



UNIVERSITAT DE
BARCELONA



**Campus
de l'Alimentació**
Universitat de Barcelona

UNIVERSITAT DE BARCELONA
FACULTAT DE FARMÀCIA I CIÈNCIES DE L'ALIMENTACIÓ
TREBALL FINAL DE GRAU

INHIBITION AND ATTENTIONAL CONTROL IN DIETARY RESTRAINT

Nicole Campbell Bartolomé

Bibliographic research

Psychology and Nutrition

June, 2020



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SUMMARY AND KEY WORDS

Dietary restraint has been the solution for many people to lose weight or simply have it under control to cope with this obesogenic environment that we live in, full of easily approachable palatable-food advertising. However, this behavior of ruling dietary intake by what must be or must not be consumed instead of following the intrinsic signs of appetite is believed to lead to an opposite reaction of failed inhibition as a result of self-control loss. Hence, not all dieters succeed in obtaining their goal. Interestingly, years of experimentation have helped to develop different assessment tools, such as experimental measures of the inhibitory pattern and the self-reported measures of dietary restraint that have helped to broaden the knowledge on this field. This way, it has been seen that some of those who are self-reported as restrained eaters vary in controlling their reaction towards food, surprisingly being those who have a more pronounced tendency for refraining from food intake the same who fail in inhibitory control. In the same line, restrained eating has been related to a more pronounced attraction to food known as attentional bias that also explains why some attempt significantly more to food consumption. Finally, based on the accumulating evidence of training inhibitory control, leads to the conclusion that such trait should be the target for treatment in order to encourage the successful and healthier performance of chronic dieters.

Key words: Dietary restraint, inhibitory control, attentional bias and behavioral measures.

RESUMEN Y PALABRAS CLAVE

La restricción dietética ha sido, para muchas personas, la solución para evitar ganar peso o intentar mantenerlo en este ambiente obesogénico que nos rodea, lleno de publicidad sobre productos alimenticios de alta densidad calórica que son fácilmente accesibles. Sin embargo, se ha visto que esta actitud de limitarse a comer solo lo que se debe cuando se debe, en lugar de hacer caso a las señales fisiológicas reguladoras del apetito, provoca un efecto adverso en la capacidad inhibitoria hacia la comida como resultado de una pérdida de control en algunas personas. En consecuencia, no todos los comedores restrictivos cumplen con su objetivo principal de controlar el peso. Con el paso del tiempo, los expertos han ido desarrollando una serie de herramientas capaces de medir tanto el patrón inhibitorio a través de unos métodos experimentales, como la tendencia restrictiva por medio de unos cuestionarios que han contribuido al conocimiento de este campo. Se ha visto así, que la mayoría de aquellos que se consideran comedores restrictivos son los mismos que presentan un control inhibitorio limitado. También se ha asociado esta población a una mayor atracción por la comida calificada como sesgo atencional lo que a su vez explica la tendencia incrementada de algunos hacia el consumo alimentario. Con todo ello, y dadas las evidencias que apoyan el uso de los métodos que entrenan el control inhibitorio, se podría decir que las intervenciones de tratamiento deberían insistir en él pudiendo así corroborar en una restricción alimentaria exitosa y saludable.

Palabras clave: Restricción alimentaria, control inhibitorio, sesgo atencional y medidas de comportamiento.

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1. INTRODUCTION

Concern about how food can have an impact on our body has led to a large number of dieting programs throughout the years. A clear example of it can be found nowadays on the media where dieting plans for becoming vegan, losing weight or promoting the Mediterranean diet to benefit from its cardiovascular protective effects is more than common.

Ironically, a constant increase in overweight and obese people can be observed, reaching to a point where it is predicted that in 2025, global obesity prevalence will reach 18% in men and surpass 21% in women (1). Such alarming data is mainly believed to be caused by an accumulating and rather excessive exposure and consequent consumption of palatable foods that are found in what is known as the contemporary Western diet. These mainly consist of high glycemic index foods that are characterized by inducing a quick blood glucose peak rise, followed by a rapid decrease resulting in an alteration of the metabolism. As a consequence, the feeling of satiety is shortened which increases the need to consume more food in a rather impulsive way, enhancing the probability to gain weight and therefore, becoming obese (2). Needless to say that the amount of salt, fat and other additives that make food last longer and taste better, also contribute to this over consumption and the following health issues.

