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Preliminary communication

Creativity and executive function across manic, mixed and depressive episodes in bipolar I disorder ☆

Márcio Gerhardt Soeiro-de-Souza[a,*], Vasco Videira Dias [b], Danielle Soares Bio [a], Robert M. Post [c], Ricardo A. Moreno[a]

[a] Mood Disorders Unit (GRUDA), Department and Institute of Psychiatry, School of Medicine, University of Sao Paulo (IPq HC-FMUSP), Brazil
[b] Bipolar Disorder Research Program, Hospital Santa Maria, Faculty of Medicine, University of Lisbon, (FMUL), Portugal
[c] Bipolar Collaborative Network, USA

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ABSTRACT

Introduction: Creativity is a complex construct involving affective and cognitive components. Bipolar Disorder (BD) has been associated with creativity and is characterized by a wide range of affective and cognitive symptoms. Although studies of creativity in BD have tended to focus on creativity as a trait variable in medicated euthymic patients, it probably fluctuates during symptomatic states of BD. Since creativity is known to involve key affective and cognitive components, it is plausible to speculate that cognitive deficits and symptoms present in symptomatic BD could interfere with creativity.

Material and methods: Sixty-seven BD type I patients medication free, age 18–35 years and experiencing a maniac, mixed, or depressive episodes, were assessed for creativity, executive functioning, and intelligence.

Results: Manic and mixed state patients had higher creativity scores than depressive individuals. Creativity was influenced by executive function measures only in manic patients. Intelligence did not influence creativity for any of the mood episode types.

Conclusion: We propose that creativity in BD might be linked to the putative hyperdopaminergic state of mania and be dependent on intact executive function. Future studies should further explore the role of dopaminergic mechanisms in creativity in BD.

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1. Introduction

Bipolar Disorder (BD) is a chronic, recurrent, affective disorder associated with manic and depressed states (Balanzá-Martínez et al., 2008). Despite the innumerous disadvantages of these mood swings, BD patients have been reported some advantages of the disease such as increased creativity (Jamison, 1996). To our knowledge, controlled studies on this theme to date have involved only medicated euthymic BD patients while no studies have investigated the differences in creativity across manic, depressive and mixed states. Even though creativity in BD has been studied largely in euthymic patients as a trait variable, creativity could also vary as a function of affective state. Since creativity is known to be a construct with affective (Jamison, 1996) and cognitive (Gundlach and Gesell, 1979) components it is plausible to speculate that cognitive deficits (CD) present in symptomatic BD could also interfere with the creative process.

The study of creativity in BD began with the description of increased rates of bipolarity in various groups of creative individuals (Akiskal et al., 2005; Andreasen and Glick, 1988; Jamison, 1989). Previous studies on creativity in BD have predominantly investigated the differences between euthymic BD patients and the general population. One of the major studies in this field examined creativity in a sample of bipolar

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* Corresponding author at: Dr. Ovidio Pires de Campos s/n 05403-010, São Paulo, Brazil. Tel.: +55 11 30696648; fax: +55 11 30697894.
E-mail address: mgss@usp.br (M.G. Soeiro-de-Souza).

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and cyclothymic disorder patients (Richards et al., 1988). Using the Lifetime Creativity Scale, Richards et al. (1988) found greater overall creative achievement in a group of BD and cyclothymic patients, as well as in their healthy first-degree relatives, compared to healthy control subjects not at risk for affective disorders. More recent creativity studies in BD have focused on comparing creativity measures among medicated euthymic patients against those of controls, reporting higher creativity in BD (Santosa et al., 2007; Strong et al., 2007). Also some authors have demonstrated an important affective temperament/ personality component to creativity in BD (Srivastava et al., 2010b). Thus, creativity in BD has typically been studied as a trait variable. A few reports of higher creativity production in mania than in depression have emerged from biographical studies and empirical research (Jamison, 1996; Rothenberg, 2001). While little is known about the biological underpinnings of creativity, previous psychological, neuropsychological, and functional imaging studies suggest a potential role of the dopaminergic system (Burch et al., 2006; Folley and Park, 2005; Richards et al., 1988).

The objective of this research was to assess possible differences in creativity scores among manic, mixed, and depressive episodes of BD. Also, the influence of executive function on creativity scores in each type of episode was examined. To this end, a sample of young, medication-free bipolar I disorder patients during manic, depressive or mixed state, was recruited.

