Brief Cutting Edge Report
EPIDEMIOLOGY/GENETICS

Obesity

Effects of Sales Promotions, Weight Status, and Impulsivity on Purchases in a Supermarket

Chantal Nederkoorn

Objective: Several environmental factors contribute to increased food consumption and play a role in the prevalence of obesity, like portion size, accessibility and relative price of high caloric foods, food commercials, and sales promotions. However, not everyone seems equally sensitive to these environmental cues and both obesity and impulsivity appears to play a role.
Methods: In this study, food purchases in an internet supermarket are tested in 118 participants, with or without sales promotions for snack foods. Both weight status and response inhibition, an index of impulsivity, are measured.
Results: Participants with less inhibitory control purchased in total more calories from the internet supermarket then participants with more inhibitory control. In addition, sales promotion, weight status, and inhibitory control appeared to interact in their effect on snack food purchases: participants with less inhibitory control and overweight bought more calories of snacks in the sales promotions condition, but not in the control condition. For the other participants, with normal weight and/or high inhibitory control, sales promotions had no effect on their purchases of calories of snacks.
Conclusions: It seems that especially the combination of low inhibitory control and overweight makes participants vulnerable for environmental cues.

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Introduction

The role of the environment in the development of the obesity epidemic is well acknowledged. For example, research showed that larger portions (1), easy accessibility (2), relatively cheap prices (3), television commercials (4), advergames on the computer (5), and sales promotions of food (6) contribute to increased consumption of food. However, not everyone seems equally responsive to these environmental cues. Not everyone becomes obese, while enduring the same societal food abundance.

Several studies showed that people respond differently to food cues in the environment: children who are obese demonstrated more alertness to food adverts than lean children (7) and obese adults showed increased attention for food cues relative to lean participants (8,9). In addition to more attention, obese individuals show increased salivary response and craving after exposure to food cues, compared lean individuals (10,11). Similarly, children who are obese ate more after exposure to food cues than normal-weight controls (12).

In addition to weight status, individual differences in impulsivity influences responsiveness to food cues. Previous studies showed that high-impulsive people tend to eat more when confronted with palatable food then low-impulsive people (13) and participants with higher levels of impulsivity experienced larger cue reactivity to pizza cues (14). One would therefore also expect high-impulsive people to be less resistant to sales promotions and commercials, aimed at marketing food items. However, to the best of our knowledge, this has not been tested yet. Moreover, since obesity and impulsivity appear related, it is interesting to study the contribution of both factors on food cue reactivity.

In the current study, we hypothesize that overweight and/or high-impulsive people buy more calories in an internet supermarket with sales promotions for snacks then without sales promotions, compared to lean and/or low-impulsive people.

Methods

Participants

Participants were recruited by advertisements on Dutch websites, using GoogleAds. When clicking on this advertisement, an informed consent was shown. The inclusion criteria (being between 18 and 50 years, at least occasionally shopping in supermarkets) were explained. Participants could give their informed consent by

Faculty of Psychology and Neuroscience, Maastricht University, P.O. Box 616, 6200 MD, Maastricht, The Netherlands
Correspondence: C. Nederkoorn (c.nederkoorn@maastrichtuniversity.nl)

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selecting the agreement button, which directed them to the first task. A total of 386 participants started this experiment, of which 130 participants completed all tasks. After close inspection, five participants were excluded because they made more then 33% errors on the stop signal task, and seven participants purchased more calories than 2.5 SD from the mean (after a square root transformation). Of the remaining 118 participants, 45 were overweight (BMI > 25) and 73 reported a healthy weight (BMI < 25). Demographics of the participants are summarized in Table 1.

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research. Approval of the Maastricht University Ethical Committee was obtained.

Procedure and materials

First, demographics were measured in a questionnaire, including gender, age, height and weight, net family income ranging from 1 (<1000 € per month) to 5 (>4000 € per month), education level ranging from 1 (no education) to 6 (bachelor or master degree), and self-reported hunger.

Next, participants performed a web-based internet supermarket task (15), in which 708 different food products from 25 main food categories (e.g., vegetables, fruits, dairy products, and candy) could be purchased. Participants received the following instructions: "Imagine that you spend three days in a holiday house, all by yourself. You are enabled to buy now all the groceries you would need for yourself and they will be delivered freshly. There are no other possibilities to obtain food or drinks: you have to buy now everything you would need for these 3 days."