However, not all individuals immersed in this obesogenic environment suffer from overweight or obesity which supports the idea that such traits may belong to a group of people who are more sensitive to food. Indeed, research has helped to affirm that subjects with a higher BMI show an increased reaction towards high-caloric foods exposure, as a consequence, it is harder for them to refrain from consuming these (3). Furthermore, accumulating studies have affirmed that obese and overweight individuals show a decreased ability for inhibition, understanding inhibition as the capacity to suppress human impulses and control one's attention, behavior, thoughts, and emotions (4). Poor inhibitory control encapsulates, as well, impulse - related disorders which help to insinuate that this cognitive deficit enhances vulnerability for suffering from an altered response such as overeating. For instance, a study in which female participants of different weight scales were experimentally assessed, showed that those with a higher BMI were strongly associated with a decreased inhibitory control over food related responses (5).

Assuming this idea, we could affirm that inhibitory control is crucial not only to avoid food temptations but also to make the right decisions when dieting and following a healthy lifestyle. In

accordance with this, there is an existing link to performing such behavior that is shared and put in practice by the so called restrained eaters. Restrained eating refers to the tendency of limiting food intake by putting in practice enough willpower to withhold eventual urges to eat and, therefore, it helps to maintain an average weight. Nonetheless, not all individuals are able to keep up to such persistence, instead, they show a disinhibited eating behavior (6).

In line with this, investigation has led to propose that restrained eaters do not form a homogenous group, they could be divided at least in two specific groups: successful restrained eaters and unsuccessful restrained eaters (6). In fact, a goal conflict model was developed which defends that the main difference between these groups appears when they see themselves facing two major opposing goals: eating enjoyment and weight control. It explains that successful restrained eaters prioritize the goal to control their weight by restricting the caloric intake, whereas unsuccessful restrained eaters appear to fail more often in this restriction since they prefer to enjoy eating, especially if they find themselves in a food-rich environment (7). In other words, successful restrained eaters demonstrate a higher control over their diet which enables them to live on an average weight.

In addition, further methods have been developed throughout the years of investigation so as to broaden knowledge on this field. On the one hand, experimental tasks such as the Go/no-go task and the Stop signal task (SST) are meant to study the inhibitory pattern of the participants, whereas visual testing tasks, also experimental, study the temporal attention or attentional bias to food that is also believed to fluctuate among restrained eaters, through computer-based tests. On the other hand, self-reported measures like the Three Factor Eating Questionnaire (TFEQ), the Restraint Scale or the Dutch Eating Behavior Questionnaire (DBEQ), among others, stand out for identifying behavioral patterns, in this case restrained eating, by undergoing paper-based questionnaires.

To sum up, it is of note that we are immersed in a society that is constantly stimulated by, especially, energy-rich foods. This is presented in different ways, from food advertising on social media to the growing invasion of fast foods, resulting in a big obstacle to regulate food consumption (8). Hence, despite the effort of some to regulate their daily intake, it seems that it is not possible for others to overcome this demanding environment which suggests that there is

work to be done to obtain a more accurate knowledge about what sustains successful restriction and use it as a future intervention resource in the context of ameliorating eating habits.

2. OBJECTIVES

The main objective of this review will be to outline the differences in restrained eaters in relation to the inhibitory function, in order to understand better their cognitive traits and to consider how to develop palliative or preventive treatments that may contribute to improve it.

The secondary objectives of this project are the following:

- To focus on other cognitive deficits related to altered eating behaviors associated with restrained eating.
- To underline the experimental measures that are used to assess the inhibitory pattern and the self-reported measures of restrained eating behavior.
- To suggest a possible education in cognitive inhibitory function.

3. MATERIAL AND METHODS

To start this review, it has been essential the use of three important searching databases such as *Scopus*, *Pubmed* and *Google scholar*. These have helped finding the right information about the subject in different articles that were easily obtained through *cercabib*, a webpage to which students from the *Universitat de Barcelona* have access to.

In order to conduct a successful research, the articles that have been looked for in such resources have been based on the latter findings. The period of time in which the current review has been set includes the years between 2010 and 2020, mostly trying to prioritize the most recent ones. Moreover, this research has also been limited to key words that have helped to proceed more accurately with the project, such as impaired inhibition, restrained eating or restrained eaters, psychological tasks and behavioral methods, among others.

