Food-Specific Inhibition Training for Food Devaluation

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Food-specific inhibition training could lead to food devaluation which, in turn, may help people to regulate their eating behavior. The effects of training on participants' food evaluation differed according to the type of evaluation; food-specific inhibition training significantly decreased participants' explicit food evaluation, but not their implicit food evaluation.

Keywords: food-specific inhibition training ; food devaluation

1. Introduction

Eating behaviors can be defined as the internal driving force for the approach and ingestion of food [1]. Dysfunctional eating behaviors, such as overeating and binge eating, can be aggravated by many factors, including higher evaluations (e.g., greater craving or wanting) of high-energy-density foods (e.g., foods that contain large amounts of sugar and fat) [2]. Both external (e.g., obesogenic environment) and internal (e.g., anxious/depressive states, impulsivity) factors could contribute to the high evaluations of high-calorie foods [3]. Critically, according to the incentive sensitization theory [4] and the dynamic vulnerability model of obesity [5][6], increased incentive salience of high-calorie food cues and the activity of the brain's reward system in response to high-calorie food cues can predict overeating and weight gain.

1.1. Food-Specific Inhibition Training

One way of devaluing appetitive foods is via food-specific inhibition training [7][8]. Inhibition or inhibitory control is defined as the ability of an individual to inhibit their impulses and habitual or dominant behavioral responses to stimuli in order to select a more appropriate behavior that is consistent with completing their goals [9], and this is a key component of broader constructs such as executive function and self-regulation [10][11]. Two types of inhibition training have thus far been developed, namely, general inhibition training, and food-specific inhibition training [12][13]. The aim of general inhibition training is to increase overall inhibitory control through responses to often-arbitrary cues. Food-specific inhibition training, by contrast, pairs specific health-related cues (e.g., high-calorie food cues) with "no-go" or "stop" signals to promote associative links between such cues and the engagement of inhibitory control. For example, during food-specific inhibition training using a food go/no-go task, participants need to quickly respond (e.g., press button B) to the food picture (e.g., high- and low-calorie food pictures) displayed on the computer screen, and to withhold this response when a stop signal (e.g., the frame around the picture turning bold) is displayed. Critically, in a task aimed specifically at retraining particular behaviors (e.g., responses to high-calorie food cues), the no-go cue is disproportionately paired with high-calorie food items (e.g., 100%). In a control task, however, go and no-go cues are usually paired equally with non-food items [14]. Regarding general inhibition training, findings from several studies have demonstrated that this type of training is incapable of changing unhealthy eating habits [15][16].

1.2. Food-Specific Inhibition Training and Food Devaluation

Several explanations for this devaluation effect have been offered. Firstly, the behavior–stimulus interaction (BSI) theory [17][18] postulates that rewarding stimuli trigger strong approach reactions, which need to be inhibited when the stimuli are paired with a no-go/stop cue. Furthermore, in order to reconcile the conflict between the approach tendency elicited by motivational stimuli and the need to inhibit this tendency, a negative affect elicited by the conflict [19] is then attached to the stimuli, meaning that the evaluation of these stimuli is decreased in order to facilitate subsequent response [20].

Another possible explanation for this devaluation is that repeated inhibition toward specific stimuli (e.g., high-calorie food cues) during inhibition training may create automatic stimulus–stop associations [21]. Furthermore, associative learning theories have argued that action and valence are closely coupled, such that stopping is associated with punishment, whereas going is associated with reward [22][23][24]. It is therefore plausible that no-go/stop foods become increasingly disliked via their associations with automatic response inhibition [25][26].

In addition, several researchers have argued that rapid successful motor inhibition could have suppressive effects—not just on a motor level, but also on cognition [27]—which could impact value [28]. More specifically, it is believed that rapid action stopping may occupy working memory capacity [29][30], which then leads to less accurate representations of the no-go stimuli and, in turn, lower evaluation.

1.3. Potential Moderators of Training Effects

The type of evaluation may be an important moderator. Researchers in this field have typically assessed two types of food evaluation: the implicit evaluation, which is measured using the implicit association task or the affective priming paradigm, and the explicit evaluation, which is measured by a visual analogue scale (VAS) (e.g., “How attractive does this food item look to you?”). It should be noted that when using a VAS to measure explicit food evaluation, the researchers’ areas of interest differ. For example, the VAS could be used to measure food preference, craving, palatability, attractiveness, monetary value, etc. Some studies have shown that not responding to food items in food-specific inhibition training may lower the explicit evaluations of these items [17][31]. In contrast, evidence of the effect of food-specific inhibition training on implicit food evaluation is relatively sparse [32][33].

Another important moderator of training effects on food evaluation may be the training paradigm. Researchers have speculated that a higher possibility of food inhibition in the go/no-go task compared to the stop-signal task might lead to a greater degree of effectiveness in terms of changing eating behaviors and food devaluation [12][34].

Food novelty in the evaluation tasks may also be an important moderator. Indeed, some studies have suggested that the devaluation effect is specific to the trained food cues, and cannot be generalized (e.g., new stimuli) [35][17].

