

## Attention Control in Presence of Food Cues in Restrained and Unrestrained Eaters

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### ABSTRACT

**Introduction:** This research tries to study the relation between dietary restraint and attention control in females admitted to diet therapy clinics in Kerman County.

**Methods:** Participants were all female subjects who had been admitted to diet therapy clinics in Kerman County. The sample size included 80 women between ages of 15 to 50 years. Participants were selected through convenience sampling. All participants were asked to fill out the Dutch Eating Behavior Questionnaire and respond to Stroop task software.

**Results:** The restrained eaters' reaction time towards food stimuli was higher than that of unrestrained eaters. The reaction time in Stroop effect condition in restrained eaters was higher than that of unrestrained

eat. In restrained eaters, the reaction time in presence of food stimuli was higher than the condition in which non-food stimuli were presented. In presence of food stimuli, the reaction time in Stroop effect condition was higher than non-Stroop effect. Finally, it was determined that in non-Stroop conditions compared to Stroop conditions, strained eaters had a higher reaction time in presence of food stimuli than the condition in which non-food stimuli were presented.

**Conclusion:** These findings verify the role of attention bias in reaction to food stimuli in restrained eaters and they suggest that diet success relies on avoiding interactions related to food.

**Keywords:** Dietary restraint, attention bias, stroop effect

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### INTRODUCTION

According to World Health Organization (WHO), the prevalence of obesity and overweight in recent decades has turned to an issue threatening the global health (1). This continuous increase in weight in societies threatens the individuals' health (2). Since obesity and overweight among children and adults are increasing, dieting is considered as an identity controlling method for solving this problem. However, a few of dieters are capable of maintaining their lost weight and could maintain that weight for a long time (3). Although, diet therapy is considered as a proper method for decreasing weight at first, this method could increase the risk of dietary restraint, and increase the risk of getting stuck in the vicious cycle of increasing and decreasing weight (4).

Restrained eaters are not necessarily successful dieters, and their behavior is determined by their continuous efforts to lose weight. In fact, these individuals never follow a real diet for losing weight (5). As most restrained eaters are not currently on a diet, they may be "best characterized as 'weight watchers' who are concerned about their food intake and try to limit intake, particularly of energy dense foods" (6). An explanation for this contradictory behavior pattern is that these individuals are highly sensitive to food cues, and in some cases, this sensitivity leads to food craving and as a result overeating (7). According to Polivy and Herman (5), food restrainers or extreme dieters consider a cognitive boundary for

themselves, which is lower than their physical prowess. They perform this in order to regulate their diet and their weight-loss process. Additionally, they use cognitive controls to remain in this condition and if they violate this boundary due to the cognitive biases, they tend to overeat. Many studies try to find the root of this food retainers' trait in their attention bias (8-9). Confronting delicious foods and even thinking about favorite foods is a strong initiator for craving more and ultimately overeating in food restrainers, compared to other individuals (10, 11). Numerous studies have introduced considering the food intake and monitoring it continuously, as one of the main food restraining behaviors. Since food restrainers frequently monitor their eating behaviors and focus on their self-imposed food restrains, any activity or event which distracts them from their monitoring causes them to leave their cognitive control and as a result, to overeat (12).

Today, the attention bias has gained a lot of attention as one of the main effective factors in dietary restraint process. Attention bias towards eating refers to the attention these individuals pay towards stimuli related to food, compared to the neutral stimuli. Individuals with nutritional disorders are preoccupied with eating. They are more sensitive towards food, and the selective attention they have towards it functionally leads to a motivational state of tendency towards food (13). In cognitive