2. Materials and methods

The sample comprised individuals with BD I, aged between 18 and 35 years old. These patients were participants in the LICAVAL clinical trial (Campos et al., 2010) and were evaluated immediately after the wash out period prior to commencing use of medications. Diagnoses were determined by trained psychiatrists using the Structured Clinical Interview (SCID-I/P) (First et al., 1997) for DSM-IV TR (APA, 2000). The Young Mania Rating Scale (YMRS) (Young et al., 1978), and the Montgomery–Asberg Depression Rating Scale (MADRS) (Montgomery and Asberg, 1979) were used to evaluate the severity of symptoms. The Clinical Global Impression scale was used to measure illness severity (Guy, 1976). The cut-off for depression was 18 points on the MADRS while for mania was 12 points on the YMRS. Patients in use of any pharmacological treatment (at least four weeks for antidepressants, mood stabilizers or antipsychotics, or eight weeks for *depot* medications) were not included based on the assumption that these drugs could influence creativity scores. Subjects with neurological disorders, previous head trauma, any illness requiring medical intervention, currently abusing any substance, or undergoing electroconvulsive therapy in the preceding six months, were also excluded.

Neurocognitive and creativity tests were carried out under standard conditions and scored by two trained neuropsychologists. Executive function was assessed using the Wisconsin Card Sorting Test [(WCST)-Conceptual level responses (WCST-CONC), Perseverative Responses (WCST-PR), Failure to Maintain Set (WCST-FMS), Corrected Categories (WCST-CC), Errors (WCST-E), Non-Perseverative Errors (WCST-NP), and Perseverative Errors (WCST-P)] (Lezak et al., 2004). Intelligence Quotient (IQ) was assessed using Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999).

Creativity was assessed using the Barrow Welsh Art Scale (BWAS). The BWAS (Barron, 1963) is an empirically derived metric consisting of 86 black and white images that individuals rate as "like" or "dislike", with higher scores reflecting preference for more asymmetrical and complex figures over more symmetrical and simple figures. Preference for more asymmetrical and complex figures is higher among artists than non-artists according to BWAS scores (Gough and Bradley, 1996). Creative individuals in disciplines other than the visual arts can also exhibit high BWAS scores (King et al., 1991). The BWAS scale could reflect cognitive/affective contributions to creativity, as it involves not only visual processing but also affective processing (like or dislike). Indeed, BWAS scores have been linked not only to creativity as measured by other means but also to emotionality (King et al., 1991).

The research ethics board of *Hospital das Clínicas of the University of São Paulo* approved the study. Written informed consent was obtained from all subjects.

3. Statistical analyses

Groups of subjects were compared using the Chi-square test for categorical data, and the ANOVA for continuous data. BWAS total sores were compared among mania, depression and mixed episodes using the ANOVA test and then by Tukey's multiple variables correction test. The influence of IQ, age, education, gender, age at diagnosis, as well as YMRS and MADRS scores, on the results from backward regression analysis was assessed. The PASW statistics version 18.0 software (SPSS Inc., Chicago, Illinois) was used for all analyses.

4. Results

4.1. Subjects

A total of 67 patients with bipolar I disorder (45 females) were included. Twenty patients were experiencing manic episodes; twenty-one mixed states and twenty-six depressive episodes. The mean age of the sample was 27.8 (±5.1) years old. Participants had 12.3 mean years (±3.1) of education and a mean IQ of 95.5 (±13.4). Regarding professional activity of individuals in the sample: 10 subjects were university students, 3 actors, 12 unemployed, 10 technicians, 10 health professionals and 22 subjects were working in business or legal professions. Subjects did not differ by episode type for age, sex, education, history of psychotic symptoms, number of previous manic episodes, clinical global impression score (CGI) or number of previous suicide attempts (Table 1).

4.2. Comparison of cognitive and creativity measures among groups

The ANOVA test showed that executive function scores, as rated by the WCST, differed between episodes (Table 2) on WCST PR, WCST Errors and WCST P. Post-Hoc analysis confirmed that the manic group had higher scores than the

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Table 1
Sociodemographic and clinical variables.