Regarding scientific evidence, the articles that have helped to settle the bases of the topic consisted mostly of systematic reviews and clinical trials. The former helped to obtain an overview of the topic and also introduced many studies positively linked to the topic. Moreover, clinical trials supported evidence of suggested theories and ideas in previous articles which reinforced the concepts that have been worked on in a more practical way. The review has also been based on fewer meta-analysis in order to add reliability. Although in most cases more research is suggested to be needed, it is remarkable the variety of resources that enable to make progress in this field.

As the research went on, it is of note that focusing on the sources from which the headings belonged, such as famous journal homepages and psychology book titles, has permitted to filter the information required. This way, it has been possible to limit the findings to the basis of the eating behavior that prevails in today's society. However, not all the citation that refers to restrained eating has been used since it enfolds a greater field than what it has been worked on in this review.

4. DETAILED DESCRIPTION OF THE ACTUAL KNOWLEDGE OF THE TOPIC

4.1 COGNITIVE ALTERATIONS ASSOCIATED WITH RESTRAINED EATING

Intentionally restricting food intake is believed to help maintain an average weight or at least not gaining it. In fact, it has been related to healthier dietary patterns such as lower fat intake, less liking of processed foods and quicker time to feel satiated (9). Not repeating a second course, not having desert or simply avoiding copious meals are habits that characterize restrained eaters. These individuals, however, rule their appetite by a mental control process based on cognitive inhibition instead of following the signs of the physiological regulation system such as hunger or satiety. Hence, they will stop eating because they decide to stop not because they are full (10). In reference to this, results from an experience sampling study that was launched among a total of 204 adult participants who varied in food restriction tendency, showed that those who rated high in response inhibition were more likely to resist food desires, not consume desired food and, even lost weight during the assessment period of 4 months (11).

Nonetheless, ignoring intrinsic signals of regulation implies a constant effort of self-regulation that is not always easy to handle, contributing to the variation of it in different dieters. This has been especially reported in people who undergo restrictive diets as part of a weight loss process but are not always able to keep up to such habit in the long term. For instance, a two-year study in which 200 obese participants were randomly assigned to either a gradual or a severe weight loss program resulted in most of them regaining their already lost weight as a result of failing in restricting food intake in the long term (12). As said by the National Institute of Health, weight regain after weight loss still remains the most substantial problem in obesity therapeutics (13). Similarly, a ten-month multidisciplinary intervention in which thirty five obese adolescents participated, surprisingly concluded that those who were considered cognitively restrained eaters not only tended to lose less body weight than unrestrained eaters, but they also reported a significant increase after providing them a 24 hour period of free will food intake suggesting that such trait could be of interest to identify adverse results in the context of youth weight loss interventions (14).

This way, studies on the dynamics that rule self-control have enabled experts to extrapolate the results and distinguish two important variants: an effortful and conscious inhibition of temptation impulses from an effortless and automatic mechanism (15). It has been observed

that those who experiment a more pronounced and successful restrained eating habit benefit from the latter variant which enables them to make healthier decisions in a regular basis. This could explain why successful restrained eaters experience lower or normal BMI results than those who appear to lack on it but yet are still considered restrained eaters (16). Pursuing the goal to lose or maintain normal weight is also a helping strength to add to overcoming tempting impulses as it is supported by the goal conflict model (7). Thus, according to this, focusing on the target of wanting to lose weight or staying on average by prioritizing it over the desire of consuming food is essential to succeed in restraining food intake too.

All of this effort trying to control food consumption makes restrained eaters more susceptible to food than normal or unrestrained eaters, especially to palatable foods. Regardless of the inhibitory capacity that is behind each one of them, controlling what they must and must not eat is a process that constantly tests their behavior with food since they mostly indicate to think and give too much time to it (17). Consequently, living in the food-rich environment that the western society is immersed in, makes it challenging for them to conduct a healthy lifestyle which leads to enhance cognitive alterations such as impulsive eating. In fact, impulsivity is strongly associated with inhibitory response, meaning that those who show difficulties in inhibiting their reactions towards food are exposed to a lack of a sensible control of eating. For instance, a total of 146 females who participated at a laboratory test and differed in dietary restraint demonstrated that, in those who rated high in dietary restraint, a milk shake preload helped to decrease impulsivity towards the food consumption that followed supporting that, in spite of the effort to refrain from food intake, cognitive traits of self-control play an important role in eating behavior (18). Similar to this, it has been of interest to see the results of a combination of a systematic review and meta-analysis in which, considering binge eating disorder as one of the most representative pathological behaviors in the core of uncontrolled eating, participants who demonstrated a decreased inhibitory control were obese which adds the idea of control loss when eating to be a possible trigger to obesity due to a lack in inhibitory ability (19). Restrained eating, however, is not yet considered an eating disorder so results from the latter study have not been directly addressed to restrained eaters who do not succeed in approaching their goal of controlling their weight but, together with the suggestions of the former study results, it could be helpful to better understand what it is that fluctuates among some of them.

