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The Effect of Binge Eaters' Anger Regulation Training on Attentional Bias and Caloric Intake

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Binge eating, defined as the consumption of large quantities of food in a short period of time, is a behavior that manifests when a binge eater, who cannot regulate negative emotion-provoking situations and has increased attentional bias to high-caloric food. This study aimed to investigate the influence of anger regulation training (reappraisal and suppression) on attentional bias to food images and caloric intake. Forty-seven binge eaters and 44 healthy control subjects were randomly assigned to one of the two anger regulation training conditions (reappraisal, suppression) and given anger mood induction and instructions. Consequently, the binge eater group spent significantly less time dwelling on food images, and caloric intake was significantly lower under the suppression condition, than the reappraisal condition. The results of the present study suggest that when trained through reappraisal, binge eaters decrease the time they spending dwelling on food images and caloric intake.

Keywords: binge eating, attentional bias, anger regulation, suppression, reappraisal

Introduction

People tend to cope by eating when they experience negative emotions, and negative emotions are triggers of binge eating (Tomiyama, Dallman, & Epel, 2011). The reason why negative emotions cause binge eating is explained in various ways. To change the typical theoretical viewpoint of negative emotion model mood under people with binge eating behavior to reduce negative emotions or less painful state to describe the generation and maintenance theory of binge eating behavior (Stice, 2001). Unpleasant emotions, such as frustration, anxiety, anger, and depression, can cause binge eating behavior. According to the Self-Control Strength model, difficulty in emotional regulation causes distress in impulse control and causes binge eating behavior (Muraven, Tice, & Baumeister, 1998). The process of cognition, emotional control, and impulse control are based on the limited resources of the self. Maladaptive emotional control strategies consume more cognitive energy and weaken impulse control, leading to alcohol consumption and binge eating behavior (Dick et al., 2010).

Anger is especially significant among the negative emotions associated with binge eating. Anger is an essential factor influencing binge eating behavior (Zeeck, Stelzer, Linster, Joos, & Hartmann, 2011). In an integrated model of negative emotions and eating disorders, when experiencing a perceived anger mood that is neither socially dangerous nor unacceptable, the individual represses anger and causes an eating disorder by interacting with secondary emotions and negative perceptions (Fox & Power, 2009). The relationship between anger and binge eating behavior in terms of emotional eating, in which binge eating behavior is intended to control negative emotions, can be a strategy to control the anger that is felt through binge eating behavior (Hilbert & Tuschen-Caffier, 2007). There are three types of anger control: anger-control,

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anger-expression, and anger-suppression. Eating disorders with binge eating exhibit state anger and anger-suppression (Waller, Loomis, & Haun, 2004). Anger-suppression is maladaptive emotional control strategies and the tendency to suppress anger led to an increase in binge eating behavior, whereas anger-control did not show a significant correlation with binge eating behavior (Brytek-Matera, 2008).

It is essential to control anger to reduce binge eating levels. Emotional regulation strategies can be changed according to the time order of emotional response (John & Gross, 2004). In other words, emotion begins with an evaluation of emotional cues, and when attention is paid to and evaluation of emotional cues in any way, emotional cues lead to a set of reaction tendencies that include behavioral, empirical, and physiological systems. When reaction trends occur, they are regulated in a variety of ways. Emotional regulation strategy is divided into the prior focus emotional adjustment strategy and the reaction focus emotional adjustment strategy. Previous focus strategies are called reappraisal, which are strategies that are activated before emotional response tendencies are activated and change behavior or physiological responses.

The reaction focus strategy is a strategy that is performed after the reaction tendency is triggered and the emotion has already proceeded. Reappraisal is a form of cognitive change that interprets emotional situations in a way that changes emotional impacts. People successfully reduce behavioral elements of negative emotions by down-controlling negative emotions through this strategy. On the other hand, inhibition is a response-focus strategy that is relatively late in emotional development and mainly modifies the behavioral aspects of emotional response tendencies. Suppression is effective in reducing behavioral expression of negative emotions, but they also have the effect of reducing the expression of positive emotions. At the same time, inhibition does not help to reduce the negative emotional experience, so negative emotions remain unresolved (John & Gross, 2004). One study found that reappraisal is positively related to subjective well-being, whereas inhibition strategies are related to negative emotions, ineffective coping styles, and depression (John & Gross, 2004).

