Addiction to food: how go/no-go tasks affect appetite

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Abstract

Obesity has an extremely high mortality rate. Most obese people try out several diets, while only a few of them are able to hold on to it and refrain from overeating. A number of studies have been conducted to discover the underlying mechanisms that cause some people not being able to fully commit to a diet. Earlier studies show that people with obesity have much stronger automatic impulses and less inhibitory control over their behavior regarding food intake. This lack in control can be trained by repeating computer tasks focusing on executive functioning. In this study it is hypothesized that a go/no-go training will strengthen impulse control.

Sixty-six adolescents were included in this study. The present study was a Randomized Controlled Trial in which thirty-three participants took part in the intervention task and thirty-three were assigned to the control task. The independent variable to train inhibitory control was a go/no-go computer task. The short term dependent variable got measured by the Bogus Taste Test and the long term dependent variable got measured by difference in Body Mass Index between baseline and follow-up measurement after three weeks.

Current study does not show any significant difference in food consumption after the intervention which means no short term effect of the training. Weight loss between baseline and follow-up measurement on the other hand, does demonstrate a significant difference, where the intervention condition shows a decrease in body weight compared to the control condition. These outcomes indicate an increased inhibitory control system on the long term which arises as a result of the go/no-go training. Being able to train inhibitory control of food related stimuli makes it an interesting topic to be further explored in combating obesity.

Keywords
Obesity, go/no-go training, executive functioning, inhibitory control.

Introduction

Overeating frequently results in obesity and as a result it has become a major topic of discussion. Some even view obesity as a life-threatening disease taking on epidemic proportions. The number of serious cases is increasing drastically every year. Mortality rate is high and is ranked as the fifth leading risk factor for deaths worldwide (World Health Organization, 2009). Many diseases like cardiovascular diseases, diabetes, musculoskeletal disorders and cancer are a direct result of obesity and are associated with the unhealthy lifestyle that coincides with obesity (World Health Organization, 2009). People desperately try out many different so-called diets, while in the end only a few people are able to hold on to them and sustain a healthy weight and lifestyle (Friese, Hofmann & Wänke, 2008).

Why is it so hard for some people to fully commit to a diet and maintain a healthy weight? One important factor in not being able to stick to healthy food habits is the trait impulsiveness. Impulsiveness has everything to do with not having the ability to inhibit urges towards stimuli and not knowing how to make the right choices. Earlier studies show that many people suffering from obesity have difficulties in decision making, where they often base their decision on what first comes to mind instead of formulating a balance between the pros and cons (Fitzpatrick, Gilbert & Serpell, 2013). Decision making is an important factor in inhibitory control and is essential in making rational choices which would provide the most positive long term outcomes. For people suffering from obesity, a lack in decision making and impulsive behavior are specifically related to food and food related stimuli (Fitzpatrick et al, 2013). A number of studies have focused on the underlying mechanisms that lead to this impulsive behavior. Hofmann and colleagues outline a model in which self-control behavior, including eating behavior, can be predicted by a dual-system perspective in which both reflective precursors (i.e. reasoning) as well as impulsive precursors (i.e. spontaneous) play a crucial role in behavior (Hofmann, Friese & Stack, 2009).

Impulsive and reflective precursors

Inhibitory control is considered to be an immensely important subject in performed behavior. The ability to control ones actions is essential in inhibiting inappropriate thoughts and behavior. This inhibitory skill allows one to be flexible in shifting from one situation to another while at the same time being able to make the best choice.

Executive functioning, a brain system in which inhibitory control is the main subject, not only focuses on behavior but is also important in planning and organizational tasks. Being able to manage current and future tasks enables the potential to make correct long term decisions. Different kinds of executive functions can be described, although all are essentially related and overlapping (Cooper-Kahn & Dietzel, 2008). If one lacks monitoring behavior or has no motivation, self-regulation will be unsuccessful (Hofmann et al, 2012). According to Friese, Wänke and Plesser (2006), there is also a relation between cognitive capacity and food consumption. This shows that people with higher cognitive load who are exposed to food, show more impulsive behavior towards eating. Lower cognitive load on the other hand, allows one to have more mental space for deliberative thinking and thus increased power to control behavior, leading to less food consumption (Friese et al, 2006).

