situations with strong demands on our attentional resources, which increases their applicability in busy daily-life settings. In addition, the prime was effective for an extended period of time: participants spent an average of 15 min in the store, and the time they took for grocery shopping did not moderate the effects of the prime. Future studies, possibly in larger stores, could look into this further to examine the temporal boundaries of health primes in field settings. In addition, future studies could assess the potential for habituation to these primes after repeated exposures, and how to prevent it to maintain high effectiveness of goal primes.

When using goal primes in field settings and interventions, the primes should not be too blatant, in order to prevent effects of reactance or defensive processing, given that research has shown that when health messages arouse too much worry or fear in perceivers, they can have adverse effects.[37] Our study found, however, that the health prime reduced participants' purchases of unhealthy snacks only when they had initially paid attention to the prime. Thus, health primes should also not be too subtle, to make sure that participants process them in the first place.

CONCLUSION

Overweight individuals can be induced to buy less unhealthy snacks when they are primed with weight and health when entering the supermarket. The effects of priming seem to be independent of conscious awareness during shopping. The grocery store is a particularly important setting for influencing consumers because snack consumption is strongly associated with overweight, and because preventing the purchases of snacks in the grocery store will affect eating behavior in the home environment. Thus, priming healthy choices at the point of purchase may be a low-cost, effective means of facilitating healthy behavior.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

The research was supported by grants of The Netherlands Organization for Scientific Research (NWO) to Esther K Papies (VENI-451-10-027) and to The Netherlands Nutrition Center (ZonMW), and designed in the context of an internship of the second author at The Netherlands Nutrition Center. We would like to thank Harm Veling and Lawrence W Barsalou for useful discussions of this research, and Unna Danner for helpful comments on an earlier version of this manuscript.

REFERENCES

1 Burger KS, Stice E. Relation of dietary restraint scores to activation of reward-related brain regions in response to food intake, anticipated intake, and food pictures. *NeuroImage* 2011; **55**: 233–239.
2 Castellanos EH, Charboneau EH, Dietrich MS, Park S, Bradley BP, Mogg K *et al.* Obese adults have visual attention bias for food cue images: evidence for altered reward system function. *Int J Obes* 2009; **33**: 1063–1073.
3 Ferriday D, Brunstrom JM. 'I just can't help myself': effects of food-cue exposure in overweight and lean individuals. *Int J Obes* 2011; **35**: 142–149.
4 Lappalainen R, Sjoden PO, Karhunen L, Gladh V. Inhibition of anticipatory salivation and craving in response to food stimuli. *Physiol Behav* 1994; **56**: 393–398.
5 Cohen DA. Obesity and the built environment: changes in environmental cues cause energy imbalances. *Int J Obes* 2008; **32**: S137–S142.
6 Levitsky DA, Pacanowski CR. Free will and the obesity epidemic. *Public Health Nutr* 2012; **15**: 126–141.
7 Mann T, Tomiyama AJ, Westling E, Lew A-M, Samuels B, Chatman J. Medicare's search for effective obesity treatments: diets are not the answer. *Am Psychol* 2007; **62**: 220–233.
8 Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet* 2002; **360**: 473–482.
9 Gortmaker SL, Swinburn BA, Levy D, Carter R, Mabry PL, Finegood DT *et al.* Changing the future of obesity: science, policy, and action. *Lancet* 2011; **378**: 838–847.
10 Hill JO, Wyatt HR, Reed GW, Peters JC. Obesity and the environment: where do we go from here? *Science* 2003; **299**: 853–855.
11 Marteau TM, Hollands GJ, Fletcher PC. Changing human behavior to prevent disease: the importance of targeting automatic processes. *Science* 2012; **337**: 1492–1495.
12 Bargh JA, Chartrand TL. The mind in the middle: a practical guide to priming and automaticity research. in Reis HT. *Handbook of Research Methods in Social and Personality Psychology*. New York: Cambridge University Press. 2000. pp 253–285.
13 Sheeran P, Gollwitzer PM, Bargh JA. Nonconscious processes and health. *Health Psychol* 2013; **32**: 460–473.
14 Papies EK, Stroebe W, Aarts H. The allure of forbidden food: on the role of attention in self-regulation. *J Exp Soc Psychol* 2008; **44**: 1283–1292.
15 Anschutz DJ, Van Strien T, Engels RCME. Exposure to slim images in mass media: television commercials as reminders of restriction in restrained eaters. *Health Psychol* 2008; **27**: 401–408.