As a result of controlling anger through suppression and reappraisal, it is necessary to confirm attention bias to food and caloric intake to investigate the effect of implicit craving on food and actual caloric intake. According to dual-process models, an impulsive system that operates rapidly and automatically, and a reflective system works slower and more deliberately (Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013). The impulsive system assesses food cues generally regarding their current emotional and motivational significance. On the contrary, the reflective system engages higher-order processes of cognitive control, careful decisions and impulse regulation that take long-term outcomes into account. Attentional bias is a tendency to focus attention on one class of stimuli because such stimuli are highly motivationally relevant and show implicit craving toward food or addictive cues (Sayette, 2016).

It is especially important to consider attention bias along with high-calorie food cues. The incentive sensitization theory (Robinson & Berridge, 2008) holds that, through repeated administration of substances of abuse, a sensitized dopaminergic response develops which causes such substances to become highly desired and "wanted." Through classical conditioning, a cue is closely related to the element also becomes significantly noticeable, so that it seizes attention (i.e., attentional bias) and guides behavior towards obtaining the incentive goal. Moreover, the relationship between attentional bias and substance craving is believed to be "mutually excitatory," whereby an increase in one produces a corresponding increase in the other (Field & Cox, 2008). Prior studies show that the binge eater allocates more attention to food-related stimuli in the early stages of information processing and automatically processes certain information before the information is conscious. Such information processing characteristics can lead to binge eating (Jansen, Naderkoorn, & Mulkens, 2005; Masheb & Grilo, 2006).

Thus, the present study aims to identify the influence of suppression and reappraisal on caloric intake after anger induction in women who are binge eaters, healthy controls, and healthy controls. To ensure strategy compliance, all participants went through a laboratory-based emotional regulation training before the experimental task. This study hypothesized that in binge eaters (compared to healthy controls) dwell time would be significantly longer in the suppression compared to the reappraisal condition; in binge eaters compared to healthy controls caloric intake would be considerably more significant in the suppression than the reap-

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praisal condition based on Gross' (2001) process model of ER.

Methods

Participants

Nine hundred sixty undergraduate students were recruited and screened in by using the Binge Eating Scale (BES; Gormally, Black, Daston, & Rardin, 1982). This study used the Korean version of BES (Lee & Hyun, 2001). Scores of 27 have conventionally served as a cutoff value for identifying the presence of severe binge eating (Marcus et al., 1988). This study selected the binge eater group who scored 27 and over which means the individual has problems with binging episodes on the BES and the healthy control group who scored below 26 on the BES (Marcus, Wing, & Hopkins, 1988). Populations including individuals with bulimia nervosa or anorexia nervosa were excluded. As a result, 47 for the binge eater group (24 for the reappraisal condition, 23 for the suppression condition) were obtained. Forty-four for the healthy control group (22 for the reappraisal condition, 22 for the suppression condition) were obtained. All participants were provided with informed consent and were informed that they could finish the experiment at any time before participation in the current study. This study was approved by the Chung-Ang University IRB (No. 1041078-201704-HRSB-072-01).

Material and Measures

Self–report questionnaires

Binge Eating Scale (BES)

The BES (Gormally et al., 1982) consists of 16-items for measuring the severity of the binge eating pathology. This study used the Korean version of BES (Lee & Hyun, 2001). Each item is rated on a 4-point scale (0 = not at all; 3 = very much so). The total score ranges from 0 to 46, with a higher rating indicating more significant numbers of binge eating episodes and severity. This study used the Korean version of BES (Lee & Hyun, 2001). The Cronbach's α was .84 in this study.

Free Viewing Task

The eye movement toward pictures of high and low caloric food is implicit craving of food. To evaluate eye movement toward pictures of caloric food, the pictorial system was likewise obtained. Additionally, 24 pairs of neutral pictures were used as filler stimuli. Two pictures were showed, one on the screen's right and one on the left side. The size of the cue was 10 × 6 cm, and the distance between the two pictures was 3 cm. First, there were practice trials for four times with using filler stimuli. Next, 80 trials of experimental tests were conducted. Twenty neutral-neutral pairs and 20 pictures of low calorie-high calorie food pairs were randomly shown on the screen twice. A fixation (+) cue was showed for 500 ms in each trial, while picture pairs were presented for 2,000 ms, and after that, a blank screen was presented for 500 ms. Participants were asked to focus on the fixation (+) cue when it was shown in the center of the screen, but once it went away, participants were instructed to view other pictures freely.