Several models are developed to analyze the inhibitory control system. According to Friese et al. (2008), the theory that people suffering from obesity have much stronger automatic impulses and less inhibitory control over their food intake compared to people with healthy weights, can be related to these models. First, there is the Reflective Impulse Model (RIM), where Hofmann, Friese and Strack (2009) describe two types of precursors to behavior. These are the reflective and the impulsive precursors. Reflective precursors allow one to reason about what actions are best for longer term effects. It is a higher functional and slower pathway than the impulsive behavioral pathway and generates behavior decision from schemes, formed by attitudes in the motor cortex. In contrast to the reflective system, impulsive precursors result in quick behavior. It often causes positive short-term results, but negative effects in the long-term. Impulses arise from within the associative clusters housing the long-term memory and is formed from earlier perceptual stimuli and experiences. The reflective and impulsive systems are continuously competing, and only one of them wins and allows the associated behavior to appear. Whether the reflective or the impulsive behavioral system takes control, is highly dependent on situational and dispositional conditions. Hofmann et al (2009) explain that inhibitory control plays an important role in shifting from domination in the impulsive behavior to domination of the reflective behavior. Being able to inhibit impulses is related to the reflective system, while automatic and lower functional processes are the underlying mechanism in more impulsive behavior. In the latter, a lack of inhibitory control is observed. People where these automatic processes are dominant show a deficiency in self-control (Hofmann et al, 2009).

Chaiken and Trope (1999) have also focused on the dual-system of behavior. They developed a model where they argued that memory is an important factor in performance. Chaiken and Tropen (1999) divided memory into explicit memory and implicit memory where explicit memory is important in controlled behavior and can be predicted by attitudes, while implicit memory is linked to less controlled and more impulsive behavior (Chaiken & Trope, 1999). This model is called the Motivation and Opportunity as Determinants (MODE) model, and shows that behavior is either the consequence of motivation resulting from reasoning or the product of the spontaneous attitude behavior process. The MODE model is similar to the model described by Hofmann et al (2009). Chaiken and Trope (1999) state that when looking further into reasoning, this is not the only factor important in deliberative acting. Opportunities, which refer to time and resources, must be present as well. Opportunities can be seen as the substitution of situational and dispositional conditions in the RIM. Without such opportunities, reasoning ability is compromised and the spontaneous attitude behavior process dominates. Examples can be found in interfering tasks that demand quick reflective responses. These interfering tasks disrupt deliberative thinking (Chaiken & Trope, 1999).

Looking at the inhibitory control system, these theories can be strongly related to eating behavior. One must not only have a negative attitude towards unhealthy food products in order to being able to resist, but must also have the opportunity to inhibit impulsive urges (Hofmann et al, 2009). Based on the dual process models, people with lower inhibition are expected to have less control over their eating behavior. This results in higher food consumption and correlated higher weights (Friese et al, 2008).

Executive functioning and obesity

Obese people do not want to be overweight and unhealthy, but they are unable to control their impulses (Hofmann et al, 2009). Several studies indicate a decreased ability in inhibitory control in people who are overweight. Barkin (2013) demonstrates that there is a relation between obesity, and brain structures that are important in executive functioning. These brain structures consist of the limbic and neural circuits, together with the orbitofrontal cortex. Earlier studies show a correlation between orbitofrontal cortex volume and food choices. Lower orbitofrontal cortex volume often results in unhealthier food choices and higher weights. Executive functioning and orbitofrontal cortex volume show a negative relation where the lower orbitofrontal cortex volume correlates with a decreased ability in inhibition of behavior (Cohen, Yates, Duong & Convit, 2011).