neuroscience, attention control refers to the capability of individuals in selecting what they have paid attention to and not selecting what they have ignored (14). There is abundant evidence that many pathological eating behaviors have a relationship with the abundance of food stimuli (advertisements or delicious food availability) in western societies (15). Attention has a great role in individuals' learning and daily performance, and in the meanwhile, it is the most sensitive cognitive process towards damage. Attention requires selection, and paying attention towards a certain set of stimuli of an environment entails emergence of behaviors related to those stimuli. In fact, attention is a determining factor for successful interaction with the environment, and it functions as a gate for cognitive issues (16). Due to the high cognitive access of dietary thoughts, it is initially possible that restrainers do not pay any selective attention towards tempting food stimuli which could be considered as a potential threat to their diet (17). The only instance that repeated exposure to delicious food cues could stimulate pleasant thoughts about food, and at the same time, lead their severe diet goals to be less accessible, food restrainers show an increase in selective attention about the food items (18). According to recent data, being a restrained eater is not only for young women. It shows that not only women with diagnosed eating disorders may show eating-related changes, but also non-diagnosed, healthy, middle-aged and normal-weighted women may have increased scores, especially in restrained eating. Menopausal status can also cause eating patterns. Thus, while not every woman is necessarily predisposed to developing restrained eating patterns during her menopausal transition, her experienced self-esteem might influence this relationship (19).

In fact, due to the abundance of stimuli, identifying the main factor affecting eating behaviors in individuals who try to lose weight is a difficult task to perform (20). Most experts believe that the cause of obesity is not one or two separate factors, but a combination of various physical, psychological and social factors, and the most successful treatments are the those that could cover a higher number of these factors, as much as possible (21). The most common method in treating obesity is limiting the calorie intake through a specific diet. However, studies suggest that, despite their inner willingness, many of the dieters do not retain the capability to follow their diet, and even if they lose weight after a diet therapy, they experience a weight gain (22). Hence, considering the previous studies and the theoretical issues, this research tries to study if food cues have any interaction with attention process in food retainers.

### Research Hypothesis

1. In background with food objects, reaction time in restrained eaters is more than that of unrestrained eaters.
2. In Stroop effect condition, reaction time in restrained eaters is more than that of unrestrained eaters.
3. In background with food objects and presence of Stroop effect, reaction time in restrained eaters is more than that of unrestrained eaters.

## METHODS

### Participants

This study was administered using a quasi-experimental design, in which, attention control in restrained and unrestrained eaters is compared in two conditions of presence of high-calorie food cues and lack of food-related stimuli. Restrained eating refers to the intention to restrict food intake deliberately in order to prevent weight gain or to promote weight loss. Restrained eating is the act of abstaining or avoiding certain foods, entire food categories, specific ingredients (like sugar) or eating in specific patterns that eliminate social flexibility.

This research included two participant categories. The first included all female restrained eaters in Kerman County who were admitted to diet therapy clinics (n=40). The second included all female unrestrained

eaters who were present in Kerman County diet therapy clinics (n=40). The study sample size was determined to be 80, considering the  $d=0.5$ , statistical power of 0.80, alpha level of 5 percent, and using G\*Power software. The sample size included 80 women between ages of 15 to 50 years. Participants were selected through convenience sampling. In this study, we needed to distinguish if a dieter is restrained or not, so the Dutch Eating Behavior Questionnaire was used to separate dieters in terms of restrained or unrestrained eaters. The cut-off point of this questionnaire was 2.49.

