Motor inhibition and cognitive flexibility in eating disorder subtypes

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ABSTRACT

Anorexia Nervosa (AN) and Bulimia Nervosa (BN) are complex Eating Disorders (EDs). Even if are considered two different diagnostic categories, they share clinical relevant characteristics. The evaluation of neurocognitive functions, using standardized neuropsychological assessment, could be a interesting approach to better understand differences and similarities between diagnostic categories and subtypes in EDs thus improving our knowledge of the pathophysiology of EDs spectrum. This study explored cognitive flexibility and motor inhibition in patients with AN considering both Restricter and Binge/Purge subtypes, patients with BN and healthy comparisons subjects (HC). Intra-Extra Dimensional Set shifting Test and Stop Signal Task, selected from CANTAB battery, were administered to analyzed set-shifting and motor inhibition respectively. AN patients showed a deficient motor inhibition compared to HC, while no evidence for impaired motor inhibition was found in BN patients; a significant relationship between commission errors in the Stop Signal Task and attentional impulsiveness was found. Moreover, no difference in set-shifting abilities was found comparing all clinician groups and HC. So our results indicated no cognitive impairment in these two cognitive functions in BN patients, while AN and BN showed different performances in motor inhibition. A similar cognitive profile was found in other obsessive compulsive spectrum disorders. Finally, the paper suggests a new interactive approach for the study of cognitive profile in psychiatric disorders; it might be more useful since it is more closely related to the executive functions complexity.

1. Introduction

Anorexia Nervosa (AN) and Bulimia Nervosa (BN) are complex Eating Disorders (EDs) and are characterized by disordered eating behaviors where the patient’s attitude towards weight and shape, as well as their perception of body shape, are disturbed (DSM-IV-TR; American Psychiatric Association, APA, 2000). Even if, in Diagnostic and Statistical Manual of Mental Disorders (APA, 2000) are considered two different diagnostic categories, they share clinical relevant characteristics as body image distortion (Lavoisy et al., 2008). Different researcher has been focused their attention on possible similarities and differences at multiple levels between these diagnostic categories, basing on data that reported a high rate of diagnostic crossover between EDs. Several longitudinal and retrospective studies found that a high rate of AN patients shift to BN diagnosis during the course of illness and vice versa (Bulik et al., 1997; Eckert et al., 1999; Monteleone et al., 2011; Strober et al., 1997; Tozzi et al., 2005). Also the crossover clinical subtypes in AN have been investigated. Sixty-two% of patients with restricting subtype (AN-Re) developing Binge/Purge subtype AN (AN-Be) (Eddy et al., 2002; Tenconi et al., 2006).

The evaluation of neurocognitive functions, using standardized neuropsychological assessment, could be a interesting approach to better understand differences and similarities between diagnostic categories and subtypes in EDs thus improving our knowledge of the pathophysiology of EDs spectrum.

Recently, since disordered eating behaviors proper to women with EDs strongly suggest the presence of dysfunction in executive functions, researchers focalized their attention on these neurocognitive domains. Findings regarding executive functions in EDs were heterogeneous, showing deficits in decision making, problem solving or working memory, response inhibition and set-shifting abilities (for review see Southgate et al., 2005).
Impaired decision making was found in AN patients (Cavedini et al., 2004, 2006; Tchanturia et al., 2007) and in BN patients (Liao et al., 2009). Only one study reported no decision making deficits in both AN and BN clinical population (Guillaume et al., 2010).

Evidences of impaired set-shifting in AN have been reported (for review see Roberts et al., 2007) consistent with the behavioural patterns that characterize the disorder. Indeed, rigid and obsessional focus as it relates to avoidance of weight gain has been thought to be the result of impaired mental flexibility and the inability to shift cognitive set. Impaired cognitive flexibility it is implicated as a risk marker (Tchanturia et al., 2002), maintenance factor (Steinglass et al., 2006), and candidate endophenotype of AN (Holliday et al., 2005; Roberts et al., 2010; Tenconi et al., 2010). Even if set-shifting seemed to be a central issue in AN patients, it was not found to be deficient in all the tests which are considered to be sensitive to this cognitive function (Roberts et al., 2007). As reported in a recent review, evidences in BN neurocognition, particularly regarding set-shifting abilities are still inconclusive (Van den Eynde et al., 2011).

