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Visoconstructive Deficits and Risk of Developing Eating Disorders

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In order to explore if neuropsychological deficits on visual constructional ability could be related to risk eating behaviors, a total of 102 women were evaluated, 51 of the participants had been formally diagnosed with eating disorders and 51 did not. All participants were given the Eating Attitude Test (EAT-40), The Rey-Osterrieth Complex Figure and The Tower of London Task. Results revealed the existence of a deficit on visual integration similar to those observed in other studies with diagnosed patients. The group at risk showed a comparatively reduced ability on the tasks and the control participants' execution was on the average. Findings revealed the need for designing studies to evaluate neuropsychological processes as possible risk factors which predict eating disorders.
Keywords: eating disorders, visual constructional ability, neuropsychology, anorexia, bulimia.

A fin de explorar si las deficiencias neuropsicológicas en el proceso visoconstructivo están relacionadas con conductas alimentarias de riesgo, se evaluó un total de 102 mujeres, 51 presentaban conductas de riesgo y 51 no las presentaban. A todas las participantes se les aplicó el Cuestionario de Actitudes hacia la Alimentación (EAT-40); la Figura Compleja de Rey-Osterrieth y la Torre de Londres. Los resultados revelaron la existencia de un déficit en la integración visual similar al observado en otros estudios realizados con pacientes diagnosticadas. El grupo con riesgo mostró una reducción en tales habilidades en comparación con el desempeño de los participantes sin riesgo, mismo que estuvo dentro del promedio. Los hallazgos revelan la necesidad de diseñar estudios que evalúen los procesos neuropsicológicos como posibles factores predictores de los trastornos de la conducta alimentaria.
Palabras clave: trastornos de la alimentación, visoconstrucción, neuropsicología, anorexia, bulimia.

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In recent years, studies published about eating disorders have become more and more frequent in scientific literature, yet in spite of the scientific community's attempts to create effective preventative forms of treatment, the prevalence of these disorders is on the rise. Due to the fact that eating disorders are caused by multiple factors, the variables involved during the onset of an eating disorder, and the relationships established between those variables, must be studied extensively (Silva-Gutiérrez & Sánchez-Sosa, 2006). There is, however, one factor that stands out. It has been analyzed in an array of studies, yet it has rarely been considered as a potential cause of eating disorders: one's neuropsychological state prior to developing the pathology.

Sufficient evidence exists to show that perceiving one's body as "fatter" than it is in reality drives patients to restrict their food intake (Toro & Vilardell, 1989; Hsu, 1990; Raich, 1994; Wadden, Foster, Srwer, Anderson, Gladis, Sanderson, Letchak, Berkowitz, & Phelan, 2004)., and that among the diagnostic criteria for having an eating disorder, overestimation of one's body weight holds an important place. Although much is known about this subject, very few studies attempt to explain the overestimation of body weight as being a perceptual alteration. It could involve difficulty with accurately estimating the size of one's body and could impede upon one's ability to develop an accurate, healthy body image.

In light of this, it is undeniably important that research has to consider to find out the alteration of body image as a fundamental, perceptual failure. Those who suffer from eating disorders find the dimensions of their bodies profoundly displeasing. They perceive their bodies as large and disproportionate, either entirely or in particular regions, and that dissatisfaction is at the root of eating disorder patients' constant struggle to maintain a normal body weight (Garcia-Camba, 2001; Wadden, et al., 2004). It causes people to adopt restrictive diets, and in little time, that becomes the foundation of the maintenance of the disorder.

Certain cognitive errors could explain these distortions. For example, Silva-Gutiérrez (2001) evaluated a group of patients with anorexia nervosa and bulimia nervosa, and found that they consistently tended to break down complex, visual stimuli into fragments. The Smeets, Smit, Geert, Panhuysen & Ingleby, 1998; Smeets & Kosslyn, 2001) hypothesis was founded on that principle, and it asserts that the same image fragmentation may occur in the case of body image. Perhaps people suffering from anorexia nervosa or bulimia nervosa break their body image down into fragments, and in attempting to reconstruct a cohesive body image, disproportions arise and some body parts seem larger than others. If that were the case, then distorted body image could stem from a perceptual problem involving an information processing deficit that prevents the production of an accurate mental image of one's own body. This could be the case for people who suffer from eating disorders.