16 Fishbach A, Friedman RS, Kruglanski AW. Leading us not unto temptation: momentary allurements elicit overriding goal activation. *J Pers Soc Psychol* 2003; **84**: 296–309.
17 Forslund HB, Torgerson JS, Sjöström L, Lindroos AK. Snacking frequency in relation to energy intake and food choices in obese men and women compared to a reference population. *Int J Obes* 2005; **29**: 711–719.
18 Levitsky DA. The non-regulation of food intake in humans: hope for reversing the epidemic of obesity. *Physiol Behav* 2005; **86**: 623.
19 Nielsen SJ, Siega-Riz AM, Popkin BM. Trends in energy intake in u.s. between 1977 and 1996: similar shifts seen across age groups. *Obesity* 2002; **10**: 370–378.
20 Yoon J-S, Lee N-J. Dietary patterns of obese high school girls: snack consumption and energy intake. *Nutr Res Pract* 2010; **4**: 433–437.
21 Drewnowski A. Energy intake and sensory properties of food. *Am J Clin Nutr* 1995; **62**: 1081S–1085S.
22 Van Koningsbruggen GM, Stroebe W, Papies EK, Aarts H. Implementation intentions as goal primes: boosting self-control in tempting environments. *Eur J Soc Psychol* 2011; **41**: 551–557.
23 Bish CL, Blanck HM, Serdula MK, Marcus M, Kohl 3rd HW, Khan LK. Diet and physical activity behaviors among americans trying to lose weight: 2000 behavioral risk factor surveillance system**. *Obesity* 2005; **13**: 596–607.
24 Custers R, Aarts H. The unconscious will: how the pursuit of goals operates outside of conscious awareness. *Science* 2010; **329**: 47–50.
25 Moskowitz GB. Preconscious effects of temporary goals on attention. *J Exp Soc Psychol* 2002; **38**: 397–404.
26 Papies EK, Hamstra P. Goal priming and eating behavior: enhancing self-regulation by environmental cues. *Health Psychol* 2010; **29**: 384–388.
27 Furst T, Connors M, Bisogni CA, Sobal J, Falk LW. Food choice: a conceptual model of the process. *Appetite* 1996; **26**: 247–266.
28 Dijksterhuis A, Aarts H. Goals, attention, and (un)consciousness. *Annu Rev Psychol* 2010; **61**: 467–490.
29 Bargh JA, Lee-Chai A, Barndollar K, Gollwitzer PM, Trötschel R. The automated will: nonconscious activation and pursuit of behavioral goals. *J Pers Soc Psychol* 2001; **81**: 1014–1027.
30 Ouwehand C, Papies EK. Eat it or beat it: the differential effect of food temptations on overweight and normal-weight restrained eaters. *Appetite* 2010; **55**: 56–60.
31 Koch C, Tsuchiya N. Attention and consciousness: two distinct brain processes. *Trends Cogn Sci* 2007; **11**: 16–22.
32 Herman CP, Polivy J. In: Stunkard AJ. *Restrained Eating in Obesity*. Saunders, 1980, pp 208–225.
33 Hofmann W, Friese M, Wiers RW. Impulsive versus reflective influences on health behavior: a theoretical framework and empirical review. *Health Psychol Rev* 2008; **2**: 111–137.
34 Papies EK, Veling H. Healthy dining: subtle diet reminders at the point of purchase increase low-calorie food choices among both chronic and current dieters. *Appetite* 2013; **61**: 1–7.
35 Gorber SC, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev* 2007; **8**: 307–326.
36 Rozin P, Scott S, Dingley M, Urbanek JK, Jiang H, Kaltenbach M. Nudge to nobesity I: minor changes in accessibility decrease food intake. *Judgment Decis Making* 2011; **6**: 323–332.
37 Witte K, Allen M. A meta-analysis of fear appeals: implications for effective public health campaigns. *Health Educ Behav* 2000; **27**: 591–615.

Supplementary Information accompanies this paper on International Journal of Obesity website (http://www.nature.com/ijo)