Training inhibitory control and the aim of this study

The brain's plasticity allows it to change and reorganize. This ability is important in manipulating and strengthening pathways necessary for inhibitory control. Interfering and manipulating behavior enables one to train the brain for the longer term (Kolb & Whishaw, 2003). Investigating the effects of training focusing on change in brain pathways is important in challenging the main problems behind obesity. Go/no-go computer tasks appear feasible in providing people a more developed impulse control system. This system helps inhibit food cravings so that weight can be maintained and obesity will decrease. The age-old problem of obesity cannot be conquered in one day and needs a therapy which fosters solid long term outcomes.

Previous studies showed that training inhibitory control is a promising strategy in learning to control eating habits. Houben and Jansen (2011) demonstrated that a go/no-go computer task where no-go cues were consistently paired with chocolate, shows less chocolate intake after the intervention. In this go/no-go task, several food items were presented on a computer screen, where the unhealthy food type (i.e. chocolate) consistently had to be inhibited (no-go cue). The other food types did not have to be inhibited (go cues). By repeatedly having a specific unhealthy food type being a no-go cue, people in the no-go condition learned to inhibit their actions with regard to this stimuli. In the control condition on the other hand, both chocolate and other food types were either no-go cues or go cues which means inhibition of the different food types took place randomly. It was seen that less chocolate was consumed during the Bogus Taste Test in the intervention group. This Bogus Taste Test took place right after the computer task. During the Bogus Taste Test, three bowls of different kinds of chocolate were given to participants. However, this study only focused on short term outcomes where measurements took place immediately after the intervention. Veling and colleagues (Veling, Van Koningsbruggen, Aarts & Stroebe, 2014) extended this study by deploying the inhibitory training for an increased period of four weeks. Participants performed the go/no-go training once a week on the internet, four times in total. Other than Houben and Jansen (2011), the dependent variable was the difference in Body Mass Index (weight / length^2) between baseline and follow-up measurement. Veling et al (2014) show statistically significant results in weight loss after performing the go/no-go training, where weight loss in the intervention group was greater than in the control group (Veling et al, 2014). These outcomes indicate that the go/no-go training decreases impulsive behavior which means this pathway is not dominating in performed behavior anymore. It seems that inadequate control of inhibition can be trained by undergoing repetitive computer tasks focusing on executive functioning

(Houben & Jansen, 2011; Veling et al, 2014). Being able to train inhibitory control of food-related stimuli makes this go/no-go training an interesting topic to be explored further in combating obesity.

In contrary to Houben and Jansen (2011), the aim of the present study not only has its focus on short term outcomes, but also concentrates on longer term effects of the inhibitory control training. Other than Veling et al (2011), the intervention in present study took place once, without repeated sessions. This was to see if applying the intervention a single time will train inhibitory control for a longer period of time. In current study, participants were randomly assigned to either an intervention group or a control group. Just like Houben and Jansen (2011) and Veling et al (2011), unhealthy food types were always no-go items in the intervention condition. In the control group healthy and unhealthy food types were both fifty percent of the times go or no-go items. After following the training, food intake was measured by a Bogus Taste Test to assess the short term effect of the intervention on eating behavior. The second dependent variable was the BMI difference between baseline and follow-up measurement three weeks after the training. BMI difference measured the long term effect of the intervention. The first hypothesis was that the intervention group would have a reduced urge to eat after the computer task compared to the control group, evidenced by less food intake during the taste test. The second hypothesis was that the intervention group would lose more weight between baseline and follow-up measurement compared to the control group.

Material and methods

Participants and design

Sixty-six participants took part in this study. All participants were recruited at Maastricht University. All the participants were female, aged between eighteen and forty years old (age: M = 21.45, SD = 1.82) and had a BMI greater than eighteen (BMI: M = 23.61, SD = 2.98). Exclusion criteria were people who were non-Dutch speakers or had an allergy for nuts, milk or gluten. The research was a Randomized Control Trial in which thirty-three of the participants took part in the intervention and thirty-three participants were assigned to the control task.