That possibility, however, has not been studied at length even though it is widely known that a variety of cognitive deficits are found in eating disorder patients (and they have been evaluated and interpreted through different, neuropsychological tests) such as problems with attention, memory and activities related to executive functioning (Dickson, et al., 2008; Duchesne, Mattos, Fontenelle, 2004; Fassino, et al., 2002; Green, Elliman, Wakeling & Rogers, 1996; Lauer, et al., 1999; Mathias & Kent, 1998; Szmukler; Andrewes; Kingston; Chen; Stargatt & Stanley). Of those cognitive deficits, alterations are most frequently reported in a process called visual constructional ability (Duchesne et al., 2004; Fox, 1981; Green, et al., Hamsher et al., Kingston, et al., 1996; 1981; Lena, et al., 2004; Mathias & Kent, 1998; Palazidou, et al., 1990; Szmukler, et al. 1992).

Some researchers have suggested that those cognitive deficits happen as a result of the malnutrition brought on by the illness itself; take the work of Mathias & Kent (1998) and Lena et al. (2004), for example. It is curious, however, that in the majority of cases, difficulty with visuoconstrruction persists even after nutritional rehabilitation, while other alterations do not (Duchesne, et al., 2004; Green, et al., 1996, Kingston et al., 1996; Palazidou et al., 1990.). This allows one to presume that the deficit came first, not the disorder, and that deficit may even contribute to eating disorder patients' distorted images of themselves. It is imperative, then, to explore the possibility that cognitive deficits occurring at the level of visuoconstruction may indicate a predisposition towards developing an eating disorder, and may also constitute a key element in rehabilitation work through cognitive therapy (Tchanturia, Whitney & Treasure, 2006).

Thus, although numerous studies have been conducted that investigate eating disorder patients' observable changes in neuropsychological processes, the majority of those have focused on evaluating cognitive functioning deficits as secondary to the disorder. This comes in spite of the fact that a genetic vulnerability to such disorders has been established (Halmi & Kaye, 2007; Koronyo-Hamaoui, et al., 2007) that predisposes certain individuals to develop an eating disorder. In other words, it is possible that there is a pre-existing, cognitive condition that could produce the onset of symptoms. The present study has explored that possibility, while placing an emphasis on the visual constructional ability process. Persistent worries about one's weight or figure is the nuclear symptom of both anorexia nervosa and bulimia nervosa, and it is rooted in ideation that overestimates the dimensions of one's body. The present study, then, is built upon the premise that an alteration in the process of integrating one's body into an image constitutes a cognitive variable that ought to be studied in order to explain the altered body image of people suffering from eating disorders.

The purpose of performing the present study is two-fold: to determine whether or not people at-risk for developing an eating disorder show alterations in their visual constructional

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ability process as compared to normal populations, and to analyze whether or not those alterations are similar to those found in studies of people who have actually been diagnosed with an eating disorder (for example, Silva-Gutiérrez, 2001; Duchesne et. al., 2004; Dickson, et. al., 2008).

Methods

Participants

Given that eating disorders are more prominent among women, only female subjects were evaluated in this study. In order to choose participants, the EAT-40 was administered to a total of 1200 young women between the ages of 17 and 24 from a range of public universities, and selected those who met the needs of the study. Initially, we chose those who scored highest on the test, which is considered to be a frank indicator of the risk behaviors and attitudes associated with eating disorders. Each of those participants selected was interviewed expressly to determine whether or not they exhibited the diagnostic criteria for bulimia nervosa or anorexia nervosa as stated in the DSM-IV, in order to exclude those with pre-existing eating disorders from participation. Those who reported suffering from any other psychiatric illnesses were also excluded, as was anyone who exhibited secondary eating behavioral changes because of other medical conditions.

The first filter used to narrow down the subject pool was to eliminate anyone who got a score of less than or equal to 3 on the EAT-40 (120 subjects), because such a low score would suggest participants were answering falsely (Álvarez, Mancilla, Vázquez, Unikel, Caballero & Mercado, 2004). 240 cases were also excluded from participation due to omissions in their questionnaires, which left us with 840 young women, of which 168 had a demonstrable tendency toward eating disorders. The cut-off point used to select the group that was at risk for developing an eating disorder was ≥26, and for the group that did not exhibit that risk behavior, it was ≤21, in accordance with Álvarez et al.'s findings (2004).

