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Original article

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Logical inference and visual memory frailty in patients suffering from borderline personality disorder: a contribution from cognitive psychopathology

Summary

Objective
Borderline Personality Disorder (BPD) is a severe psychiatric condition which causes an impairment of the individual's global mental functioning and serious social stigma. BPD patients present typical affective and cognitive features. Our study aims at clarifying which memory and executive subdomains are primarily affected in BPD patients and at exploring the connection between executive functions and impulsive/disruptive behaviours.

Methods
25 Borderline Personality Disorder (BPD) outpatients were administered Diagnostic Interview for BP-Section II investigating impulsive behaviours. Memory profile of BPD patients on Wechsler Memory Scale-IV was compared to that of a schizophrenia group (n. 25) and that of a non-clinical group (n. 50). BPD patients were also tested by Picture Interpretation Test, Stroop Test and Tower of London-Drexel version. A correlation between executive and clinical measures was performed, too.

Results
BPD patients obtained lower scores than controls in all memory tasks, except for auditory memory. They also performed better than patients with schizophrenia in auditory memory, immediate and delayed memory, but not in the critical domains of visual memory and visual working memory. Logical inference in BPD was more deteriorated than planning abilities that were associated to impulsive behaviours.

Conclusions
Visuospatial memory domain is frequently impaired in BPD. Logical inference frailty might be referred to thought process disturbances whereas planning abilities would represent a crucial dimension of BPD construct.

Key words
Borderline personality disorder • Cognitive psychopathology • Self-injurious behaviour

Introduction

Borderline Personality Disorder (BPD) is a severe psychiatric condition which causes an impairment of the individual's global mental functioning and serious social stigma [1]. People suffering from BPD often exhibit behaviours that can have dangerous consequences for themselves and for their significant others (e.g. overdoses, reckless driving and self-injuring) [2 3] in so far that, from a Public Mental Health Service perspective, treating these patients constitutes a difficult challenge [4]. They may present a typical neuropsychological dysfunction of certain cognitive domains, probably involved into behavioural excesses. To this end, the present study aims at clarifying which memory and executive subdomains are primarily affected in BPD patients and at exploring the con-

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nection between executive functions and impulsive/disruptive behaviours.

Repeated suicidal threats, gestures and behaviours, together with self-mutilation are one of the most distinctive and alarming symptoms of BPD, a real "fingerprint" of the disorder. Borderline patients usually experience a unique mixture of non-suicidal self-injury (NSSI) [5 6]) and chronic suicidal ideation, with suicidal threats and low-lethality suicide attempts [7]). Clinical responses to NSSI for borderline patients include a number of interventions including improving emotion regulation, aiding recovery from dissociative states and encouraging a compromise solution to not kill oneself and to stay alive [7]). In addition, some theoretical models have tried to further clarify the role and the development of self-injuring episodes. According to the Emotional Cascade Model [8]), people suffering from BPD enter a disturbing emotional-cognitive loop where rumination and negative feelings become progressively more intolerable. Deregulated behaviours, such as NSSI, may represent a way-out from this emotional-cognitive climax [8]). In the light of the Self-Regulation Model 7), self-injurious behaviours and suicide attempts help the patient to regulate consuming feelings and uncontrollable thoughts: self-disruptive acts permit the person to gain control on them and get relief from suffering.