Go/no-go task

The go/no-go task consisted of 360 trials. Participants were presented with a counter where different food types where shown consecutively. At the same time, two images of food types were displayed at the top of the screen. These two images functioned as

go cues. Therefore, whenever the presented food item on the counter matched one of the pictures above, participants had to click the food item with their computer mouse (i.e., these were go trials). When the presented food item on the counter did not match one of the two go cues, participants should not respond (i.e., no go trials). Food items were presented for 1000 ms on the counter. When participants responded correctly during a given trial, the food items were presented for a shorter duration (-25 ms) during the next trial. Whenever they made an error, food items in the next trial were presented for a longer duration (+25 ms). The food items were three unhealthy snacks (chips, chocolate and chocolate chip cookie), three healthy snacks (apple, banana and orange) and three filler items (popcorn, soup and rice waffle). Filler stimuli were used to mask the goal of the study and to avoid demand characteristics. Participants were randomly assigned to one of the two conditions. In the intervention condition, healthy snacks were consistently paired with the go cues, while unhealthy snacks were paired with a no-go cue. The filler pictures were presented with a go cue on half the trials and without a go cue on the other half of the trails. In the control condition, all snacks were presented with a go cue on half the trials and with a no-go cue on the other half of the trials. Go and no-go trials were always presented in random order.

Bogus Taste Test

Food intake was measured by the amount the participants ate during a so called Bogus Taste Test. Three bowls were provided with chips, chocolate and chocolate chip cookies. Participants were informed that they could eat as much as they liked while filling out two filler questionnaires (Barrat Impulsiveness Scale - 11 and Five Facet Mindfulness Questionnaire). After ten minutes the bowls were taken away. The bowls were weighed once before giving them to the participants and once after the participants had left the room. The weight difference between the first and second measurements was calculated to quantify the food intake.

Body Mass Index

Participants' weight and height were assessed in order to calculate participants' BMI. Participants were weighed with their clothes on.

Results

To see if the go/no-go training increased inhibitory control in the short term, it was analyzed whether the intervention group consumed less food than the control condition. The mean total food consumption in grams in the intervention group was 10.95 (*SD* =

14.59). The control group's mean total food consumption was 13.76 gram (*SD* = 30.50). There was no significant difference in food consumption between the two groups, t(63) = -.47, *p* = .64. Figure 1 illustrates the scatter graph of food consumption in both groups.

To see if the go/no-go training has a positive influence on inhibitory control in the long term, the BMI difference was measured in both groups and were compared with each other. Mean BMI in the intervention group decreased (*M* = .09, *SD* = .26). The control group's mean BMI increased (*M* = -.09, *SD* = .26). There was a significant contrast between the two conditions when looking at BMI difference, t(63) = 2.16, *p* = .03. The scatter graph of BMI decrease and increase (resp. intervention and control group) is shown in a boxplot in figure 2 for both the intervention and the control group.

Discussion/Conclusion

This study explored whether training of inhibitory control is possible and could reinforce impulse control regarding food intake. Present study was a Randomized Controlled Trial with a go/no-go computer task. In this task, repeated pairing of unhealthy food types to no-go cues took place in the intervention condition while both unhealthy as well as healthy food types were paired to the no-go cues in the control condition. To analyze short term outcomes, food intake was measured right after the intervention took place. The long term outcome of the intervention was analyzed by a baseline measurement compared to a follow-up measurement after three weeks, where difference in weight and thus the difference in BMI was calculated. The first hypothesis was that food intake would be lower in the intervention group than in the control group. The second hypothesis was that BMI difference between baseline and follow-up measurement would be more negative (decrease in BMI) in the intervention group than in the control group.

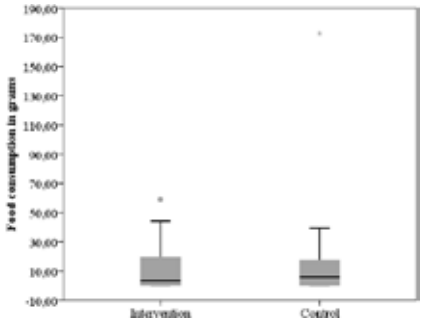

Figure 1. Boxplot of amount of food consumption per condition.