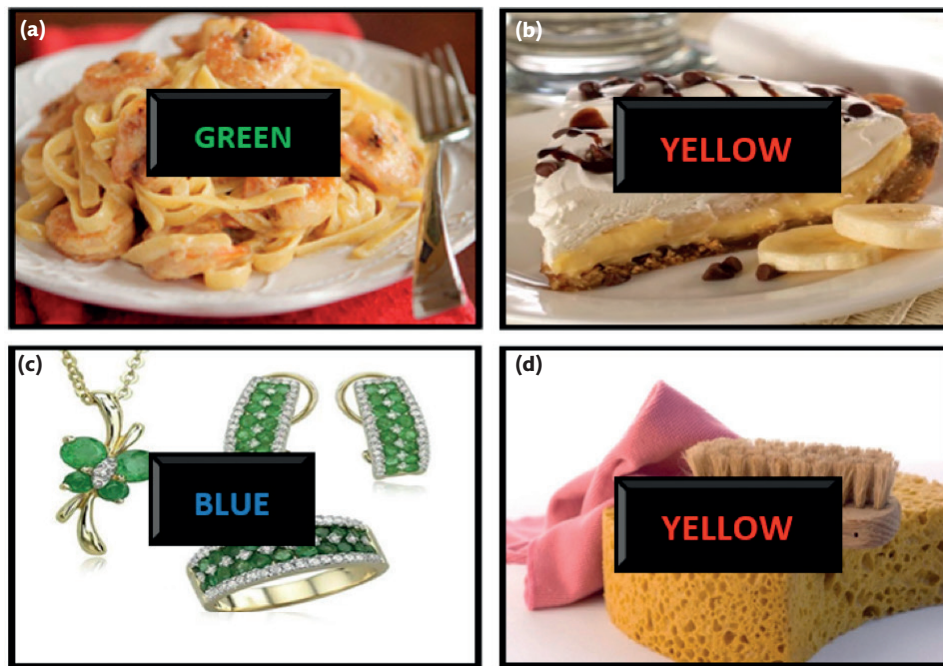
**Ethical consideration:** This study was approved by the Institutional Review Board (IRB) in SU (approval no.: IRB9891892). To conduct any of the tests, initially written consent was obtained from each participant after explaining the tests stages and procedures.

### Instruments

**Dutch Eating Behavior Questionnaire (DEBQ):** The original version of the questionnaire was in Dutch and it was published in 1986, by van Strien, Frijters, Bergers and Defares (23). This questionnaire has separated three various scales of individuals' eating behaviors (restrained, emotional, and external eating behavior) and it is executable either individually or in groups for individuals above 9 years old. Responses are in the form of five-point Likert scale and higher levels of the answers show the specific orientation in eating behavior. The Persian version of the questionnaire showed that the factor of restrained eating in DEBQ had a high internal consistency. Various studies have been conducted in this field and results suggest that the Cronbach's alpha in these studies has varied from 0.89 to 0.94 (24). By conducting a post-test on a 162-membered sample of adolescent girls, Banasiak and Voudour came to this conclusion that the reliability of this questionnaire with a 4- to 5-week delay was 0.85 and the posttest coefficient was 0.92 in a period of two weeks (25).

**Stroop Test:** Stroop test is a manifestation of reaction time. This test is used to measure selective attention, cognitive flexibility and data processing speed. To understand the attention control procedure in this research, the participants' reaction time shown to the Stroop test slides was measured. The software version of the Stroop test was designed by the researchers. To create the blocks, 90 pictures of high-fat foods and 90 pictures of non-food objects were used. High-fat food pictures were placed in nine categories. Each category contained 10 pictures. Their titles were burgers, cakes, cookies, donuts, ice-creams, muffins, pastas, pizzas and sweets. The other 90 pictures were of non-food objects. They were natural objects that were not related to food and kitchen utensils. To determine the relationship between non-food backgrounds with food cues, the images were shown to two referees. They were supposed to score the relation between pictures in a 10-point rating scale (10=highly related, 10=not-related). Findings showed that non-food backgrounds did not relate with food cues. Concordance coefficient was  $r=0.91$ .

They were put in nine 10-picture categories under the titles of: workplace, sports, and car parts, electronic appliances, washing equipment, cushions, carpets, jewelry and hospitals. The Stroop effect was two conditions of congruent/incongruent word-color. For example, in the condition of the congruent word-color the word "GREEN" with the green color was presented. Participants were required to press the green button. In the condition of the incongruent word-color the word "GREEN" with the blue color was presented. Participants were required to press the blue button. The reaction time was measured in these two conditions. There were four conditions. In Condition 1, we put a combination "background with food objects/presence of Stroop effect=word/color congruent", in Condition 2, there was a combination "background with food objects/lack of Stroop effect=word/color incongruent", in Condition 3, there was a combination "background with non-food objects/presence of Stroop effect", and in Condition 4, there was a combination "background with non-food



**Figure 1.** Different situations of experimental conditions. **a.** Background with food objects/presence of Stroop effect, **b.** Background with food objects/lack of Stroop effect, **c.** Background with non-food objects/presence of Stroop effect, **d.** Background with non-food objects/lack of Stroop effect

objects/lack of Stroop effect” (Figure 1). These 4 conditions are levels of two independent variables. To form each block, 90 trials of 9 color word combinations for ten times, were randomly prepared.