Of the 168 participants with scores indicating they were at risk, 35 manifested clear symptoms (according to the interview conducted) of having some eating disorder, while 18 reported changing their eating habits as a consequence of alterations to their physical health; they were all excluded from the study, leaving us with a total of 115 at risk participants. 54 of those 115 declined participation because they lacked the time or the interest to take the tests. The initial selection, then, was of 61 participants, but then 6 did not attend their appointments and 4 left the participation process incomplete.

Ultimately, the group at risk for developing an eating disorder was comprised of 51 women. For each, a counterpart was found among the 672 people with low scores on the EAT-40. The criteria for participation in the control group were: not exhibiting the psychiatric symptoms of an eating disorder or of any other disorder, being at the same grade-level as the at-risk counterpart, and being of approximately the same age as the at-risk counterpart, within ± 6 months. We worked with two groups of 51 participants each.

Instruments

Eating Attitudes Test (EAT-40). This questionnaire was created by Garner & Garfinkel (1979) to evaluate the behaviors and attitudes that are characteristic of people suffering from eating disorders. The instrument was designed for the purpose of offering an easy test to administer and score that would provide a meaningful evaluation of the behaviors and attitudes that are predominant among people that suffer from, or may suffer from, eating disorders (Silva-Gutiérrez, 2001). It is a self-administered questionnaire of 40 items and uses a Likert scale. Each item gives the participant a choice of 6 possible responses, which range from never to always. It evaluates 5 factors (Álvarez et al., 2004):

- Restrictive diet
- Bulimia
- Attempting to lose weight
- Worrying about food
- Perceived social pressure

In this case, the EAT-40 was used to sort participants according to their scores and select those that fit the profile of each group.

The Rey-Osterrieth Complex Figure. This is a neuropsychological test that uses pen and paper and evaluates one's visual constructional abilities and visual memory (Lezak, 1983; Akshoomoff & Stiles, 1994; Lezak, 1995; Salvador, Cortés & Galindo, 1996). It is also used to assess one's organizational skills and ability to plan and strategize in order to solve problems (Salvador et al., 1996). It requires subjects to copy a complete, geometric design (comprised of 18 different elements which are each evaluated separately), and their execution of the task is judged in terms of precision. It works in two modalities: copy and recall. First, the participant copies down the shape presented and then after three minutes, without prior warning, he or she is asked to copy the geometric design once more, this time without the help of the model (Galindo, Cortés & Salvador, 1996). As the subject draws, they are given felt-tipped pens of different colors, one by one. The evaluator holds the pens and, each time the subject moves from one element to the next, he or she is given a different color to use. Thus, in order to complete the drawing, only 18 different colors ought to have been used, but when a participant recalls and copies an element as fragments, piecemeal, the number of colors used increases.

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The following aspects are evaluated by this test:

- *Score*: Total score for all evaluation criteria
- *Execution time:* The time the subject needs to complete the full task.
- *Color:* Number of colors used to reproduce the geometric design.
- *Rotation:* When an element is displaced from its position relative to the vertical and horizontal axes (45°, 90° and 180°).
- *Placement:* When an element is copied in a different place as it was in the original model
  a. When the element is taken out of its perceptual context; in other words, when it is entirely outside of the figure.
  b. When the element is found in its proper perceptual context, in its corresponding space, yet it is displaced.
  c. When the element is placed within its context, but outside of its corresponding space.
  d. When the element is superimposed over another element or elements.
- *Repetition:* The element, or one of its components, is drawn more than once.
- *Distortion:* The element's shape is noticeably altered upon reproducing it.
  a. Uncoordinated drawing: Due to a lack of control of the precise movements of the hand (fine motor coordination), the contour of the element in the drawing is altered.
  b. Tangential error: a lack of the exactitude needed to unite the components of one element with the components of the next. The component fails to arrive at the union point, or passes it.
  c. Closing error: is the lack of the precision needed to unite an element's own components to each other.
  d. Incomplete copy: occurs when less than 50% of elements 4, 5, 7, 15 and 16 are reproduced, or when something is missing from one of the other elements.
  e. Modification of the length-width ratio: this is applicable only for elements that are square or rectangular.
- *Deficient angle formation*: Changes to the vertical or horizontal axes due to their angular relationship.
- *Size*: When the dimension of an element, or of the drawing in its entirety, is altered.
  a. Normal: When the size of the figure is unchanged.
  b. Macrographía: When the size of the reproduction is at least 25% larger than the original.
  c. Micrographía: When the size of the reproduction is at least 25% smaller than the original is.
- *Omission:* When an entire element is missing or unrecognizable.