Caloric intake

Actual caloric intake is an explicit craving for food. Caloric intake was assessed using a bogus taste-test. Participants were sat in front of 2 bowls containing biscuits and chocolate. Participants were asked to rate the two foods in terms of their palatability, their attractiveness, their smell, and taste. Caloric intake was established by subtracting the weight of the bowl after the bogus taste-test from the weight of the bowl before the bogus taste-test. This difference score was then converted into calories and used as a measure of caloric intake. They were seated on a table with the bowls and asked to answer the questionnaire about food. Fifteen minutes later, the food bowls were removed.

Laboratory–based ER training Intervention

Within the groups (binge eaters vs. healthy controls) participants were randomly assigned to either the reappraisal or the suppression condition. The training was administered in a standardized manner by using the computer according to prior research (Svaldi et al., 2014). Participants were presented five unpleasant events from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997). Next, they asked to use either suppression or reappraisal while watching the pictures. Participants were randomly allocated to one of the two emotional regulation instructions.

The reappraisal instruction was as follows: "You will shortly be

taught a strategy to deal with upcoming emotions. To this purpose, we are going to show you five pictures and present you an instruction via audiotape. It may be that the strategy is familiar to you. However, it is also possible that it is a new experience to deal with your emotions this way. In any case, we ask you to apply the strategy as good as you can. Go to the next picture by mouse click not until you have the impression to be able to implement the strategy. During the full training, the laboratory assistant will stay in the room, thereby enabling you to discuss any upcoming questions. As soon as you are ready, you can start the training by mouse click. We ask you to click the mouse button for the next picture." Following this, the respective strategy was presented by audiotape.

The suppression instruction was as follows: "While you watch the pictures, please try to behave in a way that another person watching you would think that you don't feel anything at all now. Feel whatever you feel, but try your best not to show what you are feeling right now." Following this instruction, the participant was presented the first picture, which was accompanied by the sentence "Try to hide upcoming emotions as well as you can" via audiotape.

The reappraisal instruction was as follows: "While you are watching the pictures, please try to take a step back from the picture before going into your emotions. Carefully look at the picture and try to maintain sort of an actual distance". Following this instruction, the participant was showed the first picture with "Try to develop a sort of objective distance between you and the presented content as well as you can" via audiotape.

The respective ER instruction was iterated before the presentation of each of the five pictures. Participants clicked to the next picture via mouse once they felt that they were able to select the strategy. Having selected the respective strategy for the five pictures, the laboratory assistant asked participants how they implemented the strategy to ensure strategy compliance. In total, the ER training lasted about 20–30 minutes.

Apparatus

Eye-movements were recorded with an eye-tracker, iView XTM Red-IV Eye Tracking System (Senso Motoric Instruments, Teltow, Germany). It combines the camera and the infrared sensors. Each participant was seated 75 cm in front of a 23-inch wide monitor (1,920×1,080), and the eye tracking device let the participants move their eyes and heads without any attached sensors naturally.

Procedure

Participants started with laboratory-based emotional regulation training. After that, they had a break of five minutes, during which they left the laboratory. Participants watched a three minutes segment of the movie The Art of Fight. This clip was shown to induce anger in control participants effectively. It was shown on a 17-inch monitor. Participants had the instruction to select the previously trained strategy while watching the film clip. They were instructed that the goal of the experiment was to understand better the effects the taught strategy has on the palatability of food. Also, they rated the ER compliance VAS scales. To assess compliance with the instructions while watching the film clip participants had to rate four statements on a 100 mm VAS word-anchored at each end (very untrue-very true; Svaldi et al., 2014). The items rating the compliance with the suppression instructions were: "While watching the clip, I concealed my feelings from outside" ("concealed feelings scale") and "While watching the clip, I succeeded in concealing my feelings from others" ("succeeded to conceal feelings scale"). The items rating the compliance were: "While watching the clip, I developed sort of an objective distance" ("developed objective distance scale") and "While watching the clip, I succeeded in developing a sort of objective distance" ("succeeded to develop objective distance scale").