Response inhibition (RI) had been mainly investigated in BN patients, in particular its relationship with impulsiveness traits. In the past it was investigated using Stroop interference effect with unclear results (Van den Eynde et al., 2011). Recently it was studied with Go/No go tasks. Two studies reported no impaired RI in BN (Claes et al., 2006; Rosval et al., 2006), it was only found that BN made more commission errors than HC. In these studies, no evidences for deficit in AN subtypes patients were found.

In this study, the Stop Signal Task (SST) and the Intra Dimensional/Extra Dimensional (ID/ED) set shifting Task (Downes et al., 1989) has been administrated to AN and BN patients to investigate RI and set-shifting abilities.

In EDs field no studies using SST have been published but it seems really important to better understand the relationship between these disorders, RI and impulsiveness. A study (Fowler et al., 2006) showing no evidence for a set-shifting impairment assessed by ID/ED in AN patients is present in literature and on this matter, Roberts and colleagues (2007) suggested the need for further works in this area. Moreover, impaired performances on SST and ID/ED have been shown in obsessive-compulsive (OCD) patients and their unaffected first-degree relatives, suggesting these cognitive functions as possible endophenotypes for OCD (Chamberlain et al., 2007).

On other hand impaired RI and not deficient set-shifting have been suggested by some authors to represent common pathological traits in different putative obsessive compulsive spectrum disorders (OCDS) as trichotillomania (Chamberlain et al., 2006) and pathological skin picking (Odalug et al., 2010). On the perspective that EDs belong to OCDS (Altman and Shankman, 2009; Bellodi et al.,2001), the aim of this study was to investigate RI and set-shifting abilities in AN subtypes and BN patients; we hypothesized that significant deficits in motor inhibition would be found in the AN population but no deficits of ID/ED cognitive flexibility would be identified. We expected BN patients to be more impulsive than other groups and, in this perspective, another aim of this study is to clarify the relationship between SST variables and impulsiveness.

Finally, this study wanted also to investigate the possible relationship between impairments in RI and set-shifting abilities. In fact, it seems important to evaluate the cognitive functions as working in a network, to study patient’s profiles, more than single impairment in every test. This methodology might be more useful since it is more closely related to the complexity of normal and pathologic brain functioning.

2. Methods

2.1. Sample

Fifty-two female participants with EDs among those referred to the Eating Disorders Clinical and Research In-patients Unit of San Raffaele Scientific Institute of Milan, agreed to participate to the study, over a period of 12 months. All the participants (24 AN restricting subtype, 12 with AN binge-eating/purge subtype, 16 BN) were required to meet DSM-IV diagnostic criteria (American Psychiatric Association, 1994). They were all assessed in the first two weeks of treatment, they were all taking Selective Serotonin Reuptake Inhibitors as medication. Diagnoses were obtained by a senior psychiatrist who assessed all participants using a clinical interview and the International Neuropsychiatric Interview-Plus (MINI) (Sheehan et al., 1998). Exclusion criteria for EDs patients were comorbidity with Axis I psychiatric disorders, major medical diseases, neurological syndromes, brain injury or deep trauma, drug or alcohol abuse, use of any psychotropic drugs in the previous 6 weeks, familiarity for Psychotic Disorders. Forty female healthy controls (HC) were recruited in the local community, administrative and workers staff of the hospital and agreed to participate to the study. The HC participants were free of any lifetime psychiatric disorder, medical or neurological diseases and drug or alcohol abuse. No use of psychotropic medications was necessary to be included in the healthy control sample. This screening was made by senior psychiatrists, using MINI (Sheehan et al., 1998).

All the participants gave their written informed consent to participate after the procedure and possible side effects had been fully explained. The study had been carried out in accordance The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. The study was approved by the Milan Area Health Authority Ethics Committee.