Literature about restrained eating supports, as well, their tendency to be attracted to food, it is known as the food-related attentional bias. This attractiveness is believed to induce cravings that are mostly known by the enhanced will to consume certain food types, and other eating disorders (20). Hence, higher craving levels have been related to a more pronounced approach to food leading to consume greater amount of it (21). Further along the line, cravings have demonstrated to be at the core of clinical uncontrolled eating disorders by which people tend to eat impulsively on a daily basis associated with episodes of control loss, demonstrating faster reactions to food items rather than to neutral ones comparing to general healthy individuals (22). Moreover, findings about these in restrained eaters (23) have added evidence for the prediction about a restrained – overeating paradox meaning that one could lead to another or at least they could be alternating both tendencies.

Deeper in this context, there has been a further consideration about the most common cognitive deficits that remain in eating disorders which has helped to obtain a broader overview on the field. A recent systematic review with accumulative reviews about the neurocognitive functioning in eating disorders, has emphasized on the psychological traits that underlie altered eating behaviors supporting that cognitive control processes are inherent components of self-regulation (24) that together form a multidimensional system. To perform a more accurate study of the whole, there has been a subdivision of the individual mechanisms that contribute to such system. Those are, indeed, inhibitory control, attentional bias, working memory, decision making, central coherence and set-shifting. As for inhibitory control and attentional bias, both have previously been spotted as two of the central cognitive traits of self-control to cause conflict.

Working memory functioning, however, refers to the capacity of gathering information and working with it in mind in order to conduct one's behavior (24). Such ability provides greater behavioral benefits since it offers a wide range of information processing skills, updating through new concept integration and considering different alternatives. In other words, it gives the individual a conceptual learning freedom that can contribute to guide the behavioral pattern in order to follow an adequate lifestyle and consequently, avoid overconsumption periods.

On the other hand, decision making, explained in a simple way, consists of choosing one option or carrying out one action among a set of alternatives, based on self-criteria (24). Hence, a

decision will be made after a process of evaluation and the following conduction of the choice. This mechanism is believed to be altered in those who suffer from disordered eating since most individuals of this kind are associated with failing in pursuing goals such as overeating in spite of wanting to lose weight or maintain it, and repeating actions despite knowing that they are harmful and, therefore, have to be modified like tempting snack-foods in a context that it is necessary to cut down in these.

As for Central coherence, it refers to the balanced combination of both, focusing on specific details when processing information together with the ability to integrate a general overview of the total information (24). Hence, individuals suffering from distorted eating habits often present a weaker version of central coherence given that most tend to pay greater attention to smaller details, opposing themselves to experience a broader point of view of the context. Only focusing on body weight to restrain calorie intake instead of facing a wider perspective of what is leading to overweight or obesity or what could help to maintain a normal BMI, for instance, could be clearly representative of this cognitive deficit.

Lastly, set shifting is another cognitive trait that is understood as the ability to develop and handle flexible thoughts or actions in order to adapt to the shifting situations that appear in daily life (24). Being part of the self-regulation of behavior, a deficit in this is represented as lacking skills to overcome changing demands, therefore, although uncontrolled eating follows unhealthy outcomes, a person with a weak set shifting capacity will not change this behavioral pattern since it requires to learn the healthy pattern and put it in practice.

To summarize, the approaching evidence on the different cognitive traits that remain in conflictive eating behaviors, as well as in restrained eating, seems to stem from the presence of the lack of self-control that many individuals struggle against. Hence, it could be suggested that all deficits together share the basis of impaired self-control issues which, in part, block the performance of successful inhibitory control that is believed to strengthen intentional food restriction, among others, and, therefore, diminish the beneficial effects that could derive from it.