The Tower of London-Drexel (TOL-DX). This instrument was developed by Shallice (1982) and was initially used to evaluate patients with frontal lobe damage. It may also be used as an instrument to assess executive functioning (Levin, Mendelsohn, Lilly, Fletcher, Culhane, Chapman, Harward, Kusnerik, Bruce & Eisenberg, 1994, Lezak, 1995), and executive planning in particular, in children as well as adults (Culbertson & Zillmer, 1998). In this test, a successful action is considered to be one that applies planned, sequential and recurrent movements that are executed, supervised and modified according to an overall plan of action (Levin et al., 1994).

This instrument was selected because for someone to have a visuoconstructive problem would indeed also imply a lack of functioning in the frontal areas of the brain. The test consists of a wooden base with three vertical towers and three balls of different colors: blue, red and green, and subjects are asked to solve ten problems in ascending level of difficulty. The test is applied individually and utilizes two of the towers, one for the experimenter and one for the subject. The subject moves the balls around in order to recreate the model with which they are presented. Scoring is based on the number of movements the subject uses in order to solve the problem.

The evaluation criteria are the following:

- *Number of movements:* Refers to the number of times that the subject moves the balls in order to recreate the model. Each problem has a minimum number of movements necessary to solve the problem.
- *Starting time:* This is the time that passes between the initial presentation of the problem and the subject's first movement.
- *Execution time:* This measures the time that passes from the subject's first movement to his or her solution.
- *Total time:* Is the total time it takes to execute the test.
- *Time violation:* When the subject fails to complete the problem in the given time.

Rules:

a. Type I. They cannot move more balls to a given tower than fit.
b. Type II. Only one ball may be moved at a time.

Procedure

Once the groups were decided, and the informed consent of all participants was obtained, they were each, individually, administered the Rey-Osterrieth Complex Figure test, both the copy and recall modalities, with an interval of 3 minutes before the recall task. This was followed by the Tower of London-Drexel test.

Statistical Analyses

In order to analyze the data obtained from participants on the Rey-Osterrieth Complex Figure test (copy and recall)

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and the Tower of London-Drexel test, Student's t-test was used. The two groups' means were compared on the basis of the variables measured by the instrument to determine whether there were statistically significant differences ($p < .05$) between the groups.

Results

The group was comprised of 102 women (N=102): 51 in the at-risk group and 51 in the control group. The average age of participants in the at-risk group was 19.52 years old (with a SD of 1.81 years), while the average age of subjects in the control group was 19.94 years old (with a SD of 2.04 years). For the at-risk group, the mean score obtained on the EAT-40 was 36.13 (with a SD of 8.84), and for the control group, the mean score on that test was 8.43 (with a SD of 4.99). This constitutes a statistically significant difference ($p < 0.01$) between the groups' scores.

Upon comparing the at-risk and control groups' mean scores on the Rey-Osterrieth Complex Figure test, it becomes evident that the subjects in the group that is at risk for developing an eating disorder performed worse in both the copy and recall modalities of the test (see Table 1). Also, with the exception of execution time, which was only significant in the recall modality, and of colors and repetition, which were only significant in the copy modality of the test, it was observed that the at-risk group had a greater number of errors for all other attributes.

As for the *macrographia* variable, this refers not to the figure in its entirety, but rather to an enlargement of one of the 18 stimuli, or parts, that comprise the figure. It is of interest, then, that the at-risk group more often altered the elements of the figure in this way (they depicted the figure as being at least 25% larger than the original model). As a result, shapes fit together disproportionately, and a greater number of colors were also used by subjects in the at-risk group during the copy task. This indicates they had a higher degree of image fragmentation than their counterparts in the control group. In addition, this size distortion could also explain the significant differences found between groups on variables such as rotation, placement, distortion and angle formation. If macrographia were to distort the size of one or more elements, the subjects would attempt to force the pieces together, to unite the different elements of the figure in any way possible in order to complete the task at hand.