Participants were randomly assigned by the computer to a version of the supermarket with ($n = 48$) or without sales promotions ($n = 70$). In the sales promotion condition, advertisements for snack foods, including pizza, crisps, cookies, and candy were positioned on the bottom of the screen. Prices in both conditions were equal. For each participant, the total amount of calories purchased was measured, as well as calories of snacks, including only calories from product types that were advertised.

Finally, the participants performed the stop signal task (16). The stop signal task measures response inhibition, an executive function that allows people to exert control over pre-potent impulses and which has been related to impulsivity (16). In this task, a participant must respond as fast as possible to a go signal unless a stop signal appears, in which case the response must be inhibited (25% of the trials). The delay of the stop signal is initially set at 250 ms after the presentation of the go signal, and then adjusted dynamically dependent on the response of the participant, hereby enabling the participant to stop on approximately 50% of the stop trials. The stop signal reaction time (SSRT) is calculated by subtracting the mean stop delay from the mean reaction time. A higher SSRT indicates less inhibitory control.

TABLE 1 Participant characteristics (mean and SD) and statistical tests of group differences

	Healthy weight ($n = 73$)	Overweight ($n = 45$)	*t*-value
BMI	21.7 (2.1)	29.1 (4.0)	13.1[a]
Age	29.2 (9.1)	31 (9.1)	1.05
Gender	64 females/9 males	38 females/7 males	Chi-square = 0.077
Education	5.2 (1.2)	5.2 (0.9)	0.08
Income	2.5 (1.3)	2.6 (1.1)	0.27

[a] $p < 0.01$.

Statistical analyses

Because the data on purchased calories (total calories and calories of snacks) was skewed, a square root transformation was applied. Data was analyzed with two univariate ANCOVA's, with condition (advertisements/no advertisements) and weight status (healthy weight/overweight) as between subject factors, SSRT as continuous covariate and total purchased calories and snack calories as dependent variables. None of the demographic variables, including hunger, was correlated to the dependent variables and they were therefore not included as covariates.

Results

Mean performance on the stop signal task and supermarket task are summarized in Table 2. There was no significant effect of weight status on response inhibition ($t(116) = 0.57$, n.s.).

Total purchased calories

There was no main effect of the advertisement condition ($F[1,117] = 0.44$, n.s.) and overweight ($F[1,117] = 0.02$, n.s.) on the total amount of calories purchased. Response inhibition had a significant effect ($F[1,117] = 7.3$, $p < 0.01$, $\eta_p^2 = 0.06$): less effective inhibition was related to increased purchased calories. Higher order interactions did not reach significance (all $F < 2.8$; Figure 1).

Calories of snacks

There was no main effect of the advertisement condition ($F[1,117] = 1.85$, n.s.) and overweight ($F[1,117] = 2.0$, n.s.) on the purchased snack calories. Response inhibition had a significant effect ($F[1,117] = 7.88$, $p < 0.01$, $\eta_p^2 = 0.07$): less effective inhibition was related to more snack calories. There was a significant interaction

TABLE 2 Descriptives of performance (mean and SD) on the supermarket task and the stop signal task

Task	Healthy weight ($n = 73$)	Overweight ($n = 45$)
Supermarket task		
Total purchased calories	14,392 (6744) kcal	13,380 (6200) kcal
Purchased snack calories	897 (1160) kcal	1023 (1324) kcal
Total money spend	36.6 (16) €	34.3 (15) €
Stop signal task		
Reaction time	590.3 (84.9) ms	627.8 (101.5) ms
Delay	258.2 (85.2) ms	289.2 (64.7) ms
Stop signal reaction time	332.0 (59.4) ms	338.6 (62.5) ms