4.2 EXPERIMENTAL MEASURES USED TO ASSESS THE INHIBITORY PATTERN

The characterization on restrained eating has been built on the different outcomes measured through a large variety of assessment tools. On the one hand, experimental tasks such as the Go/no-go, the Stop Signal Task and some visual tasks will be reviewed.

The Go/no-go (GNG) task is a method that demands both, a quick motor response in front of a certain stimuli and an inhibitory capacity in front of another one (25) in order to assess impairment of the inhibitory response. In other words, it helps to reveal how weak or strong a person's ability to hold a response is when confronting a task that requires such trait for processing a certain stimuli type. The method varies depending on what the outcome that is measured relates to; in this case, it is focused on food-related inhibition, resulting in the combination of food-related and non-related pictures. Therefore, images assigned to go and no-go responses are randomly presented on a computer screen, the exposition of which is measured in periods of time. Go pictures represent those that have to be responded by clicking or tapping on a computer button whereas the reaction must be withheld at the no-go pictures. As responding to go trials is easier than withholding the reaction in no-go trials, what it is used as a measure is the commission error rate, that is, how many times does the participant press the button when it is not supposed to. Thus, fewer errors signify a better response inhibition. Furthermore, in order to make it more accurate at measuring the outcome, the tasks usually alternate the category of the items putting go pictures as no-go ones and vice versa in the same experiment. As an example of its use, a study where a total of 116 lean and overweight/obese participants completed both, a food-based and neutral category control GNG task demonstrated that overweight/obese participants in comparison with those who were lean, committed more errors on the food-based GNG task only when they rated low in dietary restraint (26).

The Stop Signal Task (SST) measures a reactive inhibition, in other words, it measures the ability of an individual to withdraw a response that is currently given during the task. It consists of a computer-based method in which participants undergo a process of reacting (going) and inhibiting (stopping) responses through a similar mechanism as in the GNG task. Here, though, a horse-race model is assumed (27) and implemented on the computer program representing two independent variables, the go process, in which the participant must respond to a target, and the stop process, in which stop signals such a tone or a red dot are exposed at a variable delay after

the former target, in order to assess the speed of the inhibitory reaction. It includes three parameters: the Stop Signal Delay (SSD), the Mean Reaction Time (MRT) and the Stop Signal Reaction Time (SSRT). Being the SSRT the most representative outcome for reactive inhibition it needs the SSD, that is, the mean delay between the target and the stop signal as a measure of the probability of failed inhibition, to be discounted from the MRT on go trials, the latency of correct responses, in order to obtain the results of what is thought to be an index of impulsivity, meaning that those with longer SSRT indicate greater impulsivity and poorer inhibitory control.

However, the main difference between both experimental tasks has been pointed out to be the period of time given in between the going and the stopping reaction in the different situations, being the one in SST shorter than in GNG. Evidence on restrained eaters has demonstrated a poorer reactive inhibitory capacity in comparison with normal or unrestrained eaters (28). Interestingly, overweight and obese participants also experiment such deficiency supporting the idea that not all restrained eaters accomplish their onset goal of dieting to maintain normal weight (29).

Similar to the former experimental tasks, visual testing tasks consist of different computer-based methods which are used to assess the participant's selective attention to food stimuli, a phenomenon known as attentional bias. Although the former tasks refer to inhibitory control, attentional bias is unintentionally related to such trait since it is part of the individual's ability to control a reaction or impulse. In the first place, the Rapid Serial Visual Presentation (RSVP) task uses a stream of pictures mixed with targets that are introduced as neutral and as food-type pictures in different intervals that have to be identified. Results are measured in terms of the capacity to identify the targets in spite of the picture stream and, in some variants of the experiment, by adding food-related pictures as distractors too. When investigating on restrained eaters, especially in high restrained ones, it has been seen that when food-related pictures appear as a second target, the identification of the first target diminishes. Also, neutral targets are worse identified if food-related distractors are used along the stream, which provides a different point of view of the assessment (30). This reinforces the idea of the tendency of restrained eater to pay greater attention to food stimuli. Nevertheless, an updated study based on the RSVP task in which restrained eaters took part together with emotional and external eaters, that is to say, people with other eating patterns, suggested that attentional bias for food had no significant difference among these. Instead, all of them shared a similar tendency to react

towards food stimuli (31). Such contrasting data relies on the use of different self-reported measures that therefore, do not lead to the same results. While the former study was based on a scale that focuses on the more conflictive side of restrained eating, the latter one uses a questionnaire that suits successful restrained eaters better, as it will be explained further on.