Body weight (e.g., excessive weight/obesity vs normal weight) may be another important moderator, for two reasons [26]: (1) overweight and obese individuals may gain more from the training compared with normal-weight participants, since they could have lower inhibition capacity [36]; and (2) the greater responsivity to food of overweight or obese participants [37] may impair their performance in the inhibition training, rendering the training less efficient.

2. Food-Specific Inhibition Training for Food Devaluation

Many people today live in an obesogenic food environment, and are constantly exposed to low-nutritive-value yet appetitive foods—for example, foods containing large amounts of sugar and fat [38]. These environmental conditions paired with internal factors (e.g., impulsivity) could lead to higher food evaluation (e.g., food cravings), which might aggravate dysfunctional eating behaviors such as bulimia nervosa or binge eating [3]. Interventions aimed at lowering the evaluation of appetitive foods, therefore, may help people to regulate their eating behavior or body weight.

There are various theories to explain the food devaluation effect of food-specific inhibition training. For example, the BSI theory [17][18] proposes that the conflict between the automatic approach tendency triggered by appetitive food stimuli and the task requirement of inhibition during the go/no-go or stop-signal task elicited a negative effect, which might be attached to specific food items and cause food devaluation. In addition, some researchers have argued that stopping and avoidance are linked to an aversive system [22][23], and this association might spill over to the responses to the no-go/stop food stimuli presented during training [25].

The food devaluation effect is supported by recent neuroimaging studies [14][39]. More specifically, researchers have found that, compared with changes observed in controls, food-specific inhibition training reduces activation in reward regions of the brain (e.g., putamen, mid-insula) in response to no-go/stop food images. Critically, activation change in the reward regions of the brain in response to the no-go/stop images was positively associated with changes in the evaluation of these images (e.g., r =0.44). Although such results are still nascent, these functional magnetic resonance imaging (*f*MRI) studies and future neuroscience studies similar to them can directly measure value signals in the brain, and may provide further conclusive evidence for the food devaluation effect of food-specific inhibition training [28].

It was proposed that the decrease in food evaluation may play a critical role in promoting healthier eating behaviors. Supporting this notion are the findings of Veling et al. [40], who showed that the effect of food-specific inhibition training on food choices was entirely mediated by decreased evaluation of the foods that had been associated with the no-go cues. Lawrence et al. [41] assessed self-reported eating behaviors and weight loss, but did not observe any evidence of mediation. Further (preregistration) studies are needed to investigate whether this food devaluation effect could act as a mechanism underlying the positive effects of food-specific inhibition training in terms of changing peoples’ eating behaviors.

The effect of food-specific inhibition training on food evaluation was moderated by the type of evaluation. In particular, food-specific inhibition training was found to have a statistically significant effect on explicit food evaluation, but not on implicit food evaluation. Similarly, a previous meta-analysis showed that repeated inhibition of behaviors in response to appetitive stimuli (mainly alcohol stimuli) does not change implicit evaluation of these stimuli [42]. Taken together, current evidence suggests that stimulus-related inhibition training only changes explicit stimulus evaluation, which might provide further insights into how motor response training influences behavior. For example, it might be more likely that stimulus-related inhibition training changes behavior via changes in the explicit (but not the implicit) evaluation of stimuli, given the robust effect of training on the former.

Food novelty was also found not to moderate the effects of food-specific inhibition training on food evaluation. A series of experiments conducted by Chen et al. [17][31] showed a lack of generalization of training effects to untrained or novel food items when training was focused at the item level (e.g., similar food items appear on go and no-go trials). However, there has been evidence to suggest that food-specific inhibition training could be generalized to untrained stimuli when training is focused on a category level (e.g., healthy food = go; unhealthy food = no-go) [25][43][44]. Although the effects of food-specific inhibition training on the evaluation of trained food (g^+ = 0.291) were numerically larger than on the evaluation of generalized food (g^+ = 0.130) or mixed food (g^+ = 0.150), the differences were not statistically significant. It should be noted that there were only eight and nine studies that investigated the effects of training on generalized food and mixed food, respectively, which might result in an insufficiency of statistical power when conducting the moderator analysis. Therefore, future studies or meta-analyses should continue to test the generalization effects of food-specific inhibition training.

Weight status also did not emerge as a statistically significant moderator, suggesting that food-specific inhibition training causes similar decreases in food evaluation in normal-weight and overweight/obese participants. However, it should be noted that only seven food-specific inhibition training studies were conducted with people with excessive weight or obesity. Therefore, more studies focusing on overweight or obese individuals are needed before food-specific inhibition training can be translated into clinical interventions.

In conclusion, the idea that food-specific inhibition training can produce beneficial changes in food evaluation. In particular, the type of evaluation moderated the effects of training on food evaluation, with food-specific inhibition training significantly decreasing participants' explicit, but not their implicit, food evaluation. However, since most of the included studies focused on trained food items and short-term outcomes in normal-weight samples, more research is needed on the persistence of the training effects, and on the extent to which the effects can be generalized to untrained food items or different populations (e.g., overweight or obese individuals).

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