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Research report

Enhanced creativity in bipolar disorder patients: A controlled study

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Abstract

Objective: Associations between eminent creativity and bipolar disorders have been reported, but there are few data relating non-eminent creativity to bipolar disorders in clinical samples. We assessed non-eminent creativity in euthymic bipolar (BP) and unipolar major depressive disorder (MDD) patients, creative discipline controls (CC), and healthy controls (HC).
Methods: 49 BP, 25 MDD, 32 CC, and 47 HC (all euthymic) completed four creativity measures yielding six parameters: the Barron–Welsh Art Scale (BWAS-Total, and two subscales, BWAS-Dislike and BWAS-Like), the Adjective Check List Creative Personality Scale (ACL-CPS), and the Torrance Tests of Creative Thinking – Figural (TTCT-F) and Verbal (TTCT-V) versions. Mean scores on these instruments were compared across groups.
Results: BP and CC (but not MDD) compared to HC scored significantly higher on BWAS-Total (45% and 48% higher, respectively) and BWAS-Dislike (90% and 88% higher, respectively), but not on BWAS-Like. CC compared to MDD scored significantly higher (12% higher) on TTCT-F. For all other comparisons, creativity scores did not differ significantly between groups.
Conclusions: We found BP and CC (but not MDD) had similarly enhanced creativity on the BWAS-Total (driven by an increase on the BWAS-Dislike) compared to HC. Further studies are needed to determine the mechanisms of enhanced creativity and how it relates to clinical (e.g. temperament, mood, and medication status) and preclinical (e.g. visual and affective processing substrates) parameters.

Keywords: Temperament; Personality; Mood disorders; Creativity

1. Introduction

Poets and philosophers have long suspected, and even romanticized, associations between creativity and various forms of "madness." With the pioneering efforts of mental health investigators including Andreasen (Andreasen and Powers, 1975; Andreasen, 1987, 2005) and Jamison (Jamison, 1989, 1993), relationships between creativity and psychiatric disorders came within the purview of the scientific community and became increasingly systematic. After three decades of research, there is persuasive, if not definitive, evidence linking creativity with bipolar disorders in particular.

Most studies attempting to establish this association were conducted by documenting higher rates of bipolar disorders in eminently creative individuals, through structured or semistructured diagnostic assessments or retrospective biographical research (Andreasen, 1987; Jamison, 1989; Ludwig, 1992, 1995; Post, 1994).

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Studying eminently creative individuals avoids the thorny issues of defining and measuring creativity. However, using eminence as a *de facto* criterion of creativity is problematic because this represents only an extreme subgroup of creative individuals. Moreover, retrospective studies of eminently creative individuals have often been limited by decreased reliability due to making diagnoses based on biographical information rather than on subject interviews, and not always using standardized diagnostic criteria.

Studies examining general clinical populations not selected for creativity may better address whether or not bipolar disorders are associated with various degrees of enhanced creativity, ranging from modest to eminent. To date, however, we found only one major study which examined creativity starting with a sample of bipolar and cyclothymic disorder patients (Richards et al., 1988a). Using the Lifetime Creativity Scale (LCS), a structured interview designed to detect non-eminent or "everyday" creativity (Richards et al., 1988b), Richards and colleagues found greater overall creative achievement in a combined group of bipolar and cyclothymic disorder patients, and their healthy first degree relatives, compared to healthy control subjects not at risk for affective disorders.

Healthy first-degree relatives of patients tended to have higher creativity scores than the patients themselves. This study was remarkable for utilizing a standardized creativity metric rather than identifying creativity by eminence. However, the LCS has not been widely used, possibly due to the degree of effort required to administer and score this instrument.

The purpose the current study was to assess non-eminent creativity in bipolar disorder patients compared to healthy control subjects, using other objective and well-characterized methods. Specifically, we used a battery of easily scored psychometric instruments which can be utilized in large clinical samples — the Barron–Welsh Art Scale (BWAS) (Barron, 1963), the Adjective Check List Creative Personality Scale (ACL-CPS) (Gough, 1979), and the Torrance Tests of Creative Thinking – Figural (TTCT-F) and Verbal (TTCT-V) forms (Torrance, 1990) — to assess creativity across euthymic bipolar disorder patients, (unipolar) major depressive disorder patients, creative discipline controls, and healthy controls.