Another method that is used in this line is the Stroop test which combines both, neutral and food-related pictures as well to measure which type captures more the attention of the participants. Indeed, a study including different levels of restrained eaters that underwent the Stroop test, demonstrated a higher attentional bias to food-related stimuli together with less successful weight loss (32).

Lastly, the visual probe task measures attentional bias based on the intensity of the eye-movements that are caused by the variety of pictures exposed. For instance, a study using this task combined fattening food pictures and object pictures and approached to manipulate the participants' state of the mind by inducing healthy and less healthier mindsets to the different groups previous to the task (33). Not only it added support to the fact that restrained eaters demonstrate an attentional bias to food but it also provided evidence that this could be reduced when a healthier mindset is set previous to the task (34).

4.3 SELF-REPORTED MEASURES OF RESTRAINED EATING BEHAVIOR

On the other hand, restrained eating on its whole has been studied through years of investigation as an eating behavior by involving the participants to fill in questionnaires out of which we will be focusing on: the Three-Factor Eating Questionnaire (TFEQ), Restraint Scale (RS) and the Dutch Eating Behavior Questionnaire (DEBQ).

The TFEQ is used to provide a subjective description of restrained eating behavior. One of its common applications is carried out in patients before undergoing bariatric surgery, since it assesses any possible psychological contraindication such as impulsive eating that would not help in benefiting from the treatment in the long term. This way, it is based on three subscales that consist of the three most representative eating behavior traits to focus on when detecting restrained eaters: cognitive restraint, disinhibition and susceptibility to hunger. Cognitive restraint refers to the ability to consciously restrain food consumption in order to lose weight and/or control it, whereas disinhibition is measured as the loss of control over food intake.

Finally, susceptibility to hunger defines how easily individuals can feel the hunger that is induced by either external or internal stimulation (35). Such subscales are measured along a total of 51 items that the participants answer one by one according to which option suits them most. Thus, the overall punctuation obtained on each subscale will suggest the subsequent eating behavior: high scores coming from the items representing disinhibition and susceptibility to hunger or emotional eating subscales, has seen to be positively related to individuals with higher BMI. Concerning cognitive restraint, it is not yet clear whether it is associated to obesity or not at all (9). Most of the evidence aims for the fact that a higher score relates to overweight and obesity, since cutting off the consumption of food and mostly palatable food in this food-rich environment ends in breaking with a control loss over eating. However, there are those who rate high in cognitive restraint and benefit from a normal weight.

The RS is another method that is widely used in research on Psychology associated with eating behavior. It is built on a 10-item questionnaire all of which provide a final score that can range from 0 to 35. The results are classified among two subscales: the dieting scale and the weight fluctuation scale. Concerning the dieting scale, it is believed to give greater information about the attentional and emotional link to food since it includes six different questions regarding diet frequency and feelings representing weight awareness. The latter scale, however, focuses on weight history and fluctuations by including four questions about weight loss and weight gain. Among these subscales hide different parameters that mostly suit people who make big efforts to control their food intake but still struggle with cognitive impairments such as disinhibited eating and food craving (36).

As for the DBEQ, a 33-itemed questionnaire, it emphasizes on the study of restrained, emotional and external eating behavior that are represented as three subscales. The first one, that is, Restrained eating subscale, comprises 10 questions about restriction or avoidance of food intake. For example, one of the questions says the following: 'If you have put on weight, do you eat less than you usually do?' (36). The next subscale representing Emotional eating, contains 13 questions that reveal information about the tendency of people to eat in response to emotions that are believed to interfere with eating behavior. One type of question consists of the following: 'Do you have a desire to eat when you are emotionally upset?' (37). The third subscale about External eating offers the remaining 10 questions that insist on how external stimuli, such as the sight, smell and taste of food or just seeing another person eating can have an influence on

the quality of food intake. Questions like 'If food smells and looks good to you, do you eat more than usual?' are included in the report. On the overall content of the questionnaire, experience supports that it is better associated with good food-related self-control meaning that it is a more suitable tool to identify successful dietary restraint (36).

