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Neuropsychology of Bulimia Nervosa: New Findings

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1. Introduction

Eating disorders (ED) according to the Diagnostic and Statistical Manual of Mental Disorders, revised text (DSM-IV-RT) produced by the American Psychiatric Association (2000), are classified in anorexia nervosa (AN), bulimia nervosa (BN), and eating disorders not otherwise specified (EDNOS).

The AN is characterized by a refusal to maintain body weight at or above a minimally normal for age and height, intense fear of weight gaining, a change in weight or body shape perception and in post-pubertal women, amenorrhea. On the other hand, the BN is characterized by the presence of recurrent binge eating, use of inappropriate compensatory behaviors repeatedly (in order to prevent weight gain), such as induced vomiting, abuse of laxatives, diuretics, enemas or other drugs, fasting and excessive exercise, and self-worth excessively influenced by weight and body shape besides the presence of depressive symptoms, especially after binge. Sometimes the bulimic behavior is present in patients with AN or people whom carry out restrictive diets, but the BN itself does not produce significant weight loss. What may occur due to induced vomiting, are gastrointestinal problems, severe hypokalemia, hypercholesterolemia (Pauporte & Walsh, 2001), hypernatremia (Crow et al., 2001), hypophosphatemia (Winston & Wells, 2002), impairment in renal fluid and electrolyte balance, with changes that can influence heart function (Andersen, 1985), as well as damage to teeth due to the acidity of vomiting (Daee et al., 2002).

Historically, it has been conceptualized that the BN, like AN, has a socio-cultural origin (Lilenfeld et al., 1998), and twin studies (Wade et al., 1999), reveal an important contribution of genetic factors (between 54 and 83%). The analysis has identified areas on chromosome 10

that may be involved in the onset of BN, in addition, numerous candidate genes for their role in the risk of developing the disorder have been studied (Bulik et al., 2003), on the other hand, biological studies indicate alterations in serotoninergic function in BN patients (Steiger et al., 2005).

BN occurs mainly in adolescents, especially in women, due to different psychological mechanisms, one of them might be the difficult to assume a sexed body (Toro, 1996), although the most possible is the response to social pressure that values thinness as physical attractiveness, which plays an important role in modern societies (Lindberg & Hjern, 2003).

Resarchers suggest that although 1 to 5% of adolescents meet diagnostic criteria for BN, 10 to 50% occasionally use self-induced vomiting or binge eating (Strasburger & Brown, 1998). This disorder occurs primarily in young adults and half of cases develop symptoms before 18 years (Strasburger & Brown, 1998). Similar to AN, BN occurs predominantly in women and less than 1% of men met DSM-IV-RT criteria for this disorder (APA, 2000). The BN is often perceived as an attempt to control, prevent, or minimize the impact of stressful feelings and impulses (Steinberg & Shaw, 1997).

The patients with BN tend to be cognitive and behaviorally impulsive, disorganized, narcissistic and suggestible in nature (Lehoux et al., 2000). In addition, many of them have substance abuse disorders, depression, self-mutilation and impulsive behaviors such as shoplifting or drug abuse (Lledo & Waller, 2000). In view of AN and BN are chronic disorders, with periods of exacerbation and remission of symptoms (Herzog et al., 1999) researchers suggested that the etiological factors involved are present before and during the onset of the disorder, and during remission. It has been proposed that neuropsychological deficits preexist and underlie the etiology of the development of an ED (Silva, 2001), which could explain the high rate of exacerbation and recurrence of symptoms. In fact, treating only the symptoms (e.g. eating habits) and not the underlying problem (e.g. cognitive deficits) is likely to occur relapse (Lena et al., 2004).

Clinical observations have found that patients with ED are unable to focus on cognitive-behavioral skills learned. It has been hypothesized that when there is a specific group of cognitive deficits in a particular severity degree, deficits interfere with the development of self-esteem, assimilation of changes in body image during adolescence, identity formation, interpersonal relationships, and with autonomy, which can reinforce the development of an ED. It is important to note that there is not a single causal factor in the development of AN or BN. In fact, ED are caused by the interaction of multiple factors, however, we know that there are cognitive deficits in patients with ED. When these factors are present in a specific combination and degree of impairment, a cascade of reactions can be driven and can be an important variable in the development of the disease. In addition, the presence of cognitive deficits do not automatically promote the development of an ED, while other protective factors (e.g. adaptive coping and social support) are present, preventing or delaying the development of an ED. It is possible to prevent or intervene in the development and maintenance of an ED, by identifying a cognitive deficit in people who are at high risk or have symptoms of this disorder (Lena et al., 2004).

There is evidence of a relationship between ED and morphological (changes in volume of white matter and gray matter in the brain) and brain function alterations and it has been observed that structural abnormalities are usually reversible with weight gain (Frank et al.,

2004). However, functional abnormalities may be secondary to weight loss and could also reflect underlying primary deficits (Chowdhury & Lask, 2000).

The onset of an ED pathology is characterized by repetitive thoughts associated with body shape and aesthetic evaluation that may result from the influence of the media, wich show thin women who turn out to be more attractive the commercial products and their in turn induce some women to want to be thin, causing changes in their cognitions (Peterson et al., 1999). Within the cognitive impairment in women with ED are distorted beliefs about food, shape and body weight, negative automatic thoughts, dichotomous thinking, representations overarranged about food, weight, and shape, the selective abstraction, overgeneralization, magnification, self-referential ideas and superstitious thinking (García-Camba, 2002). Additionally, it was observed that patients with AN have lower levels of emotional awareness, compared with patients with BN (Bydlowski et al., 2005), although patients with BN have higher impulsivity (Favaro et al., 2005).