2. Methods

The study was conducted in the Bipolar Disorders Clinic at Stanford University and approved by the Stanford Administrative Panel on Human Subjects. Prior to the participation in this study, all subjects provided oral and written informed consent. All participants received a psychiatric evaluation including detailed medical and psychiatric history and Structured Clinical Interview for DSM-IV Diagnosis (SCID) (First et al., 1997) by a psychiatrist or experienced research coordinator to determine presence or absence of psychiatric disorders. In addition, clinical evaluation by a psychiatrist utilizing a semi-structured interview to assess individual DSM-IV symptoms of depression and mood elevation confirmed that subjects had been euthymic for at least four weeks.

Inclusion criteria for mood disorder participants required a diagnosis of bipolar disorder type I, II, or not otherwise specified (BP), or major depressive disorder (MDD) (2000). Beck Depression Inventory (BDI) (Beck et al., 1961) on the day of the study was used to quantify the severity of any subsyndromal depressive symptoms. Patients with primary diagnoses other than BP or MDD, or with active substance abuse, personality, or eating disorders were excluded. The BP group included a mixture of one-quarter unmedicated and three-quarters heterogeneously medicated patients.

Healthy controls (HC) had no personal or first-degree relative history of psychiatric disorder, substance abuse, or neurological illness. Absence of psychiatric illness was confirmed in separate interviews with psychiatrists and experienced research coordinators using a comprehensive battery of measures including SCID, physical examination, neuropsychological evaluation and laboratory tests. Healthy control subjects had no major medical illnesses; were taking no medications, hormones, herbal remedies or over the counter medications such as allergy or sleep aids; were employed, students or homemakers; and had a stable place of residence.

Creative controls (CC) were volunteers with no current psychiatric or substance abuse problems, recruited from graduate programs in Creative Writing, Fine Arts, and Product Design at Stanford University. Program Directors gave approval for recruitment and distributed study announcements. Interested students then contacted the investigators. Those with current syndromal psychiatric problems were not included in data analysis, and were referred for further evaluation and treatment.

Participants were administered creativity measures: the Barron–Welsh Art Scale (BWAS) (Barron, 1963), the Adjective Check List Creative Personality Scale (ACL-CPS) (Gough, 1979; Gough and Heilbrun, 1983), and the Torrance Tests of Creative Thinking – Figural (TTCT-F) and Verbal (TTCT-V) versions (Torrance, 1990). The BWAS (Barron, 1963) is an empirically-

derived metric consisting of 86 black and white images that subjects rate ”like” or ”dislike”, with higher scores reflecting preference for more asymmetrical and complex figures over more symmetrical and simple figures. Parameters based on this measure include BWAS-Like (“like” subscale total), BWAS-Dislike (“dislike” subscale total), and BWAS-Total score. Preference for more asymmetrical and complex figures is higher among artists than among non-artists and BWAS scores correlate with faculty or peer ratings of creativity (Gough et al., 1996). Creative individuals in disciplines other than the visual arts also have high BWAS scores (Barron, 1972). The BWAS could reflect a putative cognitive/affective contribution to creativity, as it involves not only visual processing (observing the figures) but also affective processing (determining whether one likes or dislikes the figures and expressing this response). Indeed, BWAS scores have been linked not only to creativity as measured by other means but also to emotionality (King et al., 1991).

The ACL-CPS is derived from the Adjective Checklist (ACL) (Gough, 1979; Gough and Heilbrun, 1983), and is considered to reflect a putative personality component of creativity. Subjects indicate adjectives identified by empirical studies to separate groups of creative and non-creative individuals. Thus, some adjectives (such as clever, confident, humorous, informal, resourceful, snobbish, and unconventional) are frequently endorsed, while others (such as conservative, commonplace, dissatisfied, honest, submissive, and suspicious) are rarely endorsed by creative individuals.