Table 1
Means and levels of significance according to Student's t-test for achievement on the Rey-Osterrieth Complex Figure test, in both modalities

Variables	COPY					RECALL			
	Groups	Mean	SD	*t*	Level of Significance	Mean	SD	*t*	Level of Significance
Score	I	23.98	3.10	7.43	0.000*	16.21	4.26	6.822	0.000*
	II	19.33	3.20			11.05	3.31		
Execution Time	I	3.39	60.55	0.42	0.675*	2.73	90.14	2.886	0.005*
	II	3.30	66.41			3.45	59.02		
Colors	I	22.66	3.83	–3.27	0.001	16.62	3.58	0.324	0.747*
	II	25.33	4.37			16.37	4.32		
Rotation	I	0.00	0.00	–2.20	0.030*	0.019	0.14	–2.242	0.027*
	II	0.11	0.38			0.13	0.34		
Placement	I	1.05	0.98	–5.12	0.000*	0.82	1.47	–2.604	0.011*
	II	2.47	1.70			1.64	1.70		
Repetition	I	0.98	0.41	–3.26	0.002*	0.45	0.94	–1.414	0.160*
	II	0.64	1.12			0.74	1.14		
Distortion	I	0.21	0.54	–3.81	0.000*	1.70	1.17	–3.621	0.000*
	II	0.80	0.95			2.64	1.43		
Angle Constructio	I	2.92	1.42	–5.89	0.000*	2.09	1.48	–3.384	0.001*
	II	4.78	1.74			3.13	1.61		
Macrograph	I	0.41	0.75	–2.84	0.005*	0.29	0.54	–2.851	0.005*
	II	0.92	1.03			0.70	0.87		
Omission	I	0.13	0.34	–2.53	0.013*	4.45	2.26	–3.388	0.001*
	II	0.37	0.56			5.92	2.11		

* Statistically significant variables, $\alpha = 0.05$.
Group I = Group that is at risk for developing an eating disorder.
Group II = Group that is not at risk for developing an eating disorder.

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Partial repetition occurred mostly in the at-risk group on the copy task of the Rey-Osterrieth Complex Figure test. Normally, on stimuli 8 and 12, since participants do not tend to count the number of lines in the original image, they draw however many they believe they saw, and this often leads to drawing more lines than there actually were in the model. However, in the recall modality of the test, this variable was not found to be of statistical significance. This may be attributed to the poor ability on the part of the participants to recover the image they had seen.

On this test, 41% of participants in the group at risk for developing eating disorders omitted, in total, almost three times as many stimuli as the control group did. One analysis in particular demonstrated that of that 41% in total, it was stimulus #7 that was most often absent from subjects' reproductions (76%), followed by stimulus #16 (14%) and stimuli #9 and #12 (5%). It may be because those elements of the picture are not directly related to its other structures that they are so frequently lost in reproduction; despite, this had a significant effect on evaluation. Meanwhile, on the recall task, there were a large number of indiscriminate omissions, so the number of colors used by subjects was not found to be significant, even though it was found that the at-risk group utilized more colors than necessary for every element in the drawing. Of all the criteria evaluated, 7 were shown to be significant in both the copy and recall modes: score, error of placement, error of distortion, rotation, angle formation deficit, macrographia and omission.

The first analysis performed using the data from the Tower of London-Drexel test was to sum the number of movements per trial, or otherwise put, to derive the number of times that the subject moved the balls in order to resolve each of the problems. In this analysis, significant differences were observed in seven of the ten trials, and the at-risk group used a greater number of movements per problem than the control group did.

That very same pattern was also observed in the measurements of the two groups' *starting times* and their *execution times;* subjects from the at-risk group began moving the balls earlier than the control group, and also took longer to execute the problem. The control group, on the contrary, took longer to move the balls initially, but once they had begun, they found the solution in less time than the subjects in the at-risk group. Those time differences actually compensated for one another and therefore, there was no difference between groups on measures of *total time*. The aforementioned data, as well as the rest of the qualification criteria, are displayed in the following table:

It is worthwhile to note that subjects from the control group only violated Rule II once – "*Never move 2 balls at the same time,"* – while subjects from the at-risk group violated the rule 16 times. As for Rule 1 – "*Do not place*

Table 2
Means per trial and level of significance according to Student's t-test on the Tower of London-Drexel test