Importantly, the characterization of cognitive processes in patients with ED and the interpretation of their behavior in terms of their cognitive structure is a central area for the development of new research. On the other hand, the research related to the neuropsychological assessment of patients with ED has found mixed results, being more abundant those studying attention, moreover, in most cases, no other tests have been used to evaluate cognitive functions additional to attention, and most studies that have measured attention with the Stroop test, have focused on measuring the latency and not the interference.

Due to the increasing number of cases of patients with symptoms of ED it is necessary to characterize the neuropsychological factors such as perseverative thinking, visual memory, selective attention, and executive planning in participants with ED by evaluating both, the time it takes them to answer, and the number of errors committed by people in a paradigm that measures attention as well as the evaluation of the effect of the valence of words related to shape and food.

2. Neuropsychology and eating disorders

Neuropsychology is a discipline mainly clinical, which converges between psychology and neurology, and studies the effects of injury, damage or malfunction in the central nervous system structures on the cognitive, psychological, and emotional processes and on the individual behavior (Lezak, 2004). It includes the study of the behavioral expression of lesions in the central nervous system, helping to identify different manifestations of brain dysfunction (Duchesne et al., 2004), and allows us to examine the relationship between behavior and brain function through psychometric tests or qualitative measures in cognitive, sensory-motor, perceptual, and emotional areas.

Neuropsychological investigation of ED began at the end of the decade of the 80 (Ben-Tovim et al., 1989) and has produced mixed results (Mendlewicz et al., 2001; Szmukler et al., 1992) and a significant number of these results support the hypothesis that patients with ED may have underlying cognitive deficits (Braun & Chouinard, 1992). Some studies have methodological limitations, i.e. patient samples have varied in severity of symptoms, different tests were used to measure the same cognitive function; further, studies have weaknesses in the research design itself (not including control group) and include small sample sizes, which leads to low statistical power (Tchanturia et al., 2005).

Some studies indicate that, compared to normal controls, patients with ED have deficits in different neuropsychological domains including verbal and visual memory, visuo spatial ability, attention and executive functions (Bowers, 1994; Camacho et al., 2008; Green et al., 1996; Jones et al., 1991; Kingston et al., 1996; Lauer et al., 1999; Mathias & Kent, 1998; Szmukler et al., 1992). Although these findings consistently indicate that ED are associated with some degree of neuropsychological dysfunction, the specific aspect that is damaged varies between studies, possibly due to variations in methodology. Some studies have found neuropsychological deficits in patients with ED (Palazidou et al., 1990; Touyz et al., 1986). It is possible that other studies with similar findings have not been reported because of the tendency to publish only significant results (Mathias & Kent, 1998).

Among the models that were developed in the area of ED (Vitousek & Orimoto, 1993), one of the most notable advances has been the growth of research that emphasizes cognitive processes and contents. The cognitive model of Vitousek and Orimoto (1993), establishes two cognitive factors that influence the initiation and maintenance of ED: 1) the beliefs of individuals with regard to the shape and the body weight, and 2) the biased processing of information in relation to body shape and weight. On the other hand, cognitive behavioral model of Fairburn et al. (1998) identified 3 factors in the maintenance of AN: 1) dietary restriction increases the sense of self control, 2) starvation promotes dietary restriction, and 3) the extreme concern about shape and weight promote dietary restriction.

Outstandingly, the characterization of cognitive processes in patients with ED and the interpretation of their behavior in terms of their cognitive structure is an important area for the development of new research. Here are some key findings in this area, according to the function evaluated.

2.1 Attention and eating disorders

Several studies have found biases in attention in patients with ED. By contrast, other studies have found no attentional biases (see Dobson & Dozois, 2004 and Duchesne et al., 2004 for a review).

Some researchers suggest that negative attitudes and beliefs about food and body shape play a role in ED and suggest the possibility of information processing disturbed in these conditions (Fairburn et al., 1991). In this sense, it is proposed that the attention process in these participants is selective, that is, they attend and respond to those stimuli related to body shape and weight more specifically than people without the disorder, so there is evidence that ED can impair neuropsychological functioning, particularly in the attention processes (Dobson & Dozois, 2004).

It was found that patients with AN have neuropsychological deficits in different domains including verbal and visual memory, visuospatial skills, attention skills and executive functions (Bowers, 1994). On the other hand, a study by Kingston et al. (1996) found that AN patients show deficits on tasks measuring attention, visuospatial skills and memory. In another study, comparing non-restrictive with restrictive eaters, Boon et al. (2000) found that restrictive eaters took less time to recognize stimuli associated with food.

Research on attentional biases in participants with ED, has been made using the Stroop test (Golden, 1994), which has been modified to examine the selective processing of information

in various clinical disorders, including ED, in order to evaluate cognitive alterations related to abnormal attitudes about body shape and weight (Ben-Tovim et al., 1989; Channon et al., 1988; Cooper et al., 1992).

It has been observed that patients with AN are slower than control participants in naming the color of words related to food and body (Ben-Tovim et al., 1989). This phenomenon can be described as the interference effect or as the Stroop phenomenon (Stroop, 1935) which is observed particularly in seriously ill patients. Ben-Tovim et al. (1989) found the Stroop effect in patients with AN and BN for words related to food and body shape and weight.

It has been shown that interference for words related to food is more consistent than for words related to the shape and weight (Huon, 1995). By contrast, Sackville et al. (1998) found greater interference for words related to the shape and weight in patients with AN. In this sense, Faunce (2002) hypothesized that patients selectively attend to relevant stimuli for the disorder.