4.4- EDUCATING INHIBITION

Given the validity of self-control on eating behavior and, more precisely, the wide range of methods that work on inhibitory control, recent approach for training response inhibition through experimental tasks of GNG and SST has already been carried out. In these tasks and in the crucial experiment condition, high density and/or palatable food is presented as no-go so the subjects must not respond to these or inhibition is simply put in practice in the stop process of the SST. If this is frequently put in practice, especially by individuals who are more vulnerable to choose palatable food as it appears to happen in some restrained individuals, it is believed that it can be extrapolated to real life. A clear evidence of it has been demonstrated when training inhibition through the no-go method reduced consumption of snack-foods (38). In that study, not only intake was reduced but also its choice and the self-served portion of it. In fact, it was highlighted that changes were more noticeable in those who were considered restrained eaters according to the scores in the DEBQ test than in those who were not. Similarly, a training process program based, as well, on the GNG task was released among a sample of 83 overweight and obese people since this collective is known to experience overeating episodes that could be related to those experienced by restrained eaters. The results demonstrated a greater weight loss as well as a lower caloric intake and preference to palatable food (39). Another study also demonstrated that snack consumption was reduced after no-go training in individuals who show low levels of self-control towards food response, although no changes were consistent in improving inhibitory control towards food comparing to individuals who were not exposed to food but to objects in the no-go training (40).

In reference to Stop-Signal task training, it has also been considered a possible method for training inhibitory response but further studies have concluded a lesser effectiveness in comparison with the no-go trials(41) suggesting that experimental training should be better focused on the GNG task.

In spite of the positive results obtained in several trials, one of the latest meta-analysis on the field working on health compromising behaviors such as alcohol drinking and unhealthy eating (42) yet defending the beneficial effects of the GNG training inhibition over the effects of the SST, does not assure a long term effect of the process simulating that there is still a need for an updated systematic examination in order to add consistency to it as a possible promising treatment to fight overeating that might derive from restrained eating.

Further on an approach for suggesting education on inhibition, updated research through a complete review of both, a systematic review and meta-analysis(43) about the effects of cognitive training on eating behavior and the following weight loss as a result of succeeding in regulating food intake, has helped to broaden the overview about possible treatment interventions. Such data relies on five important cognitive bias from which inhibition training, based on GNG and SST task, and attentional bias modification, based on diverting attention from unhealthy foods to healthier ones, appear to have a significant impact on the eating behavior by moderating it, yet again priming the larger effects of the GNG task. Regarding weight loss, however, it has given support to the positive outcomes that stem from food-specific inhibition, despite the need for more future research to emphasize on this effect.

On the overall comprehension of the training processes, recent data reinforces the mechanism that reduces the intensity of choosing palatable food in the participants of no-go trials, defining it as a result of a devaluation process (44). In other words, using high density foods as the target of response that must be inhibited, makes individuals lose interest, resulting in a reduced consumption. In line with this concept, there has been a recent approach on training individual cognitive resources by a learning process of mindfulness. The essence of this consists of putting in practice conscious decisions when eating, by first understanding the automatic process that drives some people's attention to tempting foods such as snack-foods. The representative study of this concept was carried out among randomly chosen self-reported snack eaters and compared with control subjects, demonstrating a decreasing effect of snack consumption after a week of a mindfulness training session (45). These results have led to the suggestion of a mechanism based on removing the automatic impulse of choosing palatable foods by orienting their thoughts towards practicing conscious eating, hence, the intake of these would no longer be uncontrolled.

Similar to this, a study in which attentional bias was assessed among restrained eaters together with enhancing different mindsets previous to the assessment task, showed that those who were induced a healthier mindset obtained better results in reducing attentional bias towards high-caloric foods (34). Moreover, those results were more positively pronounced in those who scored high in restraint tendency which predicts, again, that inducing a healthier mindset might also collaborate on enhancing the effects of the inhibitory training process.

Although more studies are needed to be conducted in this field, training response inhibition has been proven to be effective. Moreover, it is of note that the participants whose response has been assessed and improved after the training process consist mostly of restrained eaters and individuals who show a lower capacity to refrain from choosing or consuming the predominant food-types in society, as it also happens with overweight people. As a conclusion, educating vulnerable individuals to make clearer decisions on choosing healthier foods to include in their diet through inhibition training and putting in practice healthier mindsets could be a promising target for treatment to, once again, enhance successful restriction.