Then they performed a bogus taste-test. Finally, participants were instructed to place their head on the chin rest distancing 65 cm from the monitor. The eye-tracking device was calibrated for each participant using the nine-point calibration method. After that, the experimental session consisting of four practice trials and 80 experimental trials were conducted. Each trial started with the appearance of fixation (+) cue for 1,000 ms. Next, the stimuli image was presented for 4,000 ms. Finally, a white screen was showed for a variable time interval between 500 and 1,500 ms. The trials were presented in random order. Following that, they were probed for doubt and asked to make notes their thoughts on the aim of the experiment. The entire experimental session took approximately 60 minutes. The participants were debriefed and provided with

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Table 1. *Mean (SD) for Demographics Information of Groups*

	Binge eater		Healthy control		Test statistics (F/χ^2)
	Suppression ($N=23$)	Reappraisal ($N=24$)	Suppression ($N=22$)	Reappraisal ($N=22$)	
Gender (female)	12	13	12	11	.63
Age (yr)	21.56 (2.38)	22.73 (3.20)	21.12 (2.74)	22.68 (3.15)	.97
BMI	21.15 (6.33)	21.87 (6.91)	19.91 (5.12)	20.62 (6.31)	1.56
BES	34.05 (6.75)	35.98 (5.31)	20.65 (3.37)	22.94 (3.62)	.03*

Note. BMI = Body mass index; BES = Binge eating scale.
*$p < .05$

monetary rewards (about 10 US dollars).

Data Analysis

One-way analysis of variance (ANOVA) and chi-square test used to analyze the differences in the characteristics between the binge eater groups and healthy control groups were performed. To analyze the differences between groups and strategy types, 2 (group: binge eaters, healthy controls) × 2 (strategy: suppression, reappraisal) ANOVA was conducted on dwell time and caloric intake as a between-group variable. To examine the attention bias toward high caloric food, we used dwell time toward high caloric food images. The follow-up simple main effect tests were conducted to investigate the simple effects of groups and conditions on dwell time and caloric intake. Analysis of the eye movement and key response data was conducted with Begaze 3.1 (SensoMotoric Instruments, Teltow, Germany). Statistical analysis was performed with SPSS 22.0 for windows (SPSS Inc., Chicago, USA).

Results

Demographic Characteristics

Table 1 shows the characteristics of the participants analyzed in the present study. There are no significant differences among conditions in the following data; age [$F(3, 97) = .97$, *n.s.*], gender [$\chi^2(3) = .63$, *n.s.*], BMI [$F(3, 97) = 1.56$, *n.s.*] among each group. Difficulties engaging in total scores of BES [$F(3, 97) = .03$, $p < .05$]. The result might support that the binge eater group may undergo more binge-eating episodes. A total of 97 participants were in the present study. Given that the number of participants assigned to each group is less than 30 and that the number of samples is halved in gender difference verification, it is important to note the interpretation of the study results.

Comparison of the attentional bias results between two groups

A 2 (group binge eaters, healthy controls) × 2 (strategy: suppression, reappraisal) ANOVA on dwell time revealed a significant interaction [$F(1, 83) = 5.02$, $p < .05$, $\eta^2 = .11$], indicating that the two groups were differed in their dwell time because of emotional regulation strategy. In a further analysis of the differences in dwell time, simple main effect analysis was used to examine the group differences according to the experimental condition. The results showed that effects of condition were significant [$F(1, 83) = 5.81$, $p < .05$, $\eta^2 = .07$], but the effects of the group were not significant [$F(1, 83) = .07$, *n.s.*]. Results indicated that binge eaters who were under the condition of reappraisal showed lower attentional bias towards food cues compared to when under the condition of suppression. However, the same effect was not confirmed in healthy controls, as no main effect was found with the simple main effect analysis. That is, in the case of binge eaters, when using reappraisal to control anger, there was less attention bias to food than there was to control anger using suppression, and in the case of healthy controls, there was no difference in attention bias towards food compared to using reappraisal and suppression to control anger. Figure 1 showed the interaction of group and condition on the difference of dwell time.