To assess the specificity of the modified Stroop test as an objective measure of the BN, this modified test was administered to patients with BN and two non-clinical control groups (restrictive and not restrictive eaters). Data showed no differences between groups in Stroop effect (Black et al., 1997).

Several studies have shown that patients with ED take longer time to name the color of words related to food, body shape and weight, compared with control participants (Ben-Tovim et al., 1989; Channon et al., 1988; Fairburn et al., 1991; Fassino et al., 2002). Additionally, Cooper and Fairburn (1993) found that in the case of patients with BN, the interference is caused by the frequency of purging and not by the general psychiatric symptoms, however, Black et al. (1997) consider that the differences between bulimic patients and normal controls, do not establish a specific cognitive impairment in these patients.

Jones-Chesters et al. (1998) found that the words associated with food, diet, weight and shape, causing a marked interference and increased latency to name the color of the words in patients with BN compared to control group.

To test that the Stroop effect was restricted to individuals with ED of clinical severity, Cooper et al. (1992) compared four groups: Patients with AN, BN patients, restrictive diet participants and participants with subclinical ED. They found that both groups of patients and the group with subclinical ED, took longer time to name the color of words related to the condition that the restrictive dieters group. Similar results were found by Cooper and Todd (1997), as compared with the control group, both groups, AN and BN, showed a bias in the selective processing of information about food and weight. In another study, comparing groups of AN and BN with groups of restrictive and not restrictive controls, authors found that patients with ED are more selective processing the information related to the figure and the food, and this extends to restrictive control participants (Perpiná et al., 1993).

In a study by Green et al. (1997), they investigated whether concerns about body shape and weight, represented a specific form of anxiety or is regarded as a distinct affective state. Although there was a slowing in naming the color of words related to food, it was not affected by the degree of drive to lose weight. In this sense, there is evidence that the

concern about fat, weight and body shape is also present in women without ED. For example, women concerned about weight and are under restrictive diets, show high motivation to lose weight (Garner et al., 1984).

Lovell et al. (1997) conducted a study to investigate whether recovered women with AN or BN have bias towards cognitive aspects of the figure and the food, using a modified Stroop test. They found that BN patients, and AN recovered women were more distracted by concerns about shape, compared with controls and women recovered from BN. No differences were found between groups before and after recovery, i.e. the impairment persisted after clinical recovery.

In a study with a community sample of men and women between 9 and 14 years-old (without ED), it was asked people to name the color of word lists (Stroop-like) related to food, body shape and two sets of neutral words. The results showed a slowing to name the color of words related to food in 11-years-girls but not with words related to the shape. There were no decreases with the 9-years-group (Green & McKenna, 1993). These results can be interpreted in terms of cultural pressures exerted on women to do restrictive diet and achieve an ideal body shape at different stages of development.

In summary, it appears that ED are associated with selective processing of words related to food, weight and shape, observed in some tests designed to assess bias in information processing. Also, with regard to the findings of the Stroop, Huon (1995) argues that it is necessary to establish a theoretical framework for understanding the processes underlying such biases. Vitousek and Hollon (1990) consider that the methods used to examine cognitive biases in anxiety and depression should not only be transferred to the study of ED, besides, these studies require a theoretical foundation that needs to be tested empirically, since without clearly established theories that produce specific hypotheses, models of cognitive processing in patients with ED will be useless (Black et al., 1997). In addition, tests of cognitive processing may be useful to test cognitive theories as they provide a more objective method to assess the processes, compared with self tests. Vitousek and Hollon (1990) have proposed an ED-specific theory based on three premises. The first is that people with this disorder develop elaborate schemes on weight-related issues and its implications for themselves. These patterns influence on perceptions, thoughts, affect and behavior. The second assumption of their model is that the operation of the proposed schemes, promotes ED symptoms in a relatively automatic way. Finally, Vitousek and Hollon suggest that in people with ED, such schemes have the function to simplify, organize and stabilize their experience among themselves and the environment.

2.2 Executive functionning and eating disorders

Several authors have found deficits in the functions of planning and problem solving in women with ED (i.e. Tchanturia et al., 2004a, 2004b; Tchanturia et al., 2002). On the other hand, some studies (i.e. Gillberg et al., 2007) found no deficits in executive functions in patients with these disorders.

Green et al. (1996) compared patients with AN and control participants, finding that the AN group showed reaction time and motor speed poorer than control participants. Lauer et al. (1999) investigated the neuropsychological demands of patients with AN and BN before, during, and after treatment that lasted 7 months. It was noted that before treatment, both

groups showed deficits in attention and problem solving skills, but found no impairment in memory. At the end of treatment, they found that nearly half of patients still had cognitive deficits. In other study, visuospatial deficits in the AN group were found (Mathias & Kent, 1998). In a trial of executive functions such as abstraction and the use of strategies in patients with AN and using the Wisconsin Card Sorting Test, Fassino et al. (2002) found that patients with AN showed problems of abstraction and thinking flexibility, similar to those seen in patients with obsessive compulsive disorder. Altered body image showed a direct correlation with frontal alterations. On the other hand, Tchanturia et al. (2002), in a controlled study with 30 patients with AN, in which half were patients recovered and the rest still had the disorder, found that patients with AN and recovered showed perceptual and cognitive scores in set variation higher than controls. These results were subsequently confirmed in another sample with AN before and after weight gain (Tchanturia et al., 2004b). In a controlled study, inflexibility in problem-solving tasks set variations in AN patients and BN patients was found (Tchanturia et al. 2004a). In another study, 12 patients with AN and 14 with BN had deficits in problem solving (Lauer et al., 1999). In addition, Fowler et al. (2006) found no deficits in executive functions in 25 patients with AN compared with controls.