Considering the neurobiological correlates of BPD, it has been observed that people with a diagnosis of BPD who injure themselves show a decrease of the white matter microstructural integrity in the inferior parts of frontal brain regions, including the orbitofrontal cortex [9], as well as hypoactivation of the hypothalamic-pituitary-adrenal axis [10]. Interestingly, there is growing evidence suggesting the role of the endogenous opioid system in the pathogenesis of self-injurious behaviour [11], which could involve reduced basal opioid levels and an increased number of opioid receptors [12]. Moreover, a reduced glucose metabolism of several brain regions in BPD patients (i.e., prefrontal, premotor and anterior cingulate cortex, thalamus, caudate and lenticular nuclei) has been identified [13]. These findings have led researchers to suggest that BPD might be due to a failure of frontal cortical activation in modulating limbic activity [14]. More specifically, many core features of BPD may be underpinned by dysfunctional brain circuitry involving hippocampus, amygdala and dorsolateral, anterior cingulate and orbitofrontal cortex [15]. According to Bazanis et al. [2], repeated, self-damaging behaviour occurring in the context of borderline personality disorder may reflect impairments in decision-making and planning cognition.

As far as the neuropsychological profile of BPD is concerned, the identification of the neurocognitive strengths and weaknesses that characterise the disorder has turned out to be a fascinating challenge, as both memory and executive subdomains have been implicated in BPD [16]. Many studies have suggested that borderline patients might present deficits referred to a frontotemporal dysfunction which affects the right hemisphere more critically [17 18]. People suffering from BPD show an impairment of the memory system, both in dealing with visuospatial memory on the one hand and autobiographical memory on the other one [19 20]. Controversy arises in literature about the specific nature of the impairment regarding visual memory. According to some studies, borderline patients exhibit core deficits in nonverbal information encoding and perceptual material organization [18 21].

Interestingly, visuospatial memory deficiency seems to play an important role in BPD neurocognitive profile [16 18]. Beblo et al. [17] have hypothesized that visuospatial memory abilities impairment may constitute the core deficit of BPD neuropsychological profile. Furthermore, it has been suggested that visual perception may negatively influence performances of BPD patients on visuospatial memory tasks [22]. Perceptual speed has also been noted to be impaired in this disorder [23 24]. These findings suggest a possible relation between mnestic, visuospatial and perceptual deficits in this psychiatric condition. Deficits in visual memory and visual working memory have also been noted in schizophrenia, too [25-27], accounting for difficulties in visuospatial discrimination and attention deficits (i.e. focusing on irrelevant stimuli).

As for autobiographical memory, people suffering from BPD seem to show "overgeneral" mnestic profiles [28]: BPD patients develop a persistent scarce specificity of autobiographical memory that leads them to categorical memories about unspecific repeated events [29]. This could be due to negative early life experiences and could be protective by helping emotion regulation and limiting access to traumatic memories. This reduced specificity consists of "sterilized memories" in which subjective participation becomes objective, contrary to Marcel Proust's description of *madeleines* (i.e. every single sensorial element of the memory leads to its retrieval). This tendency towards the "semanticization" of memory is also present in other psychopathological disorders in which self-coherence and sense of agency are particularly affected, such as schizophrenia and obsessive-compulsive disorder [30]. In contrast to BPD patients, patients with schizophrenia show impairment of autobiographical memory due to a lack of autonoetic awareness and self-coherence [30 31]. In these patients, declarative memory impairment represents a core feature and it is strongly linked with a less present and more compromised sense of self, accounting for a more severe range of memory deficits

than borderline patients. Furthermore, autobiographical memory deficits seem to co-occur with an alteration of cultural life scripts (i.e. culturally shared expectations regarding the order and timing of life events in a prototypical life course within a given culture) in BPD patients, but it is not clear yet whether it might be due to their typical identity disturbance or to their negative life experiences [32]. The link between the sense of the self and memory (especially episodic one) is even clearer if we consider the peculiar role of memory system impairment that we can widely find in schizophrenia. Following the brilliant intuitions by Gazzaniga [33], we can consider that episodic memory is strictly responsible for the creation of self-awareness and the stability of the self. Because of its information processing method, which consists in encoding events in spatial and temporal coordinates, episodic memory forms "the sense of the self" as the sense of the one who commits the action in "his space" and in "his time". Encoding "my space" and "my time" are fundamental functions of episodic memory that together determine the unique sense of self and the stability of the identity across the space and the time.