**Procedure**

First a DEBQ questionnaire was administered to each participant, they were required to answer the questions in 10 minutes after that they were taught the Stroop test process then a laptop with a 10-inch monitor was given to them. In the first step, a combination of “background with non-food objects/presence of Stroop effect”, and “background with non-food objects/lack of Stroop effect was randomly presented to the participants and reaction times to each item were recorded and this process was repeated by “background with food objects/presence of Stroop effect”, “background with food objects/lack of Stroop effect”, reaction times were recorded for each item and the whole procedure separately (Figure 2). Finally, all the reaction times and the total time for each condition were compared. The questionnaire was filled out and the test was carried out individually and the test time for all participants was around ten minutes.

**Statistical Analysis**

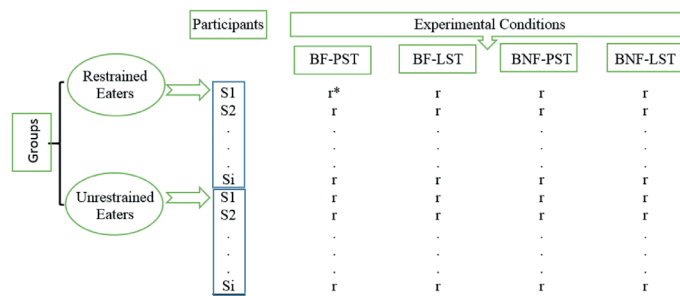
In this research, there were 2 groups (restrained eaters vs. unrestrained eaters) × 2 (presence of Stroop effect vs. no Stroop effect) × 2 (background with food objects - background with non-food objects). Hence, in order to analyze the data, repeated measures for last factor ANOVA was used.

**RESULTS**

Findings suggested that the average reaction time for restrained group was higher than that of the unrestrained group. This pattern is observed during the presentation of stimuli with food background and in the conditions where there is Stroop effect and in conditions where there is no Stroop effect. There was a slight difference found between two groups in the conditions where the stimuli were presented with a food background (Table 1).

In order to analyze the data, we used repeated measures in the last factor ANOVA. Initially, the statistical model assumptions were tested. Using *Box’s M tests*, the researchers tested the assumption of the homogeneity of the covariance matrix. Results suggested that the assumption did not turn out to be true ( $F=5.249$ ;  $p<0.05$ ). Also, Levene’s test was used to test the homogeneity of the error variance. The homogeneity of the error variance was not significant in conditions of presence of Stroop effect and without food stimuli ( $p>0.05$ ). The homogeneity of the error variance was significant in conditions of presence of food stimuli and lack of Stroop effect ( $p<0.05$ ) and it was significant in conditions of presence of food stimuli and Stroop effect ( $p<0.05$ ). Accordingly, *Pillai’s trace* was used for multivariate tests.

Results from multivariate tests suggested that the main effect of food stimuli that is background with food pictures-background with non-food pictures (*Pillai’s trace*=0.5,  $F_{1,78}=77.893$ ,  $p<0.05$ ,  $\eta^2=0.5$ ), the interaction effect of group in food stimuli (*Pillai’s trace*=0.061,  $F_{1,78}=5.04$ ,  $p<0.05$ ,  $\eta^2=0.06$ ), the interaction effect of group in Stroop (*Pillai’s trace*=0.062,  $F_{1,78}=5.18$ ,  $p<0.05$ ,  $\eta^2=0.06$ ), the interaction effect of food in Stroop