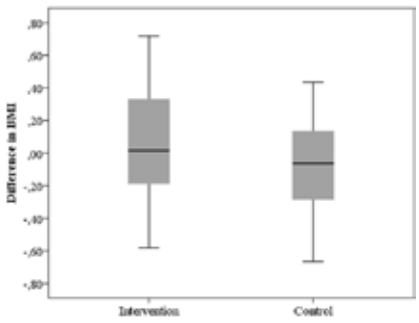

Figure 2. Boxplot of BMI difference between baseline and follow-up measurement per condition.

As opposed to earlier studies, this study investigated the role of the go/no-go training in the short and long term where the participants only followed the training for one time. Earlier studies either focused on the short term outcomes after one go/no-go training (Houben & Jansen, 2011) or the long term results after multiple trainings (Veling et al, 2014). In contrast to Houben and Jansen (2011), the present study went beyond one no-go food type, and extended it with three unhealthy food types trained for inhibition. When looking at Veling and collegues, the current study was consistent as far as the amount of trained food types. Both the current study and that of Veling et al (2014) trained more than one unhealthy food type. The difference between the present study and Veling and colleagues was that in the latter the participants took the training multiple times and used, using the internet (Veling et al, 2014). A disadvantage when applying the training on the internet is that it can never be controlled whether the participants performed the training in the right way. In the present study, participants performed the training in the laboratory, an important advantage, being that the researchers could control for bias like concentration and focus exclusively on the participants' tasks.

The first hypothesis, which was that food consumption would be lower in the intervention group, could not be proofed by this study. For the food consumption, there was no significant difference found between both conditions. This could indicate that the go/no-go training did not improve inhibitory control over food intake immediately following the training (i.e. short term outcome). This finding is not in line with Houben and Jansen (2011) who did find an effect of the training looking at food intake, where food intake was lower in the intervention group. This discrepancy could be due to the food types used as the no-go cues. In Houben and Jansen (2011) the only unhealthy food type which was applied as no-go cue was chocolate. In the current study there were three types of unhealthy no-go cues. It might be more difficult and/or take more time to have inhibitory control trained when looking at more than one stimuli. This could explain why the results in Houben and Jansen (2011) were not replicated by this study.

Regarding the second hypothesis, where the BMI difference was looked at three weeks after the go/no-go training, the intervention group showed a significant BMI decrease compared to the control group. This implies that the go/no-go training may have caused weight loss and thus decreased food intake in the long run. This finding is in line with Veling et al (2014), who also showed a significant weight loss following the go/no-go training. These outcomes indicate that even with more than one food type as a no-go cue, inhibitory control can possibly be trained when observing the longer term outcomes.

In summary, the effect of the training on food consumption, which was seen in Houben and Jansen (2011), could not be reproduced. Questions remain about what causes this difference, although it most likely has to do with the amount of stimuli that were trained. Furthermore, in future research it is crucial to make the food consumption less obvious to participants. In this study most participants were able to figure out that food consumption was a variable. They could have felt unsure about whether or not to eat the food which was presented, since they knew it was a study about food. In future research it is important that participants are blinded to the role of food consumption. This can be done either by having other people than psychology and health science students taking part, or by using less obvious ways of presenting the food. A way of doing this could be by fooling the participants and telling them that there is a totally different subject being investigated. However, the results seen in Veling et al (2014) were reproduced by this study. BMI decrease was significant when comparing the intervention group to the control group. Still, more research is necessary to be more certain about the reliability of these outcomes. To be sure that the go/no-go training keeps having the same effect in even longer terms than measured in this study, more follow-up measurements must be done. This is important in order to see how long the effect of the training is sustained and how often the training must be given for the best long term results. Although much more research must be done to confirm these outcomes, it is highly possible that exposing people who want to lose weight to a go/no-go training could be a very helpful additive in the treatment of obesity. Fighting obesity is an important issue nowadays which can benefit from every little bit of help.

Role of the student

Marlies Y. Gish was an undergraduate student, working under the supervision of dr. K. Houben. The study design was invented by the supervisor. The performance of the study and the processing of the results as well as formulation of the conclusions and the writing were done by the student.

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