Episodic memory has a pivotal role also in the creation of the sense of agency. The lack of the sense of agency is fundamental in schizophrenia, as described by Happé and Frith [31]. They suggest that the core problem in schizophrenia could be a disorder within the self-monitoring processes, a multilevel system which permits the awareness of what is originated from the self and the discrimination of what is not. These elements are summarized in what Sass and Parnas [30] called *ipseity disturbance*. This kind of phenomena can be found also in BPD patients. This is the conjunction between BPD and schizophrenia, and this could underline the common psychotic core of the two diseases. In fact, we can easily find ipseity disturbance aspects in a large amount of BPD patients, even if they are not so severe as in patients with schizophrenia.

In BPD, a deficit of executive functioning has also been identified, regarding a wide range of cognitive processes. More specifically, BPD neuropsychological profile was proven to be impaired regarding both "cold functions", such as planning, working memory and cognitive flexibility [16 34], and "hot functions", such as decision-making [24 35]. With reference in particular to "cold functions", Haaland et al. [36] have suggested that low planning abilities, cognitive flexibility, verbal fluency and sensitivity to interference constitute a selective weakness of BPD neuropsychological profile, and Hagenhoff et al. [37] have pointed out a selective deficit in working memory when patients are administered an increasing load of cognitive tasks. However, data about cognitive load effects are still controversial themselves [23]. It has also been suggested that a higher executive control and visual memory performance may predict treatment adherence in borderline outpatients [38].

On the basis of the reported literature, we assumed that BPD patients should present specific memory impairments that allow to clearly differentiate them from patients with schizophrenia and that their executive dysfunction may play a critical role for impulsive/disruptive behaviours. To this end, we initially tested a group of BPD patients on a memory battery assessing auditory memory, visual memory, visual working memory, immediate and delayed memory and then compared their performances with a group of patients with schizophrenia and healthy controls. Then, we evaluated BPD executive abilities and finally investigated their association to impulsive/disruptive behaviours.

Materials and Methods

Subjects

25 BPD and 25 patients with schizophrenia were recruited from the Mental Health Service of Pisa (Area vasta Nord Ovest Toscana, Italy). In addition to the clinical groups, a control group of healthy volunteers (CG, n = 50) was recruited from the community. All the participants gave written informed consent. At the time of evaluation, BPD patients received pharmacological treatment (as well as patients with schizophrenia), mainly consisting of typical and atypical antipsychotic drugs, benzodiazepines and antidepressants. Each BPD patient was evaluated and prospectively followed for 3 years to identify psychotic episodes, hospitalization, treatment adherence and assistance needs by two case managers (one psychiatrist and one psychologist).

Neuropsychological assessment

The borderline patients were administered neuropsychological tests and clinical measures in 120 minutes *per* session, including:

- *Brief Neuropsychological Exam (BNE)* [39]: this is a screening battery that consists of the following tests: Digit Span; Memory of Prose (Immediate and Delayed tasks); Memory with Interference (-10" and -30" tasks); Trail making Test (A and B tasks, TMT); Token Test; Verbal Fluency; Abstraction; Cognitive estimations; Embedded Figures Test; Copy Drawing; Spontaneous Drawing; Clock Drawing Test; Praxis. Each raw score was calculated and then compared to its corresponding age and education-adjusted cut-off value. Raw scores inferior to cut-offs (with the exception of the TMT scores) are suggestive of poor performances;
- *Wechsler Memory Scale-IV (WMS-IV)* [40]: this broad