	Bipolar disorder episodes						ANOVA[a]		Turkey post hoc test[a]
	Mania ($N=20$)		Mixed ($N=21$)		Depression ($N=26$)				
	Mean	SD	Mean	SD	Mean	SD	F	p	
Age (yrs)	28.90	5.13	28.67	5.00	26.46	5.17	1.64	0.201	
Gender (men/women)[b]	16/4		16/5		13/13		$p=0.06$		
Years of schooling	11.63	3.7	12.81	3.4	12.60	2.36	0.79	0.455	
MADRS	10.50	8.17	21.55	8.73	24.28	7.22	11.56	**<0.001**	Depre>Mania<Mixed
YMRS	18.05	6.73	13.86	5.79	9.60	6.33	7.95	**0.001**	Mania>Mixed
Age at diagnose	27.14	5.72	23.00	6.20	25.67	4.95	*2.47*	*0.094*	
Clinical Global Impression	3.67	0.88	4.05	1.22	3.25	0.85	*2.64*	*0.082*	
Psychotic symptoms[b]	60%		61.9%		34%		$p=0.08$		
>4 manic episodes[b]	45%		49%		53%		$p=0.34$		
Number of suicide attempts	1.64	3.15	1.73	1.77	2.24	3.05	0.249	0.780	

MADRS: Montgomery–Åsberg Depression Rating Scale; YMRS: Young Mania Rating Scale. The signs (>, <) indicate better or worse functioning and not actual scores on the tests. Bold indicates tests with statistic significance.
[a] Significance level $p<0.05$.
[b] Chi-square test, significance level $p<0.05$.

mixed group state across all neurocognitive tests (worse executive function). IQ scores did not differ among episode groups. ANOVA comparison among the three episode groups revealed that they differed in BWAS total score ($F=6.49$ $p=0.003$) (Fig. 1). Multiple comparisons analysis revealed that BWAS total score was higher in the mania group than in either the mixed ($p=0.006$) or depression ($p=0.014$) episode groups, but did not confirm the difference between mania and mixed groups. BWAS Like and Dislike scores showed no differences among episode types (Table 2).

4.3. Creativity measures and mood symptoms

Backward regression analysis revealed that YMRS, MADRS and CGI did not influence BWAS total scores in depressive ($F=1.06$ $p=0.40$) or mixed ($F=0.15$ $p=0.99$) episodes. In manic states however, the mood symptom scales influenced BWAS score ($R^2=0.76$, $F=8.67$, $p=0.007$). Separate analysis of these scales revealed that YMRS ($B=1.96$ $t=4.57$ $p=0.002$) and MADRS ($B=1.16$ $t=3.25$ $p=0.012$) were responsible for this interference. Both YMRS and MADRS in mania positively influenced BWAS total score.

4.4. Creativity measures and cognition

Executive function scores (WCST) did not influence BWAS total score in mixed ($F=0.92$ $p=0.51$) or depressive ($F=0.48$ $p=0.81$) episodes. However, in manic episodes, the subtests WCST CC ($B=12.96$ $t=2.3$ $p=0.036$ Partial Eta Squared 0.29) and WCST NP ($B=-2.34$ $t=-2.9$ $p=0.012$ Partial Eta Squared $=0.39$) influenced BWAS total score. The WCST CC positively influenced BWAS total score in mania while the WCST NP had a negative impact.

Table 2
Comparison of executive function, intelligence and creativity between episodes.

	Bipolar disorder episodes						ANOVA[a]		Turkey post hoc test[a]
	Mania ($N=20$)		Mixed ($N=21$)		Depression ($N=26$)				
	Mean	SD	Mean	SD	Mean	SD	F	p	
WCST CONC	42.74	11.54	45.33	8.69	49.27	6.57	3.08	0.053	
WCST PR	13.58	12.27	9.05	5.02	6.85	3.67	4.42	**0.016**	Mania<Depression
WCST FMS	0.37	0.59	0.10	0.30	0.58	0.98	2.44	0.095	
WCST CC	2.89	1.59	3.40	1.39	3.65	1.19	1.67	0.196	
WCST Errors	21.26	11.54	18.67	8.69	14.15	6.44	3.73	**0.029**	Mania<Depression
WCST P	11.32	9.45	8.10	3.76	5.92	3.39	4.57	**0.014**	Mania<Depression
WCST NP	9.95	8.59	10.20	6.99	8.15	5.74	0.58	0.559	
Intelligence Quotient	92.40	14.69	96.81	13.46	97.00	12.50	0.78	0.459	
BWAS Like	13.06	6.52	11.21	7.53	6.53	7.73	2.96	0.06	
BWAS Dislike	12.93	10.81	14.78	8.61	11.00	7.52	0.56	0.57	
BWAS total score	27.25	12.10	26.80	10.94	16.76	10.97	6.53	**0.003**	Mania>Mixed Mixed>Depress

WCST: Wisconsin Card Sorting Test – Conceptual level responses (CONC), Perseverative Responses (PR), Failure to Maintain Set (FMS), Corrected Categories (CC), Errors (E), Non-perseverative Errors (NP), Perseverative Errors (P); BWAS: Barrow Welsh Art Scale. The signs (>, <) indicate better or worse performance and not actual scores on the tests. Bold indicates tests with statistic significance.
[a] Significance level $p<0.05$.