2.2. Clinical assessment

The severity of eating symptoms was assessed with the Yale–Brown Cornell Eating Disorder Scale (YBC–EDS) (Mazure et al., 1994) while the physical condition of the subjects (both patients and controls) was examined with the Body Mass Index (BMI) expressed as kg/m². All subjects answered two self-report questionnaires: Barratt Impulsiveness Scale – version 11 (BIS-11) which measures motor, attention and non planning impulsiveness (Patton et al., 1995) and State Trait Anxiety Inventory – version 2 (STAI-2), which investigates trait anxiety (Spielberger, 1970). Age of onset, illness duration and years of education were also collected.

2.3. Neuropsychological assessment

Patients and control participants were assessed with Stop Signal Task (SST), specific for the investigation of motor inhibition and Intra Dimensional/Extra Dimensional Shift Task (ID/ED task), specific for the assessment of attentional set shifting. Each test was chosen from CANTAB battery (Robbins et al., 1998).

SST is a test, based on the “dual race model” (Logan et al., 1984), which uses interleaved staircase functions to generate an estimate of stop signal reaction time, giving a measure of an individual’s ability to inhibit an ongoing motor response (Stop Signal Reaction Time, SSRT). The test consists of two parts: one block of 16 trials for the subject to practice in pressing a button on left or right in congruent direction with an arrow. Then, there are 5 assessed blocks, each of 64 trials where the subject have to continue the same task but, if they hear an auditory signal (a beep), they should withhold their response and not press the button. The timing of the auditory stop signal changes throughout the test, depending on the subject’s past performance, so that stopping occurs approximately 50% of the time for each subject according with Logan’s theory. This test has three key outcome variables: (a) SSRT, that is the time, in ms, to internally suppress prepotent motor responses; (b) Mean reaction time on “go” trials, that is the time, in ms, to press the button on the pad when there is no auditory signal; (c) Directional Errors, which measures the number of errors pressing the wrong button both in “stop and go” trial and on “go” trials.

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ID/ED Shift Task asks subjects to progress through the test by satisfying a set criterion of learning at each stage (6 consecutive correct responses). If at any stage the subject fails to reach this criterion after 50 trials, the test terminates. The test involved nine stage using multidimensional stimuli presented as a visual discrimination task and gave, after any choice, a feedback (correct or incorrect answer). Key outcome variables were: (a) the number of errors made in the block 6, assessing extradimensional set-shifting; in this stage subjects are required to continue to attend to the previously relevant dimension of shape and learn which of the two new exemplars is correct. (b) the number of errors made in block 8, assessing extradimensional set-shifting. In this stage subjects are required to shift attention to the previously irrelevant dimension and learn which of the two exemplars in this dimension is now correct. (c) the adjusted total number of errors: a measure of the subject’s efficiency in attempting the test. Thus, whilst a subject may pass all nine stages, a substantial number of errors may be made in doing so. It is crucial to note that subjects failing at any stage of the test by definition have had less opportunity to make errors. Therefore, this adjusted score is calculated by adding 25 for each stage not attempted due to failure.

The neuropsychological tasks were administered by a trained neuropsychologist, in the same controlled environment in a two different sessions, because they were inserted in two different neuropsychological batteries (90 min each). The choice to use two batteries can be explained with need to avoid possible mental fatigue’s effects in subjects. The two assessment had to be performed in a maximum time range of a week.

2.4. Statistical analysis

Statistical analysis were made using Statistical Package for Windows (Statistica 6.0, StatSoft Inc, Tulsa, Oklahoma). Shapiro’s test was made to verify normal variables distribution. One-way analysis of variances (ANOVA) were made to compare demographic and neuropsychological variables between the male and female in HC group.

ANOVA were made to compare demographic, clinical and neuropsychological variables between the four groups (HC, AN-Re, AN-Be and BN). Where significant group differences were detected according to ANOVA, post hoc significant differences test were conducted in order to compare study groups. Accepted significance threshold was p=0.0035 because of Bonferroni’s correction for multiple comparison. The relationships between neuropsychological outcomes and other variables were investigated with Spearman’s coefficient (correlation analysis).