BF-PST= background with food objects/presence of Stroop effect, BF-LST= background with food objects/lack of Stroop effect, BNF-PST= Background with non-food objects/presence of Stroop effect, BNF-LST: background with non-food objects/lack of Stroop effect. \* = reaction time (dependent variable)

**Figure 2.** Diagram assignment of participants to experimental conditions.

**Table 1.** Mean and standard deviation of the completion time of Stroop test in different groups (n=40)

Group	Food stimuli	Stroop effect	Mean	Standard deviation
Restrained eaters	Food background	With	4024.67	579.97
		Without	4545.25	721.33
	Non-food background	With	4111.85	519.86
		Without	3637.45	483.27
Unrestrained eaters	Food background	With	3536.10	356.95
		Without	3945.22	431.68
	Non-food background	With	3734.80	370.66
		Without	3258.70	327.44

**Table 2.** Comparing pairs of groups in the three-way interaction in the Stroop test stimuli

Food stimuli	Stroop	Group		Mean difference	SE	P
Non-food background	Without Stroop	unrestrained	restrained	-378.75	92.30	0.0001
	With Stroop	unrestrained	restrained	-377.05	100.95	0.0001
Food background	Without Stroop	unrestrained	restrained	-600.05	132.92	0.0001
	With Stroop	unrestrained	restrained	-488.57	107.68	0.0001

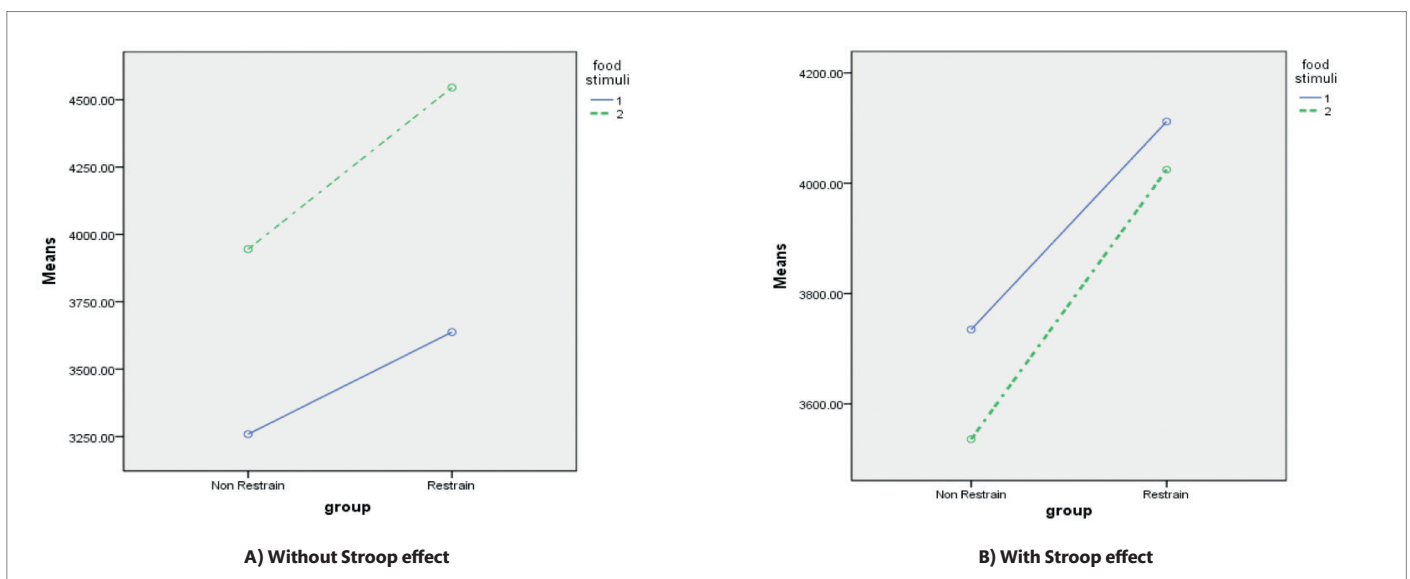
(*Pillai's trace*=0.945,  $F_{1,78}=1333.47$ ,  $p<0.001$ ,  $\eta^2=0.945$ ), and the three-way interaction effect of group in Stroop in food stimuli (*Pillai's trace*=0.06,  $F_{1,78}=4.54$ ,  $p<0.05$ ,  $\eta^2=0.06$ ) were significant, while the main effect of Stroop (congruent/incongruent word-color) was not significant (*Pillai's trace*=0.002,  $F_{1,78}=0.175$ ,  $p>0.05$ ).