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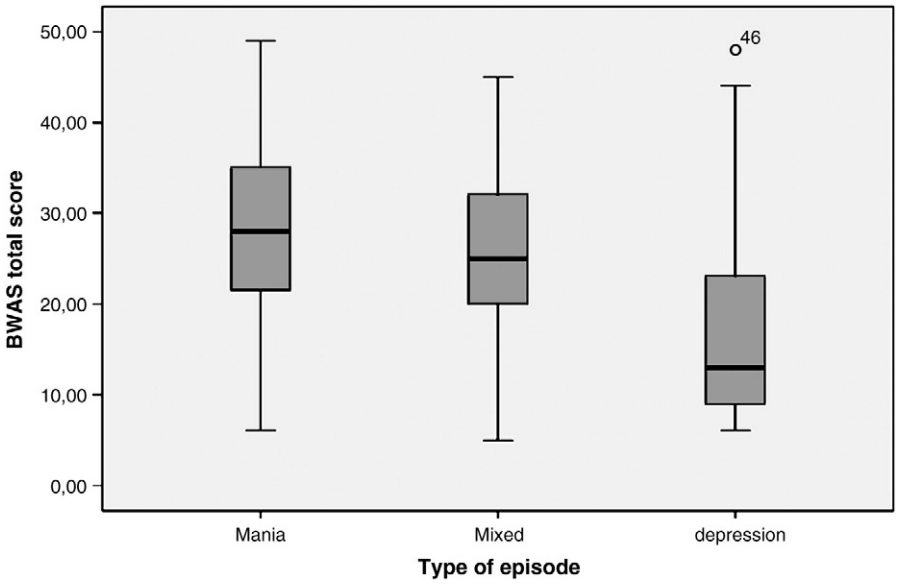

Fig. 1. Boxblot graphic comparing BWAS total scores in mania, mixed and depressive episodes ($F = 6.49$ $p = 0.003$).

IQ had no influence on BWAS scores for any type of episode (mania: $F = 0.30$ $p = 0.59$; mixed: $F = 0.06$ $p = 0.80$; depression: $F = 0.24$ $p = 0.62$).

4.5. Creativity measures and other variables

Regression analysis to evaluate the influence of gender, education, and age as cofactors, on BWAS total scores revealed no influence for any type of episode (mania $F = 2.62$ $p = 0.08$); (mixed $F = 0.45$ $p = 0.71$); (depression $F = 1.26$ $p = 0.31$).

5. Discussion

The present study reported that the validated measure of creativity (BWAS) differed among bipolar mood states and that executive function influenced creativity differently in each mood state. Manic patients were found to have higher creativity scores, in agreement with previous empirical observations (Jamison, 1996; Rothenberg, 2001), although this difference only reached statistical significant when compared with depressive episodes, but not with mixed episodes. Executive functioning was related to creativity scores only for mania, where WCST CC was positively, and WCST NP inversely, correlated to creativity score. Creativity scores in manic patients were shown to be positively influenced by executive function where the more creative the individual, the more categories on the WCST were completed, and the fewer non-perseverative errors made.

The manic stage of bipolar disorder shares the underlying common characteristic of an elevated mood, and is characterized by an increase in the quantity and speed of physical and mental activity. In our study, higher creativity scores were associated with better performance in executive function within the manic group, which is consistent with the concept that creativity requires the generation of multiple and appropriate stimulus (Lubart, 1994). In this sense, high creativity in mania is associated with better executive function. Nevertheless, compared to depression and mixed states, mania still had the worst executive function when analyzed individually.

To our knowledge, no previous studies have undertaken a combined analysis of creativity in each mood state of BD and analyzed how executive functions influence creativity during BD episodes. However, this topic has been studied in schizophrenic patients. In schizophrenics, performance on executive function tasks has been shown to play a mediating role in specific aspects of creative cognition, congruent with our results for mania. In fact, the study in schizophrenics reported that the performance of the schizophrenic group on measures of creativity elements of fluency were mediated by their performance on the executive control tasks (Abraham et al., 2007).