2.3 Memory and eating disorders

Regarding the evaluation of memory in ED, results have been mixed: Some studies have found deficits in memory (Green et al., 1996; Jones et al., 1991; Kingston et al. 1996; Sebastian et al. 1996; Sherman, et al., 2006), while others have found no such bias (Fowler et al., 2006; Lauer et al., 1999; Touyz et al., 1986). Green et al. (1996) found worsening in working memory in 12 patients with AN compared to control group of 17 participants. This deterioration remained even after regaining weight. In another study, with groups of patients with AN, obese eaters, restrictive and not restrictive eaters, it was found that the first three groups recalled more words related to weight and food and fewer words related to the shape, compared with the group of non-restrictive eaters (King et al., 1991). On the other hand, in a study of 18 patients with AN, there was deterioration in verbal memory compared to the 19 participants without disorder (Sherman, et al., 2006), using the Complex Figure Test Rey (1999). Sebastian et al. (1996) conducted a study comparing patients with ED and a symptomatic (concerned with the weight) and asymptomatic control groups. These authors report a bias in memory for words related to fat, compared with two control groups. These results can be interpreted in the sense that schema activation in participants with ED produces a bias, when participants are exposed to fat-related stimuli.

Based on the literature, the work related to the neuropsychological assessment of participants with ED: a) have obtained different results, being more abundant those studying attention, specifically with the Stroop test, in both, its standard and the modified version, using words related to food and the shape and these versions have not been standardized, b) in most cases, no other tests have been used additionally to assess cognitive aspects in addition to those evaluating the Stroop test, and c) most studies that have measured attention with the Stroop test, have focused on measuring the reaction times but not errors. The results of the implementation of the modified Stroop test provide evidence that the task of mentionning the color of the words, is altered by the semantic content of words related to the concerns of people with ED, consequently, exists competition to name

the color and the activation of words whose contents are similar to the participants schemes. In this way, few studies have examined attention bias for words other than those of negative valence. There is evidence that patients with ED exhibit biases in attention to stimuli associated with food, body shape and weight and these biases are not consistently on restrictive diet groups. The neuropsychology of BN has been less studied, although research suggests that may be present cognitive disturbances, including deficits in selective attention and executive functions. Additionally, it is estimated that the prevalence of BN in women ranges from 1% to 3%, while that of AN is 0.5% (Hoek & Hoek, 2003), indicating that although the BN has been less studied, is more prevalent among the population so that their study is relevant from the neuropsychological perspective. The investigation of neuropsychological functioning is of great clinical importance, since alterations in selective attention may be a way that keeps the symptoms of ED. Therefore, it is important to note that the characterization of cognitive processes in ED patients and interpreting their behavior in terms of their cognitive structure is an important area for the development of new research. Therefore, this study aimed to conduct an assessment of perseverative thinking, non-verbal memory, selective attention and executive planning in patients with BN by applying Wisconsin Card Sorting Test (Heaton et al. , 1993), the original Stroop test (Golden, 1994) and modified version, the Rey Complex Figure Test (Rey, 1999) and the of Tower of London Test (Culberston & Zillmer, 1999). Particularly, for the process of attention we used a computer paradigm that records with millisecond precision, the participants' answers to each stimulus presented to them. In the foregoing, it was hypothesized that patients with BN, in contrast to community samples without disorder, may have neuropsychological impairment, specifically in the perseverative thinking, non-verbal memory, selective attention and executive planning.

3. Method

3.1 Hipotesis

Patients with BN will show poorer neuropsychological performance (lower non-verbal memory capacity, increased perseverative thinking, planning executive poorer, higher latency and interference in attention) compared to participants without ED.

3.2 Variables

Verbal memory: It was measured by scores on the reproduction of the figure in the memory section of the Rey Complex Figure Test (1999).

Perseverative thinking: It was measured by the number of perseverative responses (total responses in which the participant continues to responding incorrectly to category in turn: color, shape or number), assessed with the Wisconsin Card Sorting Test (Heaton et al., 1993).

Executive Planning: This variable was measured by the total execution time, total number of movements and total number of violations in the Tower of London Test (Culberston & Zillmer, 1999).

Interference in selective attention: It was measured by the number of errors made by the participants naming the color of the stimulus words, positive and negative, associated with food and body shape in the modified Stroop Test (Camacho et al. 2009) and standard Stroop

Test (Golden, 1994) with three colors. Both paradigms were applied in a computerized version based on E-prime software (Schneider et al., 2002).

Latency in selective attention: It was measured by the scores (milliseconds), obtained by the participants naming the color of the stimulus words, positive and negative, associated with food and body shape of the modified Stroop Test (Camacho et al., 2009) and standard Stroop Test (Golden, 1994) with three colors. Both paradigms were applied in a computerized version of the program based on E-prime (Schneider et al., 2002).

Presence / absence of BN: defined as the presence (or absence) of the disorder, according to the diagnostic criteria of DSM-IV-TR (APA, 2000).

3.3 Participants

A total of 64 women, intentionally selected, participated in the study (32 with BN and 32 controls without ED). The mean age of the 32 patients was 21.03 ± 3.81 years old, the body mass index (BMI) mean was 23.64 ± 5.39, and 13.28 ± 1.92 years of mean schooling. The mean age of the 32 control participants was 21.00 ± 3.76 years old, BMI of 21.77 ± 3.17, and 13.25 ± 1.52 years of schooling. The group with BN was selected from ED clinics in the metropolitan area of Mexico City. The control group included 32 women with no history of an ED and was extracted from the community population, matching the disorder group based on their demographic variables (age, sex and schooling). For both groups, tests for the selection and characterization of participants and tests to assess cognitive functions were answered.