First, we hypothesized that in background with food objects, reaction time in restrained eaters is more than unrestrained eaters. Results showed that the interaction effect of group in food stimuli ( $GG=55386.403$ ,  $F_{1,78}=5.04$ ,  $p<0.05$ ,  $\eta^2=0.061$ ) was significant. That is, in presence of food cues, the average reaction time for restrained group was higher than that of the unrestrained group ( $dMean=544.13$ ,  $p<0.001$ ).

Second, we hypothesized that in Stroop effect condition, reaction time in restrained eaters is more than unrestrained eaters. Results showed that the interaction effect of group in Stroop ( $GG=64042.903$ ,  $F_{1,78}=5.188$ ,  $p<0.05$ ,  $\eta^2=0.06$ ) was significant; that is, in both cases of Stroop effect

(presence-lack), the average reaction time of the restrained eaters was higher than that of the unrestrained eater ( $dMean=489.40$ ,  $p<0.001$ ).

Third, we hypothesized that in background with food objects and presence of Stroop effect, reaction time in restrained eaters is more than unrestrained eaters. Subsequently, three-way interaction was tested. In multivariate tests, the three-way interaction effect was significant ( $GG=60252.753$ ,  $F_{1,78}=4.545$ ,  $p<0.05$ ,  $\eta^2=0.055$ ). Results of post hoc tests showed that in both conditions of food stimuli (background with food objects-background with non-food objects) and in both conditions of Stroop (presence vs no presence), the average reaction time of restrained eaters was higher than that of the unrestrained eaters. As it could be observed from Figure 3 Diagram A, the average reaction time of restrained eaters in the condition of lack of Stroop effect and background with food pictures, is higher than the reaction time of unrestrained eaters. This pattern is also observed in conditions with Stroop effect, although in the first conditions, the differences are more intense (Table 2 and Diagram B).

**Figure 3.** Three-way interaction in food stimuli in the Stroop test. 1) Non-food background. 2) food background.

Also, in cases where the results of multivariate tests were significant, univariate post-hoc tests were conducted. Findings suggested that the main effect of food stimuli ( $GG=856053$ ,  $F_{1,78}=77.893$ ,  $p<0.05$ ,  $\eta^2=0.5$ ) was significant; that is, the average reaction time in presence of food cues was higher than in presence of non-food cues ( $dMean=327.12$ ,  $p<0.001$ ). Findings showed that the effect of food stimuli in Stroop ( $GG=17676230.25$ ,  $F_{1,78}=1333.47$ ,  $p<0.05$ ,  $\eta^2=0.945$ ) was significant; that is, in presence of food cues, the average reaction time of Stroop effect was higher than that of the non-Stroop effect ( $dMean=464.86$ ,  $p<0.05$ ).