SSRT scores were transformed in Z scores (with Statistica 6.0 package) to reclassified subjects in good (less than one standard deviation), normal (−1 < SD <1) or bad performers (SD > 1). Looking at results (see Table 2), it was clear how each group show different distributions in this variable. So SSRT outputs for AN, BN and HC subjects were transformed independently in each group. ANOVA were made to compare IED outcomes between the three typology of subjects in each group. This analysis was made to investigate a relationship between SST and ID/ED tasks.

3. Results

Demographic results for the four groups are presented in Table 1. Groups are well-matched in terms of age and education. Patients with both AN subtypes exhibited significantly lower Body Mass Index than HC and BN patients. Clinical groups reported no significant differences in terms of onset, duration and illness severity. HC subjects showed significantly lower score than other groups in STAI-2 self-report questionnaire. No significant differences between groups were found both on BIS-11 Total score and “Non Planning Impulsiveness” BIS-11 factor. HC exhibited significantly lower scores than AN-Be and BN in “Attention Impulsiveness” factor. Results in “Motor Impulsiveness” dimension showed no significant differences between AN-Be, BN patients and AN-Re, HC subjects.

Regarding SST performances (Table 2), patients with both AN groups exhibited significantly lengthened Stop Signal Reaction Times compared to HC; AN-Be showed higher SSRT than BN patients. The four groups did not different significantly in terms of Mean correct Reaction Times on “go” trials on SST. Finally, BN patients made more directions errors on “go” trials than HC but it’s necessary to notice that the main p threshold in the ANOVA was under Bonferroni’s correction.

To investigate a possible effect of impulsiveness, BIS score dimensions were correlated with SST direction errors both on “go” trials. Significant t coefficient were found in the correlation with “Attention Impulsiveness” (Al [r = .35; p = 0.002]. So an ANCOVA (AI as covariate) was made with direction errors on “go” trials as dependent variable: results showed no difference between groups (p = 0.39), and a significant effect of the covariate (p = 0.03).

Not all the subjects performed the ID/ED task (see at 2.3 section); however no significant difference were found in SST variables.

### Table 1

Demographic and clinical variables in the full sample (mean, SD).

<table>
<thead>
<tr>
<th>Demographic and Clinical Variables</th>
<th>AN-Re (n = 24)</th>
<th>AN-Be (n = 12)</th>
<th>BN (n = 16)</th>
<th>HC (n = 40)</th>
<th>F (3,88)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>26.70 (9.58)</td>
<td>27.08 (8.86)</td>
<td>25.31 (5.79)</td>
<td>25.95 (8.41)</td>
<td>0.14</td>
<td>0.933</td>
</tr>
<tr>
<td>Sex, female %</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education, yrs</td>
<td>13.12 (3.59)</td>
<td>15.16 (3.27)</td>
<td>13.12 (3.28)</td>
<td>15.20 (1.88)</td>
<td>3.96</td>
<td>0.010</td>
</tr>
<tr>
<td>Body Mass Index**</td>
<td>14.26 (1.21)</td>
<td>15.05 (1.55)</td>
<td>20.43 (3.65)</td>
<td>19.21 (1.57)</td>
<td>4.60</td>
<td>0.000</td>
</tr>
<tr>
<td>Age at Onset*</td>
<td>19.34 (7.35)</td>
<td>17.50 (4.60)</td>
<td>18.60 (4.83)</td>
<td>20.11 (4.83)</td>
<td>0.34</td>
<td>0.710</td>
</tr>
<tr>
<td>Duration of illness, yrs*</td>
<td>6.56 (6.40)</td>
<td>9.41 (6.86)</td>
<td>6.80 (4.91)</td>
<td></td>
<td>0.97</td>
<td>0.400</td>
</tr>
</tbody>
</table>