Movements	Groups	Means	SD	*t*	Level of significance
Problem 01	I	2.333	4.325	–1.445	0.152*
	II	3.568	4.309		
Problem 02	I	3.274	4.280	–2.902	0.005*
	II	5.980	5.100		
Problem 03	I	1.372	2.660	–2.204	0.030*
	II	2.764	3.641		
Problem 04	I	3.235	3.896	–2.447	0.016*
	II	5.313	4.649		
Problem 05	I	4.313	4.221	–0.528	0.599*
	II	4.725	3.639		
Problem 06	I	2.019	2.572	–2.236	0.028*
	II	3.313	3.234		
Problem 07	I	2.196	2.645	–3.591	0.001*
	II	4.294	3.226		
Problem 08	I	1.980	2.963	–2.148	0.034*
	II	3.470	3.971		
Problem 09	I	1.647	2.347	–1.432	0.155*
	II	2.352	2.621		
Problem 10	I	1.274	2.030	–2.312	0.023*
	II	2.490	3.158		

* Statistically significant variables, $\alpha = 0.05$.
Group I = Group that is at risk for developing an eating disorder.
Group II = Group that is not at risk for developing an eating disorder.

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Table 3
Overall performance on the Tower of London-Drexel test

Movements	Groups	Means	SD	*t*	Level of significance
Total number of movements	I	23.647	15.686	–4.598	0.000*
	II	38.274	16.432		
Starting time	I	108.825	75.460	–2.726	0.008*
	II	75.863	41.983		
Execution time	I	209.675	76.640	–2.677	0.009*
	II	255.959	96.800		
Total time	I	318.500	105.632	–0.610	0.543*
	II	331.823	114.771		
Time violation, >60	I	1.019	1.104	–0.548	0.585*
	II	1.156	1.405		
Violated Rule I	I	0.000	0.000	–1.661	0.100*
	II	0.078	0.337		
Violated Rule II	I	0.019	0.140	–2.627	0.010*
	II	0.313	0.787		

* Statistically significant variables, $\alpha = 0.05$.
Group I = Group that is at risk for developing an eating disorder.
Group II = Group that is not at risk for developing an eating disorder.

more balls on the towers than fit," – although there were no statistically significant differences between groups, the control group did not violate this rule even once, while the at-risk group violated it four times.

Discussion

The data from the present study suggests that participants from the group that was at risk for developing an eating disorder have greater difficulty executing both the Rey-Osterrieth Complex Figure test and the Tower of London-Drexel test than the control group did. Bearing in mind what characteristics those instruments measure (Lezak, 1995; Culbertson & Zillmer, 1998) allows one to suppose, based on the results, that people at risk for eating disorders tend to make neuropsychological errors, particularly pronounced in their visuospatial construction abilities and in their executive functioning, and that those errors are similar to those found in patients who actually suffer from eating disorders (Kingston et al., 1996; Lauer et al., 1999; Silva-Gutiérrez, 2001; Duchesne et al., 2004).

In all measures, the achievement of the participants in the at-risk group fell below that of the control group; nevertheless, their errors were not nearly so severe as those reported in studies of patients who have been diagnosed with eating disorders. This suggests that certain deficits may exist prior to the disorder itself that indeed worsen as the eating disorder takes its course. This supports the research of people such as Kingston et al. (1996) and Duchesne et al., (2004), who have posited that such deficits escalate and become increasingly severe over time for those suffering from eating disorders because cerebral dehydration results from malnutrition, and because of the ways in which these disorders directly impede upon one's everyday life.

In both modalities of the Rey-Osterrieth Complex Figure test, copy and recall, the at-risk group did not perform well. In the majority of cases, participants did not identify the organization of the structures that made up the stimuli; rather, they perceived the segments of the stimuli one by one, piecemeal. Evidence of this was their consistent fragmentation of the figure upon drawing it. Evidently, the analytical activity that would ordinarily allow one to visualize and create a hierarchy of shapes and forms does not occur successfully among individuals who are at risk for developing an eating disorder.