## DISCUSSION

This research was conducted to study the attention control in restrained eaters in presence of food cues and Stroop effect. Results of this research showed that our first hypothesis was not rejected. We hypothesized that in background with food objects, reaction time in restrained eaters is more than unrestrained eaters. These findings are in accordance with those of Fedoroff et al. (8, 17) and Harvey et al. (25) who showed that food olfactory and cognitive cues form a stronger motivation for eating in restrained eaters, compared to unrestrained eaters. Accordingly, it was found that environmental cues impact the eating behavior in restrained eaters and obese people. Also, this finding is in accordance with previous studies which showed that pre-exposure to food cues leads to attention bias towards delicious foods in restrained eaters, so that, higher degrees of pleasure from delicious foods leads to increase in attention bias towards those foods (26-28). Also, in a study which was carried out by Papies (16), it was determined that pleasant thoughts, which are stimulated by pre-exposure with food-related cues, will direct the restrained eaters' attention towards items which are perceived as pleasant items. Based on previous studies (29), it is assumed that exposure to food cues disturbs the fragile balance between pleasant thoughts and dietary goal, that naturally permits the regulation of eating behavior in restrained eaters. Perceiving delicious foods leads to the activation of pleasant thoughts in restrained eaters and ultimately, the mental representation of the conflicting goal of diet is restrained. Although this goal could not immediately suppress pleasant thoughts and further food cues processes are guided by the pleasant thoughts, instead of dietary goal, it seems that this cognitive reaction to the food cues is an underlying mechanism which leads restrained eaters to direct their attention towards food stimuli that are consistent with bias along with pleasure.

Second, we hypothesized that in Stroop effect condition, reaction time in restrained eaters is more than unrestrained eaters. This is in accordance with the findings of Overduin et al. (26) that showed that the higher the delay in naming the colors, the higher the attention bias. In fact, attention bias towards food related words could indicate the tendency towards food, or avoidance of food or body-related stimuli. However, previous studies on the role of restrained eating in guiding selective attention towards food, have reached controversial results. Although some of the studies have concluded that, compared to unrestrained eaters, restrained eaters have shown more interference in food-related words in Stroop task (29), other studies have not found any evidence on selective attention to food in restrained eaters. These controversial results could be due to the impacts of concerns about diet in restrained eaters on attention process or due to the tools which traditionally measure these processes. Due to the high cognitive access of dietary thoughts, it is initially possible that restrainers do not pay any selective attention towards tempting food stimuli which could be considered as a potential threat for their diet (17). The only instance that repeated exposure to delicious food clues could stimulate pleasant thoughts about food and at the same time, lead their severe diet goals to be less accessible, food restrainers show an increase in selective attention about the food items (18).

Third, we hypothesized that in background with food objects and presence of Stroop effect, reaction time in restrained eaters is more than

unrestrained eaters. Based on previous findings, it was determined that in the condition of presence of food cues, restrained eaters' attention bias is higher than unrestrained eaters. Retrieved results indicate that restrained eaters' attention bias in the time of reaction towards congruent words is higher than the reaction time towards incongruent words in presence of food stimuli. Results of this research show that cognitive components have a fundamental role in tempting dieters and controlling these components could help increase the probability of following the diet (30). This focus on delicious and attractive food cues could probably impact further eating behaviors and most probably lead to overeating. Without considering the diet goal as a mechanism, it is unlikely that overweight leads to cognitive processes. It seems that bias in selective attention reflects the personal differences in motivation for reaching and consuming that material (30).

Results suggested that reaction time is highest in interaction condition of presence of food stimuli and Stroop effect. However, the effect of Stroop conditions is not significant without considering food stimuli and groups. These findings show the attention bias role in reaction towards food stimuli among restrained eaters and it shows that diet success depends on avoiding food-related interactions. Accordingly, the attention role is approved as one of the fundamental causes of diet success or failure. However, it should be noted that in this study, groups are not formed randomly so causal inference should be made with caution.

## Acknowledgment

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**Ethics Committee Approval:** This study was approved by the Institutional Review Board (IRB) in SU (approval no.: IRB9891892).

**Informed Consent:** To conduct any of the tests, initially written consent was obtained from each participant after explaining the tests stages and procedures.

**Peer-review:** Externally peer-reviewed.

**Author contributions:** Concept – ST; Design – ST; Supervision – ST; Resource – MG; Materials – MG; Data Collection &/or Processing –MG; Analysis&/or Interpretation – ST; Literature Search – ST, MG; Writing Manuscript– MG; Critical Review – ST.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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