battery provides a deep evaluation of memory system and consists of different subtests evaluating specific abilities, listed as follows: Logical Memory (LM) (Immediate and Delayed): strategic learning; Verbal Paired Associates (VPA) (Immediate and Delayed): associative learning; Designs (DE) (Immediate and Delayed): spatial memory; Visual Reproduction (VR) (Immediate and Delayed): visual memory; Spatial Addition (SA): visuospatial working memory; Symbol Span (SSP): visual working memory. Raw scores were transformed into Scaled Scores (m = 10; *SD* = 3), which were summed up and then transformed into Index Scores (m = 100; *SD* = 15). Index Scores provide information about patients' global performances and are listed as follows: Auditory Memory (AMI): LM I and II, VPA I and II; Visual Memory (VMI): DE I and II, VR I and II; Visual Working Memory (VWMI): SA and SSP; Immediate Memory (IMI): LM I, VPA I, DE I, and VR I; Delayed Memory (DMI): LM II, VPA II, DE II and VR II. This memory battery was also administered to patients with schizophrenia and healthy controls;

- *The Tower of London-Drexel University version (TOL^{DX})*[41]: this is a planning task in which several parameters are considered: Total Move Score, Total Initiation Time, Total Problem-Solving Time, Total Execution Time, Total Time Violations and Total Rule Violations. Raw scores of TOL^{DX} were converted into percentiles according to examinees' age and then transformed into Equivalent Scores (ES)[42] ranging from 0 to 4, by following the correspondence to them (Table I);
- *Picture Interpretation Test (PIT)*[43]: the PIT is a test for the evaluation of logical inference abilities. The PIT was performed by using the picture proposed by Bisiach and colleagues in 1983, a small scale colour reproduction (19 x 13 cm) of a picture by Giacomo Favretto (Figure 1) representing a domestic scene in which three girls are standing on chairs and a boy is searching for something on the floor. The room is in a mess and one of the girls is pointing to something behind a piece of furniture. The examinee has to guess that a mouse is being hunted by girls within a time period of 3 minutes. The task completion time is transformed into the corresponding ES;
- *Stroop Test-Brief Version*[44]: this famous task assesses the ability of inhibiting interferences. Time and Error Interference effects are calculated and then turned into ES.

TABLE I. *Equivalent Scores (ES) and their corresponding percentiles, ability levels and clinical evaluation of the performances*

Equivalent Scores (ES)	Corresponding percentiles	Ability level	Clinical evaluation of the performance
4	≥ 50°	Medium-Superior	Normal
3	49°-36°	Medium-Inferior	Modest
2	35°-20°	Medium-Inferior	Modest
1	19°-5°	Medium-Inferior	Modest
0	≤ 4°	Poor	Poor

Clinical assessment

- *The Modified Overt Aggression Scale (MOAS)*[45 46] was used to investigate the presence and the severity of several types of aggressive behaviour (physical aggression, verbal aggression, auto-aggression, aggression against property). Raw scores were transformed into a scaled score whose total quantifies the global grade of the patient's aggressiveness.
- The *Diagnostic Interview for Borderline Patients (DIB)*[47] was administered to evaluate the main psychopathological features of BPD. For the purposes of this research, only Section II investigating impulsive, self- and hetero-disruptive behaviours was administered.

Statistical analysis

Statistical analysis was conducted by using SPSS 23.0 IBM software. Descriptive analysis of BPD patients on BNE was first reported. BPD memory performances on the WMS-IV were compared to those of a schizophrenia group and those of a non-clinical group with a One-Way ANOVA (Scheffé post-hoc). The *p value* was set at $p < .01$. Then, Pearson *r* correlations between executive measures and clinical variables of BPD group were calculated. Finally, a Wilcoxon Sign-Rank Test (Bonferroni corrected) was used to make comparisons between BPD patients' performances on executive measures.

Results

With reference to the main qualitative results from BNE (Table II), we found that BPD patients' performances on Memory with Interference Tasks -10" and -30", on the TMT B and on the Entangled Figures Test (high education group), as well as performances on the TMT B,

on the Verbal Fluency task and on the Entangled Figures Test (low education group), were below cut-off values [39]. Such findings are in line with previous research suggesting both an impairment in "cold" executive functioning (i.e. working memory, divided attention, cognitive flexibility) [36-38] and in visuoperceptual information organization [18].