**Barratt Impulsiveness Scale**

| Attention dimension**             | 16.00 (3.43)  | 17.27 (3.19)  | 19.14 (3.37)| 17.60 (3.32)| 11.63   | 0.000 |
| Motor dimension                   | 18.80 (1.98)  | 21.08 (5.19)  | 21.14 (5.53)| 18.00 (3.25)| 3.20    | 0.031 |
| Non-Planning dimension            | 25.75 (3.12)  | 26.33 (4.45)  | 25.5 (5.88) | 26.68 (4.19)| 0.74    | 0.530 |
| Total BIS score                   | 60.55 (6.07)  | 65.08 (10.38) | 66.78 (13.38)| 56.64 (8.43)| 4.84    | 0.008 |
| Trait Anxiety (STAI-2)**          | 52.87 (14.41) | 56.50 (10.40)| 58.00 (9.41)| 37.48 (8.26)| 19.85   | 0.000 |

**Yale-Brown Cornell EDS**

Preoccupation                      | 13.68 (2.96)  | 12.75 (2.59)  | 13.71 (2.84)|             | 0.49    | 0.614 |
| Rituals                            | 13.05 (2.63)  | 14.50 (3.17)  | 15.07 (2.43)|             | 2.41    | 0.102 |
| Total Cornell Score                | 26.73 (5.22)  | 27.25 (5.24)  | 28.87 (4.32)|             | 0.29    | 0.748 |

*F(2,60): Healthy Control Group was not included in the ANOVA.

**Significant post hoc tests (Bonferroni’s correction = 0.0035): BMI, AN-Re = AN-Be > HC = BN (all p < 0.001); BIS-ATT, HC < AN-Be (p = 0.001), BN (p = 0.000); STAI-2, HC < all clinical groups (all p = 0.000).
between ID/ED performers and no-performers for each group (all p > .25). On the ID/ED task, Eating Disorders patients did not differ from that of HC.

Finally, all SSRT scores were transformed in Z-scores with an independent analysis for each group (AN both subtypes; BN; HC). Subjects of each group were divided in bad (more than one standard deviation), normal and good performers (less than one standard deviation). An ANOVA was made for every group (AN, BN, HC), using this in-group categorization. As dependent variables ID/ED outcomes were used; no significant differences were found in BN (0.290 < p < 0.708) and HC (0.742 < p < 0.860) subjects, while AN bad performers showed significantly more errors than normal performers in ED shift (Table 3). No differences were found between the AN SSRT performers for variables as age, BMI, onset, disease duration and other SST variables. Then, no significant correlations were found between BMI, year of education, age at onset, years of duration and severity of illness and neuropsychological variables (all p > .163).

4. Discussion

This study explored cognitive flexibility and motor inhibition (MI) in patients with Anorexia Nervosa (AN) considering both Restricter and Binge/Purge subtypes, patients with Bulimia Nervosa (BN) and healthy comparisons subjects (HC). We are particularly interested to examine possible similarities and differences in these neurocognitive functions between diagnostic categories (AN and BN) and clinical subtypes (Restricter and Binge-Purge). Intra-Extra Dimensional Set shifting Test (IED) and Stop Signal Task (SST), selected from CANTAB battery, were administered to analyzed Intra and Extra Dimensional set-shifting and Motor Inhibition respectively.

Regarding Motor Inhibition, AN patients, independently from clinical subtype, showed a deficient performance compared to HC subjects, suggesting that this diagnostic category could be characterized by impaired inhibitory control. Patient with BN showed equivalent stop signal reaction time compared to HC subjects, suggesting that this diagnostic category could be characterized by normal motor inhibition. So our data suggested that the motor inhibition deficit could distinguish AN from BN patients. Further studies in a large sample of AN patients is needed to replicate these results, and more data about possible diagnostic crossover between AN-Be and AN-Re in the same patient should be needed; in fact in this study descriptive statistics suggested a worst performance in AN-Be than AN-Re.