One possible explanation for the differences seen in creativity among episode types might involve dopamine (DA) variations. CD mechanisms in BD have been proposed to include deficits in DA in the prefrontal cortex (PFC) (Randrup and Braestrup, 1977; Williams and Goldman-Rakic, 1995). Historically, dopaminergic models of BD have been dichotomous and support dopamine (DA) excess in mania and deficiency in depression (Randrup and Braestrup, 1977). Insufficient (hypodopaminergic) and excessive (hyperdopaminergic) D1 receptor stimulation have been reported to impair PFC function (Arnsten and Li, 2005; Granon et al., 2000; Zahrt et al., 1997), leading to CD. For this reason it has been suggested that PFC cognition needs an optimal level of DA to achieve normal function (Goldman-Rakic et al., 2004; Mehta et al., 2000). DA has also been reported to influence mood and cognition (Cousins et al., 2009) while psychological, neuropsychological as well as functional imaging studies, indicate its potential role in the biology of creativity (Burch et al., 2006; Folley and Park, 2005; Richards et al., 1988). High DA has been reported to decrease inhibition of incoming stimuli from the surrounding

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environment (latent inhibition) (Ellenbroek et al., 1996; Swerdlow et al., 2003), which is characteristic of creative individuals (Carson et al., 2003). Also, the ability to generate many different ideas about a topic in a short period of time (divergent thinking), a key aspect of creativity (Gundlach and Gesell, 1979), is influenced by the dopaminergic function (Reuter et al., 2006). Therefore, in a putative hyperdopaminergic state such as mania in which the optimal amount of DA for good executive functioning may be exceeded (Goldman-Rakic et al., 2004; Mehta et al., 2000), high creativity was observed in those with less compromised executive function. It is possible that to sustain the high creativity associated with high DA, a minimum of executive function is required, and if this optimal level is disrupted creativity then becomes impaired.

Previous controlled studies about creativity in BD have involved euthymic and medicated patients. Santosa et al. (2007) evaluated a mixture of euthymic medicated and unmediated BD I, II, and not otherwise specified and reported similar scores of creativity to creative controls and higher scores than non-creative controls. Data from this same cohort revealed that temperament and personality traits contributed to higher creativity in mood disorders (Srivastava et al., 2010b; Strong et al., 2007). Earlier studies have previously suggested a relationship between cyclothymia and creativity indicating the existence of an affective temperament/personality component to creativity (Akiskal and Akiskal, 1988; Akiskal et al., 2005). Furthermore some studies have indicated a cognitive temperament/personality component to creativity and suggest that intuitive cognitive processing may contribute to creativity by enhancing positive discrimination (Srivastava et al., 2010b). To our knowledge, there are no studies reporting correlations between affective and cognitive temperament/personality components and neuropsychological aspects in BD patients. Based on our results, creativity could be considered partially state dependent as opposed to solely a trait related to a BD diagnosis. We agree that probably the cognitive temperament/-personality component to creativity may become indistinguishable in a sample that is medication free and full of symptomatology but this is undoubtedly the best way to evaluate magnificence of creativity in BD and its differences among episodes.

Among the limitations of the present study, the group sizes should ideally have been larger in order to demonstrate significant differences more clearly. Also, although the sample included many women, gender analysis by episode was not done due to the small sample size. The strengths of this study include its use of a validated measure of creativity in patients, without interference of medication, in a sample of young BD I patients in three different mood states. By contrast, most previous studies have involved euthymic and medicated patients (Santosa et al., 2007; Srivastava et al., 2010b; Strong et al., 2007). However, the general association of bipolar disorder to increased creativity suggests that some individuals may show altered creativity as a trait variable (Akiskal and Akiskal, 1988; Akiskal et al., 2005; Srivastava et al., 2010b; Srivastava and Ketter, 2010a), in addition to the differences among states seen in the present study. Tests on the same individual across different mood states, and in comparison to unipolar and nondepressed controls, may be indicated. Moreover, other measures of creativity and of creative accomplishments may yield different relationships to mood states.

6. Conclusion

This study is the first to report measures of creativity for three different types of mood episodes of BD, as well as their association with executive function. In agreement with clinical observations, mania was the mood state with the highest creativity score. Furthermore, high creativity in manic patients was shown to be associated with better executive function. We propose that creativity in BD episodes might be positively influenced by DA levels in the PFC, but may also be dependent on executive function. Future studies should attempt to replicate our findings and clarify the connection between DA, mania, and creativity in BD.

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Conflict of Interest

The authors do not have any conflict of interest to report.

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