Comparison of the caloric intake results between two groups

A 2 (group: binge eaters vs. healthy controls) × 2 (strategy: suppression, reappraisal) ANOVA on caloric intake (calories eaten) revealed no significant interaction [$F(1, 77) = .40$, $p = .53$, $\eta^2 = .43$], indicating that the two groups were different in caloric intake because of emotional regulation strategy. In a further analysis on difference of caloric intake, it was revealed that there was a signifi-

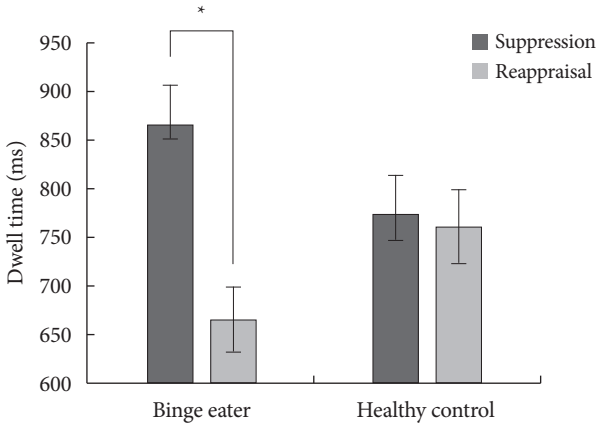

Figure 1. *Comparison of dwell time toward high caloric food images between all groups.*
Note. Error bars represent standard error of the mean.
**p < .05.*

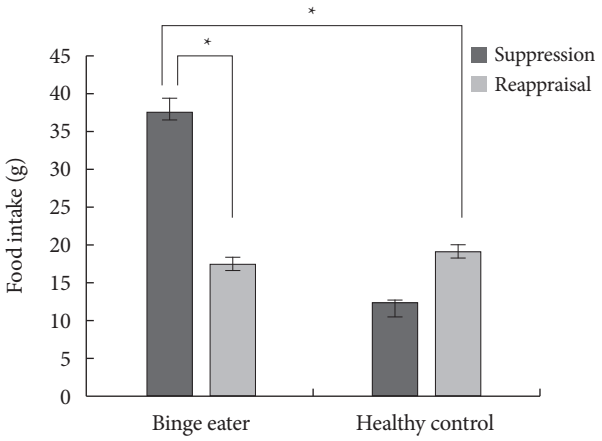

Figure 2. *Comparison of high caloric intake between all groups.*
Note. Error bars represent standard error of the mean.
**p < .05.*

cant main effect due to group [$F(1, 77) = 19.54$, $p < .05$, $\eta^2 = .11$], and a significant main effect due to strategy [$F(1, 77) = 4.48$, $p < .05$, $\eta^2 = .05$]. Results indicated that binge eaters who were under the condition of reappraisal showed lower attentional bias toward food cues compared to when under the condition of suppression. However, the same effect was not confirmed in healthy controls, as no main effect was found with the simple main effect analysis. That is, in the case of binge eaters, when using reappraisal to control anger, there was less caloric intake than there was to control anger using suppression, and in the case of healthy controls, there was no difference in caloric intake compared to using reappraisal and suppression to control anger. Figure 2 showed the interaction of group and condition on the difference of caloric intake.

Discussion

This study investigated the influence of anger regulation training (reappraisal and suppression) on attentional bias to food images and caloric intake. Binge eater and healthy control groups were trained in either expressive suppression or reappraisal by using ER training. Subsequently, they received a negative mood induction, which was followed by eye-tracking and a bogus taste-test. This study hypothesized that binge eater than the healthy control caloric intake and attentional bias would be significantly higher in the suppression than the reappraisal condition. The hypothesis was based on self-report data and prior study suggesting ER deficits in individuals affected by BED (Svaldi, Griepenstroh, Tuschen-Caffier, & Ehring, 2012; Whiteside et al., 2007) and the data suggesting ER-mediated the link between the desire to eat and negative emotions (Svaldi, Tuschen-Caffier, Peyk, & Blechert, 2010).