According to the principles for interpreting performances of WMS-IV included in the technical and interpretative manual [48], the examination of BPD patients' memory profile highlighted that they have mild difficulties in visual memory performances (as evidenced by VMI and VWMI scores), while patients with schizophrenia show a clear impairment of auditory memory (AMI), immediate and delayed memory (IMI, DMI) and visual memory (VMI) and a deficiency of visual working memory (VWMI) (Table III).

All the participants were demographically matched in terms of age (30.4 ± 9.2 in BPD, 34.7 ± 8.7 in SCH, 32.4 ± 8 in CG) (BPD *vs* SCH, t = -1.298, p = .205; BPD *vs* CG, t = -0.651, p = .520; SCH *vs* CG, t = 1.407, p = n.s.), education (11 ± 4 in BPD, 10.9 ± 2.3 in SCH, 12.5 ± 1.8 in CG) (BPD *vs* SCH, t = 0.109, p = .914; BPD *vs* CG, t = -1.928, p = .057; SCH *vs* CG, t = -2.691, p = .061) and gender (M:F in BPD = 9:16; in SCH = 11:14; in CG 28:22, χ^2 = 1.473, p = .225). Mean illness duration was 11.6 (± 8.7) for BPD patients and 10.4 (± 2.3) for patients with schizophrenia.

BPD patients significantly obtained lower scores than CG in all Indexes of the WMS-IV (p < .01), except for AMI (Table III). Moreover, BPD patients performed significantly better than patients with schizophrenia in Auditory Memory, Immediate Memory and Delayed Memory Indexes (p < .01), but not in the critical domains of visual memory and visual working memory (p = n.s.).

In the BPD group, a significant correlation between TOL^{DX} Total Problem-Solving Time (in seconds) and DIB Section II total score was found (*r* = .623, p < .05); no significant correlations were found between DIB Section II and the other executive measures as well as between MOAS and all the executive measures.

To end with, BPD patients' performance on the logical inference task (PIT) was lower than that on the planning task (TOL^{DX} Total Initiation Time) (p = .006) (Table IV).

Discussion

The neurocognitive profile of borderline patients is characterized by specific mnestic and executive deficits primarily affecting visual memory and logical inference domains, respectively.

TABLE II. *Descriptive statistics of BPD patients' performances on BNE.*

Subtests	BNE scores high education group		BNE scores low education group	
	M	SD	M	SD
Digit Span	5.6	1	5	1.4
Memory of Prose - Immediate Recall	16.8	5.8	14	11.3
Memory of Prose - Delayed Recall	17.6	5.2	12.5	14.8
Memory with Interference - 10 sec.	7.2 *	2.2	7.5	2.1
Memory with Interference - 30 sec.	6.9 *	2.9	7	2.8
Trail Making Test A (sec.)	50.5	16	59	26.8
Trail Making Test B (sec.)	181 *	126.8	109*	0
Token Test	4.9	0.2	5	0
Verbal Fluency	12.3	4.9	7.9 *	0.4
Abstract Thinking	5.6	0.8	4.5	2.1
Estimations	4.5	0.7	4	0
Entangled Figures Test	28.2 *	8.7	31.5*	6.3
Copy	1.8	0.4	1	0
Spontaneous Drawing	2	0	2	0
Clock Drawing Test	9.1	1.1	8	2.8
Praxis	5.8	0.4	5.5	0.7

*BPD: borderline personality disorder; * Subtests below cut-off values.*

TABLE III. *Means ± SD of WMS-IV Indexes and Scheffé post-hoc inter-groups comparisons on WMS-IV Indexes.*