5- DISCUSSION

Food is essential to meet energy and nutrient requirements. It has, indeed, immersed the society in the large field that it offers from the promotion of foods and the development of nutritional facts and health claims, to the study of eating behavior and its dynamics. In spite of its amplitude, the aim of this review has been to focus on restrained eating as an eating behavior that is rather promising in order to avoid the increasing habit of massive consumption of unhealthy food. However, the continuous research that this project has been built on, has led to the conclusion that not all chronic dieters succeed in achieving their goal of avoiding weight gain by voluntarily restricting food intake, instead, most individuals appear to fail since they are driven by cognitive traits that relate to a lack of self-control. Hence, impulsive eating, food cravings or attentional bias enhance the tendency to overconsumption.

As research on the field of eating behavior is still remarkably improving, there is more and more evidence that the constant food stimulation is what triggers the vast majority of the population to undergo periods of uncontrolled eating. Easily approachable high glycemic index foods (8) predominate on our daily basis breaking with the balance between food intake and uptake. Furthermore, contemporary Western diet (46) provides low-fiber products which interrupt the bowel transit that is associated with a lower evacuation of feces and further damage of nutrient digestion and absorption. Such foods also contain high levels of saturated fats that alter lipid profiles in our organism and are able to cause damage in the cardiovascular system in the long run. All together makes it clear for the fact that making the correct food choices is important not only to avoid weight gain but also to avoid related adverse health outcomes.

Going through the different cognitive traits that exist in altered eating behaviors, not only has it helped to highlight that there are diverse subscale cognitive traits underlying self-control but that there is an existing link between these being impaired and performing unsuccessful food intake. Although the deepest insight in cognitive functioning has been limited to clinical eating disorders, it can be helpful to further understand what is behind restrained eating and yet fluctuating in what at first seems like a promising behavior towards food restriction.

Consistent with it, this review has underlined the importance of self-control as the main source to maintain a balanced relationship with food. This way, not only has it brought out the experimental methods that assess the inhibitory pattern but it has also outlined the self-reported

measures, providing information about how the different items that are taken into account might contribute to the lack of a homogenous point of view about restrained eating. As for the self-reported measures, for example, it is to say that even though they all focus on restrained eating, there are differences between the questions to which the participants must undergo resulting in a variability on the interpretation of the overall score. Such diversity is believed to impede replicability among the restrained and it has been clearly remarked when comparing the Restraint Scale and the Dutch Eating Behavior Questionnaire in which the former adapts better to those who have issues when restraining food intake whilst, the latter stands for those who succeed in chronic dieting. Accumulating literature on assessment methods has also remarked the lacking reliability on these since many questions tend to highlight delicate aspects of eating behavior for some to confess like snack consumption or overeating frequency resulting in mislaid information.

On the contrary, experimental methods in which the results are assessed by following an evaluation template based on the outcomes that will be measured, appear to offer a smaller error range when interpreting the results since it consists of objective information. However, these methods tend to the generalization of the results when these are really obtained out of a specific sample of the population.

However, it has been seen that individual diversity also contributes to conflicting data about eating behavior and cognitive patterns adding support to the fact that more than the need of a bigger amount of studies, what it has been suggested is a registration of a wider variability of physical and cognitive attributes to provide more accurate information about eating behaviors and its association with health outcomes. This could be, indeed, solved by carrying out more precise individual studies since it would help to start off with a more complete knowledge about each person.

Regarding training response inhibition, although most studies approve the objective mechanism of no-go trials to manipulate the cognitive pattern of those who are considered to be under the influence of impulsive reactions, it would be of interest to extend that of inducing a healthier mindset and developing awareness of food intake. After all, it is what seems more challenging and yet useful to manage our own impulses at the whole learning process. Nevertheless, giving another point of view about moderating inhibition would be to consider a combination of both,

inhibition control training through experimental methods and training cognitive resources as an individual continuous practice.

6- CONCLUSION

In conclusion, it is clear that nutrition is not just meeting nutrient and energy needs but it consists of a more complex concept that involves the individual by making an effort to be more aware of what is behind a healthy lifestyle. Therefore, the variability in success of restrained eating in terms of inhibition, together with the knowledge that the last years of experimental and subjective assessments have provided, should still be challenging in the context of eating behavior so as to improve the treatment interventions by practicing longitudinal tasks which would help to offer more individualized and encouraging methods in the future. Hence, chronic dieting will no longer be performed by individuals who want to control their weight without healthy and well-conducted inhibitory control.

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