3.4 Measures

3.4.1 Selection and characterization of participants.

- *Eating Attitudes Test* (Garner & Garfinkel, 1979), identifies the presence of symptoms and concerns characteristic of AN. It consists of 40 items and international cut-off point is greater than 29. It has been validated in Mexico with a reliability of .93 and a cut-off greater or equal to 28, where scores over 28 indicate anorectic symptomatology (Alvarez, 2000).

- *Bulimia Test* (Smith & Thelen, 1984), identifies the presence of symptoms and concerns characteristic of BN. It consists of 36 items and international cut-off point is greater or equal to 102. It has been validated in Mexico with a cut-off point greater or equal to 85, where scores over 85 indicate bulimic symptomatology (Alvarez, 2000).

Interview for Diagnostic of Eating Disorders (Kutlesic et al., 1998), designed for the differential diagnosis of ED according to DSM-IV criteria.

3.4.2 Evaluation of cognitive functionning.

- *Memory Complex Geometric Figures Test* (Rey, 1999). Measures the ability to organize planning for problem solving, memory, and visuo-constructive capability. This test was validated in Mexico, obtaining a reliability of .83 and .78 for the copy to memory (Cortés et al., 1996). In this study, the Test was used in order to assess non-verbal memory. The most common quantitative system for this Test, distinguishes 18 elements, each of which can be scored with a maximum of two points, for a total of 36. Factor analysis showed that 18

perceptual units are grouped consistently in four factors explaining 43.6% of the total variance for copying and 38.6% for memory (Cortés et al., 1996).

- *Wisconsin Card Sorting Test* (Heaton et al., 1993). Measures the ability to make abstract concepts (abstract thinking ability), so as to maintain and change the classification criteria with feedback, namely, the ability to vary the cognitive strategies and skills to develop and maintain an appropriate strategy for problem solving. This test has reliability coefficients of .52 for perseverative errors, 71 for number of errors and .72 for perseverative errors. Factor analysis indicates a three-factor solution explaining 70% of the variance (Heaton et al., 1993). It has shown adequate test-retest reliability for the number of categories completed (.88), number of trials (.74), number of errors (79), number of perseverative answers (68), number of perseverative errors (72) and learning to learn (.67, Tate et al., 1998).

- *Tower of London-Drexel* (Culberston & Zillmer, 1999). It is a test originally developed to assess the relationship between attention and performance in sequential actions (Raizner, 2002). It was modified by Culberston and Zillmer (1999) to measure planning and problem solving, behavioral inhibition and impulse control, location of attention, cognitive flexibility, abstract /conceptual reasoning, and behaviors based on rules. The test-retest reliability in an interval of 20 days is acceptable for number of movements and violation of time. Correlations were moderate to high. Factor analysis yielded 5 factors with higher loads in the executive measures, suggesting that it is an useful tool for measuring higher-order problem solving and is more sensitive to the measurement of executive planning, compared with other tests that measure frontal lobe functioning.

- *Computerized Stroop Word Color Test* (Golden, 1994), standard and modified version with stimulus words related to food and body shape. This test evaluates the ability of selective attention, requires that the participant suppress automatic responses in favor of a specific response requested by the evaluator. The test-retest reliability is .86 for the first list (read words), .82 for the second (color naming) and .73 for the third list (color-word; Golden, 1994). This research used the standard version in a computer format for the three lists with one hundred stimuli each. Before each list, instructions for the task were presented to the participant, including three trial exercises that were not counted. Additionally, at the end of the three lists of standard Stroop, participants were presented eight lists with one hundred stimuli words each (food or shape-related), or neutral in two blocks of 400 words each one (Camacho et al., 2009).

3.5 Procedure

For BN group, the tests were answered in situ at the clinic where patients were under treatment, in an isolated place (office or cubicle) to avoid interference. For the control sample, tests were applied in the doctor's office.

Stroop Versions were answered with a 14-inch-screen laptop, while the remaining tests were answered in its traditional format.

The sample with ED was recluted from specialized clinics in treatment of ED in Mexico City. Women who agreed to participate were asked to sign informed consent (or their parents if they were under-age) and tests for assessment of cognitive functions and tests for the characterization of participants were answered individually and counterbalanced (the order

of application was different for each participant). Height and weight were obtained from records of clinics, based on measurements made by the dietitian or doctor of the clinic and were used to calculate BMI. For the control sample, 50-basic school, 50-high school, and 50-college women, answered the Eating Atitudes Test and Bulimia Test, then, those that did not exceed the cut-off points in both tests, were interviewed by an expert by means of the Interview for Diagnosis of Eating Disorders (Kutlesic et al., 1998), to exclude the presence of an ED. As a result, we selected 32 control women. After being characterized and matched with the BN group, the control group, signed informed consent (or their parents if they are under-age) to participate in the investigation and answered individually and counterbalanced, the tests for the assessment of cognitive functions.

4. Results

We identified 32 women with BN and 32 with no disorder. Ages, BMI, and years of education are shown in Table 1. 75% of the sample had at least high school level in both groups.

Variable	Control (n = 32)		BN (n = 32)		t(62)	
	M	(SD)	M	(SD)		p
Age (years)	21.00	(3.76)	21.03	(3.81)	0.07	n/s
BMI (weight in kg./height in meters at square)	21.77	(3.17)	23.64	(5.39)	0.10	n/s
Education (years)	13.25	(1.52)	13.28	(1.92)	0.03	n/s

Table 1. Distribution of groups by age, BMI, and years of education.

Since the groups were matched, t test indicated no statistically significant differences between ages, BMI, or the education level of both groups.