WMS-IV Index	BPD	SCH	CG	BPD *vs* CG SCH *vs* CG BPD *vs* SCH
AMI	96.7 ± 20.8	69.5 ± 18.9	104.1 ± 16	n.s.>.01>.01
VMI	80.3 ± 15.8	71.1 ± 15.3	103 ± 14.9	>.01>.01 n.s.
VWMI	80.3 ± 16	76.2 ± 13.3	102.7 ± 14.8	>.01>.01 n.s.
IMI	85.2 ± 18.9	67.7 ± 16.9	103.7 ± 15	>.01>.01>.01
DMI	88.5 ± 19	67.2 ± 15.3	104.9 ± 17.4	>.01>.01>.01

AMI: Auditory Memory Index; VMI: Visual Memory Index; VWMI: Visual Working Memory Index; IMI: Immediate Memory Index; DMI: Delayed Memory Index; BPD: borderline personality disorder patients; SCH: patients with schizophrenia; CG: control group.

BPD performances on WMS-IV are intermediate between those of controls and patients with schizophrenia. In particular, auditory memory seems to be borderline patients' neurocognitive profile strength, as corroborated by the comparison with the clinical and the non-clinical group. By contrast, poor performances in visual memory and visual working memory tasks may reflect a deficiency in the elaboration of visuospatial information, as suggested by several studies [18 21]. In particular, BPD patients show difficulties in complex cognitive tasks involving non-verbal material and visual perception. This might be due to their inability to solve visual discrimination and filter information affecting memory for spatial location and visual details. Visual acuity deficits and working memory dysfunction have been recognized as critical factors that may influence visual memory performances on WMS-IV [48].

We would stress that a significant difference between BPD and patients with schizophrenia does exist in relation to auditory, immediate and delayed memory. Patients with schizophrenia present a severe deficit in verbal memory and in the ability to recall (verbal and visual) information in immediate and delayed conditions, because of the deep crumbling of self, which is typical of the disorder [49]. The concept of self is strictly linked to the development of episodic memory [50]. Patients with schizophrenia manifest a severe damage of the sense of self and a lack of autonoetic awareness with negative implications for memory consolidation and retrieval [51]. Borderline patients' self is not so severely impaired, even if some "cracks" are present and responsible for identity disturbances. Consequently, the integrity of episodic memory and self-awareness can be sufficiently maintained. Therefore, our findings confirm previous literature on the relationship between (impaired) self and (impaired) episodic memory processes.

Moreover, very intriguing facts emerge. The positive correlation between TOL^{DX} Total Problem-Solving Time and DIB Section II Total Score might indicate that planning abilities are a factor underlying a crucial dimension of the BPD construct (i.e. impulsivity), which includes the accomplishment of self-disruptive behaviours but is not limited to them. TOL^{DX} Total Problem-Solving Time evaluates overall executive planning as mainly related to problem-solving speed.

Impulsivity represents a multidimensional construct and a common feature in BPD and can be conceptualized

TABLE IV. *Mean Rank of BPD patients and p values from executive tests comparison.*

Neuropsychological tests	BPD patients Mean Rank	Executive tests comparisons	p values
Picture Identification Test	2.92	PIT *vs* Stroop Int./Time	.021
TOLDX Total Initiation Time	5.92	PIT *vs* TOLDX Total Initiation Time	.006
TOLDX Total Execution Time	3.33	PIT *vs* TOLDX Total Execution Time	.317
TOLDX Total Problem-Solving Time	3.79	PIT *vs* TOLDX Total Problem-Solving Time	1.57
Stroop Interference/Time	5.04	Stroop Int./Time *vs* TOLDX Total Initiation Time	.271
-	-	Stroop Int./Time *vs* TOLDX Total Execution Time	.035
-	-	Stroop Int./Time *vs* TOLDX Total Problem-Solving Time	.132

BPD: borderline personality disorder; TOLDX: Tower of London Drexel University version; PIT: Picture Identification Test; Stroop Int./Time: Stroop Interference/Time. Differences are significant for $p < .05$ (Bonferroni corrected).

as actions with no foresight, lacking adequate control over cognitive and behavioural response to emotions. Such a result might reflect a failure in the ability to plan efficiently in a limited period of time that expires in playing out impulsive behaviours as a direct consequence of a compromised ability. TOL^{DX} performances, indeed, are largely poor in BPD patients [36 52]. However, logical inference -as thought process consisting of deriving logical conclusions from premises assumed to be true- was less efficient even than planning ability (i.e. TOL^{DX} Total Initiation Time).