The main finding of this study is that binge eater under the suppression condition consumed significantly more caloric food than binge eater under the reappraisal condition after induction of anger. These results are consistent with a previous study (Svaldi et al., 2014). This finding suggests that reappraisal is an effective way to reduce caloric intake in an angry situation. While reappraisal involves a re-evaluation of a potentially stressful situation to decrease its emotional relevance, suppression refers to a conscious inhibition of ongoing emotion-expressive behavior (Gross, 2013). According to incentive motivation theory, after repeated associations with the drug, the initially neutral environment (unconditioned stimulus) acquires secondary incentive motivational properties and becomes a conditioned stimulus capable of producing a conditioned response and influencing behavior in the absence of the drug (Robinson & Berridge, 2008). When binge eaters cannot regulate negative emotion, they may experience an increased amount of craving for food.

The second finding of this study is that binge eater in the suppression condition consumed significantly more attentional bias than binge eater in the reappraisal condition after induction of anger. In other words, reappraisal is more effective than suppression

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in modifying the attention bias of binge eaters. This is in part consistent with the findings that eating disorders tend to bias attention to food stimuli as compared to the healthy group, and that such cognitive traits affect dysfunctional thinking. The results of previous studies show that the bingeing group allocates more considerable attention to food-related stimuli at the early stage of information processing and automatically processes specific information before the information is conscious (Masheb & Grilo, 2006). Attention is an early stage of the cognitive process and has an essential meaning in determining the cognitive content to be processed later. A reappraisal may be proposed as a way of modifying the state bias, one of the factors that cause or maintains high-wingers' binge eating. Anger-like emotional responses tend to be more effective than reaction-focused emotional control inhibitors that attempt to control emotions after emotional response tendencies have already been activated (Gross, 2001).

Using suppress strategy, the binge eater had significantly higher caloric intake than the healthy control. Although not significant, binge eaters were more likely to consume food using suppress strategy compared to reappraisal, while healthy controls were less likely to eat food when using suppress strategy compared to reappraisal. That is, binge eater increased caloric intake by using suppress anger while healthy control did not increase caloric intake by using suppress strategy anger mood. This implies that the suppression strategy is more maladaptive in the binge eater because the anger suppression is connected to the increased caloric intake in the binge eater rather than the healthy control. Previous research has shown that negative mood is a definite antecedent of increased food consumption in BED (Stein, Simmons, Feinstein, & Paulus, 2007).

The present study has some limitations. First, this study only investigates two ER conditions. Reappraisal was chosen based on its demonstrated beneficial effects regarding eating behavior in experimental studies (Evers, Marijn Stok, & de Ridder, 2010) and was primarily used as a comparison condition for the expressive suppression condition. As prior research has found BED group to habitually reappraise less and suppress more upcoming emotions (Svaldi et al., 2012), it is possible that control group still engaged in suppression. Therefore, in BED group with reappraisal would probably lead to a smaller high caloric intake when compared to a control group. Second, this study did not measure the baseline of caloric intake and attention bias. Future studies will need to compare the baseline levels of caloric intake and attention bias with those of post-intervention.

Despite all these limitations, this study has some implications. First of all, the study suggests that therapeutic interventions focusing on the mediation of more adaptive emotional regulation skills could be beneficial. This training would be useful to decrease binge eating episodes. Secondly, this study confirmed the effect of the only laboratory-based ER training on attentional bias to food and caloric-intake in an experimental method. Also, this study is the first to examine the relationship between anger regulation and both explicit and implicit binge eating behavior within an experimental method. In this study, anger emotions were manipulated through video clips, but no manipulation check was performed. However, prior research has already shown that manipulation is valid by merely viewing stimuli from movies and other excerpts (Brumbaugh, Kothuri, Marci, Siefert, & Pfaff, 2013). In future studies, it is necessary to use the Visual Analogue Scale (VAS) to determine the level of anger before and after watching video clips to measure the correct anger-inducing effect. Finally, using both automatic and implicit methods, the study can confirm a cognitive process to food such as attentional bias of binge eaters according to emotional regulation strategy. Considering that our samples consisted of non-clinical female and male participants, the results can be generalized for a wider population. In conclusion, this study confirmed the influence of anger regulation training (reappraisal and suppression) on attentional bias to food images and caloric intake.

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