Variable	Control (n = 32) M (SD)	BN (n = 32) M (SD)	t(62)
Non-verbal memory (number of recalled elements)	24.41 (4.32)	21.22 (5.28)	2.64**
Executive planning			
Total number of movements	33.81 (14.47)	42.28 (16.24)	2.20*
Total execution time (in seconds)	191.56 (57.30)	234.44 (88.63)	2.30*
Total number of violations	0.34 (0.94)	1.19 (1.62)	2.56**
Perseverative thinking (number of perseverative answers)	8.78 (5.43)	12.38 (8.46)	2.02*

Table 2. Comparisons between groups on non-verbal memory, executive planning, and perseverative thinking scales. * $p < .05$; ** $p < .01$.

The results of verbal memory, executive planning, and perseverative thinking scales, are shown in Table 2. In memory scale, statistically significant differences between both groups were found. The group with BN scored lower (fewer items recalled) than the control group.

The results on the scale of executive planning indicate that there were differences in the total number of movements in the total execution time and the total number of violations. It is noted that the group with BN, made more movements and took longer to complete the test, also committed more violations compared with the group without the disorder. Regarding the perseverative thinking, the group with BN showed more perseverative responses compared with control.

For the standard version of Stroop Test, the number of errors and response times are shown in Table 3. There were no differences in the number of errors or response times for each of the lists between the two groups ($p > .05$). The intragroup comparisons showed as expected, the Stroop effect for the control group, $t(62) = 7.28$, $p = .0001$, and for the group with BN, $t(62) = 6.92$, $p = .0001$. This indicates that there is no differential effect for patients and nonpatients with the standard test.

	Control (n = 32)		BN (n = 32)		
List	M	(SD)	M	(SD)	$t(62)$
Interference[1]					
Black list	2.16	(2.10)	2.34	(3.76)	0.24
XXXX list	1.50	(1.52)	2.41	(2.34)	1.84
Color list	1.84	(1.74)	2.34	(2.06)	1.05
Latency[2]					
Black list	1036.89	(245.17)	1002.02	(210.75)	0.61
XXXX list	964.99	(222.73)	956.95	(198.73)	0.15
Color list	1117.98	(279.05)	1185.56	(310.84)	0.10

Table 3. Means for the groups in the standard version of Stroop Test. [1]Number of errors for each list. [2]Reaction times for each list in milliseconds.

For the modified version of Stroop Test, the number of errors and reaction times are shown in Table 4. Outstandingly, this modified version in all cases (number of errors and response times) no differences were found between the two groups for lists of neutral words. Statistically significant differences were found for the number of errors in the lists of positive and negative words related to shape, where the BN group made more errors than the control group. It was also noted that the group with BN took longer to respond to both, positive and negative words related to body shape.

Additionally, bivariate intragroup comparisons were made with t test for related samples (Table 4) between each list of stimulus words and their respective neutral word list for each group (control and BN). We found that BN group made more errors in the list of positive words related to body shape and showed higher reaction times in both, positive and negative shape-word lists. Finally, no differences were found in comparisons of the lists in the control group ($p > .05$).

Word list		Control (n = 32) M (SD)	BN (n = 32) M (SD)	t(62)
Interference[1]				
Food positive		2.03 (2.16)	2.88 (3.01)	1.29
Neutral words		2.38 (2.21)	3.03 (3.53)	0.89
	t [3]	*1.11*	*0.35*	
Food negative		2.00 (1.80)	2.78 (2.71)	1.36
Neutral words		2.41 (2.05)	2.78 (3.05)	0.58
	t [3]	*0.87*	*0.00*	
Shape positive		2.13 (1.81)	3.59 (2.76)	2.52**
Neutral words		2.50 (2.20)	2.38 (2.46)	0.21
	t [3]	*1.38*	*4.48****	
Shape negative		1.97 (2.13)	3.50 (3.40)	2.16*
Neutral words		2.34 (2.32)	3.00 (2.55)	1.08
	t [3]	*0.91*	*0.85*	
Latency[2]				
Food positive		1032.17 (194.58)	1026.51 (224.14)	0.11
Neutral words		1008.63 (182.84)	998.99 (220.29)	0.19
	t [3]	*1.66*	*1.38*	
Food negative		1035.83 (199.43)	1055.41 (230.44)	0.36
Neutras		1017.09 (205.00)	1029.26 (229.11)	0.22
	t [3]	*1.95*	*1.53*	
Shape positive		1023.86 (202.12)	1136.34 (218.86)	2.14*
Neutral words		1026.13 (185.33)	1034.15 (204.09)	0.17
	t [3]	*0.11*	*8.65****	
Shape negative		1009.77 (193.04)	1115.59 (229.50)	2.00*
Neutral words		998.02 (172.26)	997.29 (194.78)	0.02
	t [3]	*0.79*	*5.01****	

Table 4. Means for the groups in the modified version of Stroop Test. [1]Number of errors for each list. [2]Reaction times for each list in milliseconds. [3] t test for related samples. * $p < .05$; ** $p < .01$, *** $p < .001$.

5. Conclusion

The aim of this study was to evaluate non-verbal memory, perseverative thinking, executive planning, as well as latency and interference in selective attention, in a group of patients with BN. The results indicated deterioration in cognitive functioning in the group with BN.