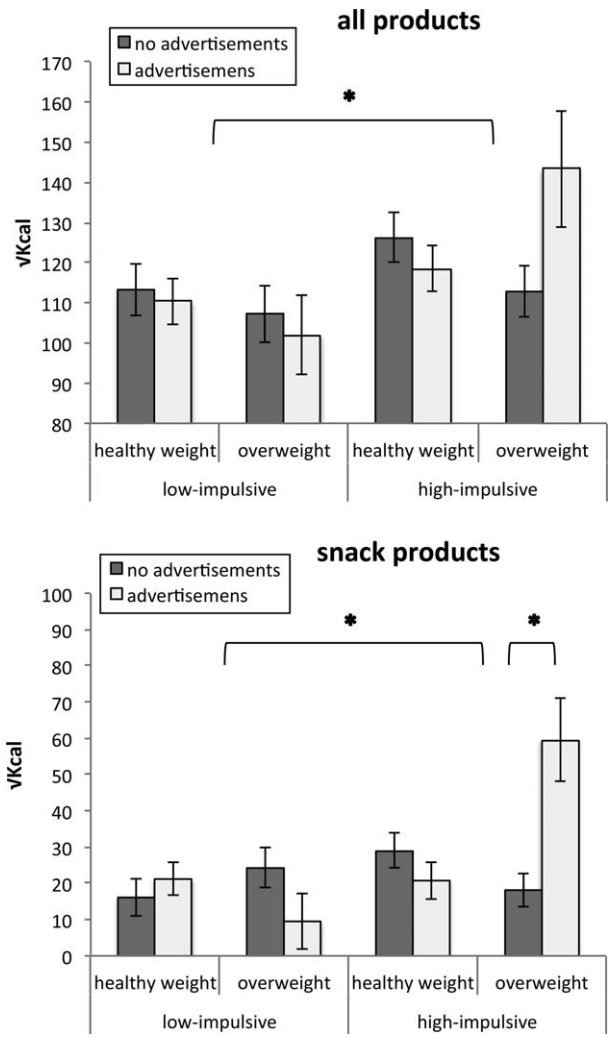

FIGURE 1 Purchased calories from all products and snack foods, which were advertised in the sales promotion conditions, by condition (advertisements/no advertisements), weight status, and inhibitory control (1 SD below or above the mean SSRT). Error bars indicate standard errors of the mean.

between response inhibition and advertisement condition ($F[1,117] = 4.67$, $p < 0.05$, $\eta_p^2 = 0.04$): participants with less effective inhibition bought more snack calories when the products were advertised. There was also a marginally significant interaction between overweight and advertisement condition ($F[1,117] = 3.05$, $p = 0.08$, $\eta_p^2 = 0.03$); overweight participants bought more snack calories when the products were advertised. Both interactions were qualified by a significant three-way interaction between response inhibition, overweight, and advertisement condition ($F[1,117] = 12.4$, $p < 0.001$, $\eta_p^2 = 0.10$; Figure 1). When splitting the data in a healthy weight and overweight group, it appeared that there was no significant interaction between response inhibition and advertisement condition ($F[1,72] = 1.8$, n.s.) in the healthy weight group. However, in the overweight group, the interaction between response inhibition and advertisement condition was significant ($F[1,44] = 10.5$, $p < 0.005$, $\eta_p^2 = 0.20$): response inhibition increased the purchase of calories when advertised ($F[1,13] = 9.5$, $p < 0.01$, $\eta_p^2 = 0.44$), but not without advertisements ($F[1,30] = 0.9$, n.s.). This means that the three-way interaction between response inhibition, overweight, and condition was mainly driven by the increased purchase of calories of snacks by the high-impulsive, overweight participants.

Discussion

This study showed that high-impulsive people purchased more calories from the supermarket then low-impulsive people did. This confirms earlier findings of the effect of impulsivity on food intake and food cravings (13,14). The food advertisements did not show the expected main effect on purchases, and neither did weight status. However, the advertisements interacted with impulsivity and weight status: high-impulsive individuals bought more calories from snack products when they were advertised, but only when they were overweight. Lean high-impulsive individuals were not influenced by advertisements.

This study partly confirms our hypothesis. Although it was expected that impulsivity would render all participants more vulnerable for advertisements, this appeared only true for overweight participants. Lean impulsive participants were capable of resisting the advertisements. Our findings are in line with earlier studies, in which the combination of impulsivity and a preference for snack foods predicted weight gain (17) or in which the combination of low self-control and increased neural reward responding to food cues is associated with increased BMI (18). It seems therefore that the combination of impulsivity and reward of snack foods makes people more vulnerable to the environment. This explanation suggests that the overweight participants in this study found snack foods more rewarding. Unfortunately we did not measure this, but existing evidence indeed suggests that overweight participant find high caloric snack foods more reinforcing (19). This implies that impulsive people without such an inclination might exert their impulses in different domains, according to their own personal preferences. A limitation of this study is that BMI was self-reported. Because people tend to underestimate their BMI, some participants might be misclassified. In addition, an online supermarket may not be a comparable setting to normal supermarkets.

In conclusion, low inhibitory control leads to increased caloric purchases in an internet supermarket. In addition, low inhibitory control, in combination with overweight, makes participants especially vulnerable for environmental food cues. O

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