The result about BN patients was in agreement with two previous studies (Claes et al., 2006; Rosval et al., 2006) that did not find impairments in this neurocognitive function. Furthermore, no correlation between impulsivity, assessed by BIS-11, and Motor inhibition was found. This results did not support the hypothesis that the high impulsivity that traditionally characterized this patients could be reflected in impaired Motor Inhibition, as suggested by some authors (Péhés-Lledó et al., 2002; Rosval et al., 2006; Steiger et al., 1995). An interesting result in BN patients regard the number of directional errors. Performing Stop Signal Task, BN patients made more direction errors compared to HC and AN subtypes, in agreement with two previous studies (Claes et al., 2006; Rosval et al., 2006) that found similar results. These authors suggested that the high rate of direction errors could be explained by the impulsivity traits characteristic of these patients, but did not find any significant correlation between impulsivity and directional errors. In this study, a positively correlation between directional errors and cognitive impulsiveness assessed by BIS-11 has been found in the full sample, suggesting that higher “attention impulsiveness dimension” scores (a factor of the self report questionnaire BIS-11 that is sensible to cognitive impulsiveness) specified more direction errors in SST. It should be note that, no correlation between impulsivity and motor inhibition has been found supporting the idea that no longer SSRT can be explained by impulsiveness traits; this evidence underlines that impulsiveness is not associated with motor inhibition impairment, but with more errors during the test performance.

Studies in patients with frontal lesions have suggested that the SST performance is dependent upon the intact right inferior gyrus, but it doesn’t seem to be related with the extension of the damage in this brain region (Aron et al., 2003, 2004). More recently, neuroimaging evidence have suggested that Response Inhibition is modulated by a more extensive system of regions including orbitofrontal, anterior cingulate, dorsolateral and medial frontal, temporal and parietal cortex. Consequently, a worsening in these areas could explain that AN patients showed lower performance than HC and BN patients.

Table 3

Variables mean and SD in AN sample, categorized by SSRT Z scores.

<table>
<thead>
<tr>
<th>Variable</th>
<th>AN bad SSRT performers (n = 4)</th>
<th>AN normal SSRT performers (n = 16)</th>
<th>AN good SSRT performers (n = 3)</th>
<th>F(2, 20)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>19.5 (1.73)</td>
<td>28.14 (9.33)</td>
<td>20.0 (4.58)</td>
<td>2.56</td>
<td>0.102</td>
</tr>
<tr>
<td>Education, yrs</td>
<td>15.66 (2.51)</td>
<td>13.93 (3.64)</td>
<td>15.56 (2.51)</td>
<td>0.84</td>
<td>0.442</td>
</tr>
<tr>
<td>Age at onset</td>
<td>15.5 (2.38)</td>
<td>19.62 (7.37)</td>
<td>14.66 (1.15)</td>
<td>1.43</td>
<td>0.261</td>
</tr>
<tr>
<td>Duration of illness, yrs</td>
<td>4.0 (2.44)</td>
<td>7.75 (7.63)</td>
<td>5.33 (4.50)</td>
<td>0.55</td>
<td>0.580</td>
</tr>
<tr>
<td>SST, Direction errors on “stop and go” trials</td>
<td>4.50 (2.88)</td>
<td>2.0 (2.60)</td>
<td>2.33 (2.08)</td>
<td>1.47</td>
<td>0.251</td>
</tr>
<tr>
<td>SST, Direction errors on “go” trials</td>
<td>3.00 (3.16)</td>
<td>1.50 (2.22)</td>
<td>2.00 (1.73)</td>
<td>0.66</td>
<td>0.525</td>
</tr>
<tr>
<td>SST, Mean Correct RT on Go trials</td>
<td>450.29 (240.43)</td>
<td>476.66 (121.50)</td>
<td>424.75 (80.58)</td>
<td>0.19</td>
<td>0.825</td>
</tr>
<tr>
<td>IED total errors (adjusted)</td>
<td>42.70 (18.76)</td>
<td>24.18 (16.98)</td>
<td>26.66 (22.94)</td>
<td>1.71</td>
<td>0.204</td>
</tr>
<tr>
<td>Errors, ID shift</td>
<td>0.42 (0.51)</td>
<td>0.10 (0.31)</td>
<td>0.54 (0.68)</td>
<td>0.86</td>
<td>0.466</td>
</tr>
<tr>
<td>Errors, ED shift</td>
<td>11.14 (11.64)</td>
<td>12.50 (11.36)</td>
<td>10.81 (11.74)</td>
<td>0.82</td>
<td>0.482</td>
</tr>
</tbody>
</table>

* Significant post hoc tests (Bonferroni’s correction = 0.0035): SSRT, AN-Re > HC (p = 0.0034), AN-Be > HC (p = 0.0000); Direction errors on “go” trials, BN > HC (p = 0.0031).