Regarding the visual delayed memory, patients with BN scored lower (fewer items recalled) than the control group. These results indicate that nonverbal memory problems as measured by the Rey Complex Figure Test (1999), are associated with planning problems which are strategic in nature and in patients with BN, implying a possible weakening processes in strategic memory located in the prefrontal cortex (Sherman et al., 2006). It is likely that the impairment in the memory in patients with BN, can at least partially be attributed to the intense preoccupation with thoughts related to the shape and weight observed in the attention test. An alternative mechanism that could explain the deficits in memory, could be

the coexistence of psychological variables not measured in this investigation, such as anxiety and depression. Jones et al. (1991) found that anxiety contributes to a poorer cognitive performance in a sample with AN. However, most studies have not found an association between cognitive performance and depression or anxiety in patients with AN (Green et al., 1996, Kingston et al., 1996, Lauer et al. 1999; Mathias & Kent, 1998), although in this review, we found no studies of BN. In terms of clinical implications, the findings of this study are consistent with the idea that women with BN have difficulty to remember complex and unfamiliar information and the novelity of information can increase the specific cognitive demands. Clinical work with ED patients is based on providing new and complex information in a psychoeducational format, regardless of therapeutic modality. The transmission of such information, should consider the difficulties that women with BN may experience to recall complex information or new. In this sense, the information should be presented so clearly as possible, or more than one time and in different formats (eg verbal, written or video) and should be accompanied by discussion and homework activities between sessions. In the present investigation, results suggest that these difficulties are considered in terms of problems in information processing and not in terms of problems associated with resistance to therapy.

The results on the executive planning scale indicate that there were differences in the total number of movements, in the total execution time, and the total number of violations. It is noted that the group with BN make more movements, it took longer to complete the test, and make more violations in comparison to the group without the disorder. This indicates that the group with BN was deficient in its ability to establish an appropriate strategy to solve problems. These results are consistent with those of Ferraro et al. (1997) who found differences between the group with BN and the control group in executive planning. It is likely that patients who participated in this investigation possess a bad strategy or choose a bad strategy or do not take the time to select a strategy, which could indicate a planning problem. In addition, participants with BN showed cognitive impulsivity. Thus, it can be argued that cognitions and impulsive behaviors in patients with BN, lead to sporadic eating behaviors and out of control. In this sense, it is likely that the impulsive behavior of patients with BN may be a method to achieve independence through self-control; in addition, vomiting and purging behaviors, usually experienced after a binge, could be an effort to reduce anxiety and recover control. Parallel to the mechanisms used by individuals with ED, studies have shown that people with cognitive deficits, have rigid and compensatory strategies, used regardless of the circumstances. It can be postulated that altered dietary patterns are a coping mechanism that can be used by people with neuropsychological deficits as a way to achieve a sense of autonomy and inner control.

Regarding the perseverative thinking, the group with BN showed more perseverative responses compared with control, consistent with those reported by Tchanturia et al. (2005) in the logic that patients with ED have inflexibility on cognitive tasks and inability to change thought patterns. From this perspective, patients with BN have a bias in a skill that is essential for cognitive flexibility and that in these patients, prevents adapting their behavior to changing environmental demands and the use of appropriate strategies for problems solution.

It was observed that patients with BN made more errors on words with positive and negative valence shape-related. These findings are consistent with the results of Cooper and

Fairburn (1993) who found that patients with BN are more concerned with weight and body shape. However, these results contrast with those of Quinton (2004) who found no difference between the BN and control groups. In this sense, it is proposed that patients have knowledge general units or "schemes" that determine which aspects of a situation are more important and what information will be stored and processed. More specifically, cognitive biases are presented for information linked to person concerns (Sebastian et al., 1996). Patients with ED are prone to deny the severity of their disease. This denial can lead to distortion of their answers in the self-report questionnaires, however it is unlikely that the denial of their concerns and symptoms, affect the results produced by the Stroop technique. This is because their performance can only be altered voluntarily, slowing their responses to words related to food and body shape, although the deliberate slowing down would be recorded as an indicator of food-related concern or shape, so is unlikely that a person who seeks to minimize a food problem, adopt the strategy (Ben-Tovim et al., 1989). In this sense, cognitive paradigms offer many advantages for the study of ED, including tests that people are unable to decode, and therefore to alter (Cassin & von Ranson, 2005). Cognitive models of ED have highlighted the role of dysfunctional thinking in relation to body shape and weight in the development and maintenance of the symptoms of these disorders, including the way in the person processes information (Vitousek & Orimoto, 1993). From this perspective, alterations in attention to stimuli related to the shape and weight, found in the present research in participants with BN, represent different forms of bias in information processing, because there is a distortion in the way they perceive and interpret their experiences (Faunce, 2002) because they preferentially attend to body shape related stimuli. Unlike the results reported by Dobson and Dozois (2004) in the logic that patients with BN exhibit biases in attention to words related to food and body shape, in our investigation we found bias for words related the shape only, which also contrasts with the findings of Ben-Tovim et al. (1989) who found no differences between the group with BN and control group with a list of 100 words related to shape, although differences for words related to food were found. Biases for both, words related to shape with positive and negative valence were also found, indicating that patients attend to both, congruent and incongruent words with their own schemes (Vitousek & Orimoto, 1993). In a meta-analysis, Groesz et al. (2002) found that body dissatisfaction among women was higher when they were exposed to images of thin models, compared to exposure to images of women with normal size and / or overweighted. However, this research found in the group with BN, attention bias for both positive and negative words-shape related. This could indicate that there is an activation of thinness schemas in patients with BN and who are highly motivated and cognitively prepared to think about themselves in relation to weight, shape and beauty. It has been suggested that BN is associated with a bias in attention to threats to the ego that are self-directed, so any negative social interactions can cause a perceived threat of isolation and social rejection (Waller et al., 1996). To escape this threat, patients with BN use cognitive strategies that lead to disinhibition of behaviors that would normally inhibited, such as eating. Because body dissatisfaction is a main feature of BN, biases in attention may be due to processes associated with social comparison, based on the shape of others as a way to self-assess their own level of physical attractiveness. Using the model of Williams et al. (1988), which states that attention operates at an automatic level of information processing, one can assume that attention will show a higher tendency towards cognitive biases for relevant schemes. It is likely that people with ED turn their attention to materials related to

their own schemes. More specifically, selectively attend to material related to their schemes when different materials are in competition for attention, because this simplifies processing and eliminates the need to address all environmental stimuli.