This study observed the frailty of memory and executive subdomains in BPD patients. Such findings have relevant implications, given that performances on tests evaluating executive functions and visual memory may predict treatment adherence in BPD outpatients [38]. Our findings first point out the failure of a logical inference capacity because of patients' inability to communicate what is happening in the portrayed scene they see, accounting for a difficulty in the ability to explore complex stimuli visually and to attribute meaning to them. This could reflect some thought process disturbances (i.e. paranoid ideation, dichotomous thinking) that crucially depict the disorder Second, they highlight that impulsivity and planning abilities are intimately connected to how patients respond to negative emotions: the time they take to execute moves correctly to reach a solution in TOL^{DX} tasks might be indicative of BPD patients' difficulty to select the most adaptive behaviour in relation to their inner instability and rapid mood shifts. However, these results should be replicated with a more rigorous methodology mainly including a larger sample size. Thus, caution should be adopted by researchers in the interpretation of the results due to the small size of psychiatric samples.

Conclusion

We have reported the initial results of the comparison of performances among BPD patients, patients with schizophrenia and controls on WMS-IV and the use of PIT for the assessment of logical inference in BPD. The first is not a simple memory battery to be administered in the case of psychiatric patients and represents a reliable tool for researchers and clinicians interested in identifying the strengths and the weaknesses of the whole memory system profile in clinical and non-clinical populations from which cognitive trainings can be set up. To date, studies on cognitive remediation for BPD are very limited. As recently suggested by Vita et al. [53], cognitive remediation currently represents a feasible intervention especially in multimodal treatments of BPD and it is effective in ameliorating specific cognitive abilities related to the executive domain, such as working memory, that may positively affect psychosocial functioning and symptom severity. Despite these encouraging preliminary results, more research is needed to manage this disabling clinical condition starting from a reliable and complete cognitive assessment. The latter is a suitable test not commonly used for the examination of pre-frontal patients with a very quick and effortless administration. It has been associated to specific lateral areas of the frontal lobe, more related to strategy building, and to ventromesial ones, more involved in behaviour initiation and general activation [43]. Intriguingly, given the findings on the dual-process accounts for reasoning and on deduction paradigms [54 55], future research should better disentangle the links between BPD neuropsychological (i.e. working memory) and psychopathological features and the cognitive systems underlying reasoning processes. Furthermore, as the relationship between thought abnormalities (which also include obsessive-compulsive symptoms) and impaired sense of self and coping abilities in BPD was reported [56], future research should also aim at better clarifying the role of self disturbances in psychopathological conditions, as well as their mutual influences (e.g. co-morbid diagnoses). To end with, a recent meta-analysis by Unoka and Richman [24] has confirmed that an impaired executive functioning in BPD patients is linked to BPD symptomatology, especially for impulsivity, emotional liability and poor self-control and it is sustained by evidence of abnormalities in brain structure, function and neurochemistry, by mostly pointing out prefrontal areas hypometabolism.

The main limitation of the present study consists of a reduced number of BPD patients. It should be implemented with the collection of more extensive data to allow researchers to clarify and differentiate BPD neurocognitive profile from that of the other psychiatric disorders in order to improve knowledge on cognitive phenotypes characterizing mental disorders. Moreover, the influence of pharmacological treatment on cognitive performances not taken into account and the lack of a comparison between BPD and schizophrenia performances on executive measures constitute other constraints of our investigation.

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Conflict of Interest

None.

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