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parietal cortices, the cerebellum and basal ganglia (Menzies et al., 2007). Our results, that describe impaired motor inhibition in AN patients, but this hypothesis need further research particularly using functional neuroimaging during the performance of SST task.

Regarding set-shifting ability, no difference in this function was found comparing AN patients, BN patients and HC comparison subjects. Furthermore, AN clinical subtype seem to be equivalent in set shifting abilities. Our results are in contrast with a large body of literature suggesting impaired cognitive flexibility in Eating Disorders, particularly in Anorexia Nervosa (for review see, Roberts et al., 2007) and with studies that have also provide evidence for this cognitive feature as an endophenotype of this disorder (Holliday et al., 2005; Roberts et al., 2010; Tenconi et al., 2010). It should be note that these studies have assessed set-shifting using different neuropsychological tasks and that each task have provide different and contradictory results (Tchanturia et al., 2004; Tchanturia et al., 2005). The lack of impairments in set-shifting abilities found in our clinical sample, could be explained by the type of the task that we used to assess the function. Only one previous study administered ID/ED task to women with Anorexia Nervosa ( Fowler et al., 2006), and no evidence for intra or extra-dimensional set shifting in these patients have been reported. BN patients have never been assessed with this test, but our results seems to be congruent with other studies evaluating no impaired set shifting in this clinical population (Gelderisi et al., 2011).

Interestingly, Tchanturia et al. (2004) explored how set-shifting tests, such as Trail Making B, the Bixton Test, Verbal Fluency, the Haptic Illusion Test, CatBat Test and a picture set test, differ each other. They found four set-shifting components; so it’s possible that ID/ED task could identify another factor or it could fit in the unique factor “Perseveration” that authors have supposed to be integer in AN and BN. So, if the cognitive performance is analyzed in its entirety, impaired SSRT was found in AN patients but it was associated with intact cognitive flexibility on the ID/ED task. This profile has been reported in other obsessive compulsive spectrum disorders as trichotillomania (Chamberlain et al., 2006) and pathological skin picking (Odlaug et al., 2010), so our results can be considered as an indirect proof of the AN’s belong to OCDS. By the way, these consideration should be considered carefully, in fact these two psychiatric disorders and AN are really different under a clinical analysis.

Finally, this study tried to specify the degree of relationship among the two target functions and thereby contribute to understanding of the unitary versus nonunitary nature of executive functions. We analyzed the relationship between the two performances in AN patients, dividing them in good, normal or bad performers on SSRT variables (look at 2.4 section) and analyzing if this sub-categorization was able to explain different performances in IED. Our results could explain that bad SSRT performance in AN patients was associated with ED set shifting impairment, but the little number of the sample can’t be considered sufficient to generalize these results. This method could be considered as an alternative method to research cognitive profile in psychiatric patients and future directions in the study of executive functions in psychiatric disorders should analyses the influence of any cognitive function with other ones, looking for a cognitive profile of every psychiatric disorder.

5. Conclusion – Future directions and limitations

Although this article is the first assessing EDs patients with Stop Signal Task and the second to assess AN with ID/ED task, several limitation should be underlined. First, pharmacological variables were not considered, then lifetime crossover diagnoses between AN and BN in AN subtypes were not investigated. Then, even if BMI was not related with SSTR performance, we are not able to exclude that AN patients improve their cognitive performance with gain of weight. Future studies should analyze results, considering the possible influences of these variables. Moreover, patients were recruited with axis I diagnoses and it could be argued that this sample doesn’t fully represent EDs population; on the other hand this paper results should not be explained from other psychiatric disease. Finally, bigger sample size could give more statistical power to the study.

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