The standard Stroop Test indicated no differences between groups so that test did not discriminate controls from patients with BN. On the other hand, the lack of overlap between the results of the control group and the group with BN, indicate that the modified Stroop paradigm used in this research, could be a useful tool in neuropsychological characterization of patients with BN as it discriminates between participants with and without BN. It would be important to use this paradigm with other patient groups (e.g. AN) to determine whether the effect is specific for patients with BN. Another comparison group may be women under restrictive diets because they are highly concerned about food, weight and shape, and could show interference in naming color words. It is noteworthy that from the methodological point of view, the choice of words, both, neutral and stimuli, was made based on rigorous methodological criteria, which may contribute to the findings of this research. However, results for the group with BN should be treated with caution due to small sample size, so for further research, we suggested to increase the number of participants with BN.

Research has shown that patients with ED have alexithymic tendencies (Corcos et al., 2000), se we can assume that the neuropsychological deficits found in this research in cognitive areas including executive functions and attention, do not allow patients to develop constructive strategies to solve problems related to social interactions, and may develop maladaptive eating behaviors as a coping mechanism of the conflict in interpersonal development.

Lauer et al. (1999) and Szmukler et al. (1992) explained their findings suggesting that the observed cognitive deficits are a consequence of starvation and can be reversed with proper nutrition. Unfortunately, the hypothesis of malnutrition does not explain the cognitive deficits found in groups with BN. In addition, recent studies indicate that certain cognitive functions do not improve after refeeding or weight gain (Green et al., 1996, Grunwald et al., 2001; Hamsher et al., 1981; Katzman et al., 2001, Kingston et al., 1996; Szmukler et al., 1992), and do not correlate with BMI (Bayless, 2002). Thus, it can be suggested that neuropsychological deficits in various cognitive domains preexist before the development of an ED and are not a consequence of the disorder. It has also been suggested an association between the number of cognitive deficits and a poorer prognosis after treatment (Hamsher et al., 1981; Szmukler et al., 1992).

Some studies show that ED symptoms decrease if the cognitive problem receives treatment (Lena et al., 2004). In these studies, treatment of cognitive deficits, promoted a decrease in symptoms of ED and allowed patients to recover from their abnormal eating patterns. It is likely that cognitive deficits, are the basis for developing an ED, so should be evaluated and incorporated in the treatment of patients with ED, in addition, there is no consensus on whether these abnormalities are related to weight loss, given its focal and asymmetric nature, and the fact that some abnormalities, such as a decrease in gray matter persists despite weight gain. Thus, it is plausible that the observed abnormalities may represent an explanation for the underlying neuropsychological disturbances found in adolescents with ED.

Finally, since the literature reports that ED symptoms in people persist even after recovery from AN or BN (Wagner et al., 2006), it is important to assess cognitive functions before and after treatment, in order to determine whether the biases in these functions remain after recovery. In assessing the effects of cognitive deficits on the development of an ED, it is important for researchers to identify early ED behaviors to minimize the effects of time, and thus, the chronicity of the disorder. Further studies are needed to determine the appropriate follow-up period, which may be specific to an individual, depending on the duration of the disorder and the combination of cognitive deficits.

6. Summarising

- This study was conducted to assess perseverative thinking, non-verbal memory, selective attention and executive planning in patients with BN.
- In memory scale, statistically significant differences between both groups were found. The group with BN scored lower (fewer items recalled) than the control group.
- The results on the scale of executive planning indicate that there were differences in the total number of movements in the total execution time and the total number of violations. Participants with BN showed cognitive impulsivity.
- Regarding the perseverative thinking, the group with BN showed more perseverative responses compared with control.
- The BN group made more errors than the control group. It was also noted that the group with BN took longer to respond to both, positive and negative words related to body shape.
- BN group made more errors in the list of positive words related to body shape and showed higher reaction times in both, positive and negative shape-word lists.
- It is likely that the neuropsychological impairment in patients with BN, can at least partially be attributed to the intense preoccupation with thoughts related to the shape and weight observed in the attention test.

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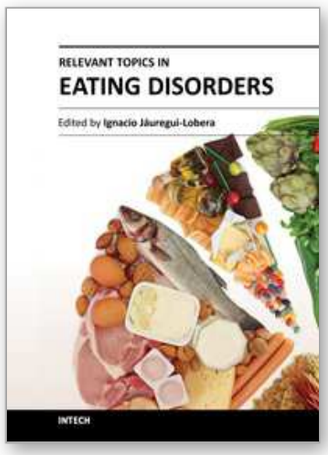

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Eating disorders are common, frequently severe, and often devastating pathologies. Biological, psychological, and social factors are usually involved in these disorders in both the aetiopathogeny and the course of disease. The interaction among these factors might better explain the problem of the development of each particular eating disorder, its specific expression, and the course and outcome. This book includes different studies about the core concepts of eating disorders, from general topics to some different modalities of treatment. Epidemiology, the key variables in the development of eating disorders, the role of some psychosocial factors, as well as the role of some biological influences, some clinical and therapeutic issues from both psychosocial and biological points of view, and the nutritional evaluation and nutritional treatment, are clearly presented by the authors of the corresponding chapters. Professionals such as psychologists, nurses, doctors, and nutritionists, among others, may be interested in this book.

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