Breaking the design down into fragments, piece by piece, definitely made it more difficult to organize the information and to follow a sequence that allowed for the task to be executed well, which shows that planning problems occurred, too. As a consequence, there was no greater order guiding subjects as they drew the elements of the picture, and upon integrating the parts of the figure into a whole, some lines, in an attempt to make them appear more like the model, were forced into place, which ultimately left the figure out of proportion, with some parts relatively larger than others. This result was more pronounced in participants' performance on the recall task, where the elements of the drawing produced were larger than they ought to have been. This may be due to the fact that, according to Lacks (1984), when image reproduction becomes complicated, subjects tend to maximize its details for the sake of clarity, molding them into a larger size than they really are. Nevertheless, macrographia did not occur on the figure as a whole, which

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diminishes the possibility of there being a global, perceptual problem involved.

What if the above were to occur when one processes his or her body image, as that, too, constitutes a complex, visual stimulus? It would appear distorted because of the same visuoconstructive deficit that impedes patients with eating disorders from constructing appropriate mental images of their own bodies. Then again, in both the recall and copy modalities of the Rey-Osterrieth test, a greater number of omissions occurred in the at-risk group than in the control group which, according to Lezak (1995), could suggest working memory errors during the recall task and attention deficit during the copy task.

The at-risk group exhibited errors of placement and errors of different types of rotation, which could be explained as a consequence of image fragmentation, and of the resulting inadequate integration of the components of the image. However, those criteria evaluate visuospatial perception, so it is also possible that, apart from the visuoconstructive deficit, a problem is occurring in the parietal lobe, given that it has been suggested that the posterior parietal pathway (dorsal stream) is implicated in recognizing the location of objects (Carlson, 2006; Rains, 2004). For that reason, it would be worthwhile to conduct a study that more specifically analyzes, using *ad hoc* tests, whether or not there is actually some error in that region for people suffering from eating disorders. If that were the case, we could contribute to answering the question of why people that suffer from eating disorders tend to consider themselves so wide, for example, that they might not fit through spaces or passages that they could actually pass through with ease (Garcia-Camba, 2001).

Certain clear differences were observed between the two groups in how they went about solving the Tower of London-Drexel problems. For example, the control group analyzed possible solutions before beginning to move pieces, which indicates a greater capacity to plan one's actions, while the participants in the at-risk group did not pause to think about how to resolve the problem before beginning to try and execute it, which echoes the lack of planning and general impulsivity that is characteristic of patients that suffer from eating disorders.

It was affirmed, then, that the participants in this study that were shown to be at-risk for developing an eating disorder had difficulty conceptualizing changes, anticipating movements, responding objectively, generating and selecting alternatives, and sustaining their attention. In other words, they did not comply with the characteristics required by the process of planning (Culbertson & Zillmer, 1998).

The data obtained in the present study make us to consider the possibility that there exists some deficit in executive functioning, judging by the type of abilities evaluated by the instruments (Curnmings, 1993; Lezak, 1995; Culbertson & Zillmer, 1998), that affects the process by which we mentally represent complex visual stimuli. However, it would be necessary to conduct further studies in order to localize that deficit because executive functioning, planning, and visuoconstructive organization in particular, are the product of the interaction of different areas of the brain.

The most important finding of this study was identifying neuropsychological changes in people that face similar risks as those diagnosed with anorexia nervosa or bulimia nervosa (Silva-Gutiérrez, 2001), although the degree of severity appears to be less. That finding is a direct counterpoint to the assertions of authors such as Mathias & Kent (1998).

By virtue of the difficulties observed in the present study, the constant fragmentation of complex visual stimuli, the lack of planning needed to achieve an objective, impulsivity and inattention, and to the extent that body image itself constitutes a highly complex visual stimulus, it is possible that there is some deficit that predisposes certain individuals to perceive his or her own body as large and disproportionate, and that may contribute to the development of eating disorders. We suggest that hypothesis be explored in future studies.

In conclusion, given that there is an association between being at risk for developing an eating disorder, visuoconstruction and planning abilities, it must be determined whether or not such eating disorder pathologies could be associated with a degree of neuropsychological dysfunction prior to the onset of the disorder. The lack of improvement in visuoconstructive functioning even after nutritional rehabilitation, together with the results of this study, indicates that those errors probably antecede the development of mental illness. If that is the case, not intervening at this level, in the early stages, could worsen the prognosis for patients and could contribute to the continuation of the disorder. For that reason, it is imperative that neuropsychological abilities not only be studied as secondary to eating disorders, but as a factor that could even precipitate the onset of pathological eating disorder symptoms.

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