The TTCT-F and the TTCT-V (Torrance, 1990) are derived from Guilford’s Structure of Intellect model, and are considered to reflect divergent thinking, a putative cognitive contributor to creativity. Subjects are encouraged to devise novel figurative and verbal responses to figurative and verbal stimuli.

Mean scores for the six creativity parameters (BWAS-Total, BWAS-Like, BWAS-Dislike, ACL-CPS, TTCT-F, and TTCT-V) were compared across BP, CC, MDD, and HC groups. Bonferroni corrections were applied, using a significance threshold of $p=0.05/6=0.0083$, correcting for a total of 6 comparisons (one for each creativity parameter). Correlations between different creativity parameters and effects of demographics and mood on creativity were also assessed. Means (±standard deviations) are reported, unless otherwise indicated.

3. Results

3.1. Subjects

A total of 153 euthymic subjects participated in the study; 49 BP, 25 MDD, 32 CC and 47 HC. The 49 BP consisted of 29 subjects with bipolar I disorder, 16 with bipolar II disorder, and 4 with bipolar disorder not otherwise specified. As there were no significant differences between these bipolar subgroups with respect to demographic parameters, creativity measures, or temperament/personality measures, these subgroups were combined into a single BP group. Of the 32 creative controls (CC), nine were studio arts (painting, photography, sculpture, or multimedia), 10 were creative writing (fiction or poetry), and 13 were product design (Master of Fine Art or Master of Science in mechanical engineering) graduate students. Nineteen of the 32 CC (59%) met SCID criteria for a past psychiatric disorder, with history of a major depressive episode being the most common (seen in 14). In addition, and in some instances comorbid with depression, 8 had a history of anxiety disorders (primarily panic disorder), 5 had a history of substance abuse, and 3 had a history of eating disorder. Thirteen had no history of mental disorder. None of the CC subjects had a history of hypomania, mania, or psychosis.

The average age of all subjects was 34.1±11.5. There was a statistically significant group difference in age ($F(3,149)=3.16$, $p=.03$), with CC being significantly younger than BP ($t(79)=3.93$, $p<.001$), but other pair-

Table 1
Sample description

	HC	MDD	BP	CC
N	47	25	49	32
% Female	61.7	68.0	63.3	53.1
Age	33.8±14.2	33.5±12.3	37.5±10.8	29.7±3.5*
Education	5.6±1.6	6.6±1.6	5.9±1.6	7.6±0.5 **, ***
BDI	0.8±1.4	7.2±3.2 *, ****	4.4±3.5 ****	5.7±3.5 ****

*$p<0.001$ versus BP; **$p<0.0001$ versus BP, HC; ***$p<0.001$ versus MDD; ****$p<0.0001$ versus HC. BP=bipolar disorder patients; MDD=(unipolar) major depressive disorder patients; CC=creative discipline graduate student controls; HC=healthy controls. BDI=Beck Depression Inventory.

Table 2
Creativity measures across groups

	HC	MDD	BP	CC
N	47	25	49	32
BWAS-Total	18.8±10.1	21.3±13.0	27.2±11.7 ****	27.9±8.1 ****
BWAS-Dislike	8.2±7.3	13.4±9.9	15.6±10.0 ****	15.4±10.4 ****
BWAS-Like	10.6±6.6	8.1±6.3	11.6±6.3	12.4±6.1
ACL-CPS	56.7±9.1	60.2±9.2	55.9±8.9	59.6±8.0
TTCT-F	112.2±21.8	104.4±15.5	106.3±20.0	117.2±16.0 *
TTCT-V	100.4±15.4	98.6±14.1	101.6±14.3	98.7±10.5

*$p=0.0076$ versus HC; ****$p<0.001$ versus HC. BP=bipolar disorder patients; MDD=(unipolar) major depressive disorder patients; CC=creative discipline graduate student controls; HC=healthy controls. BWAS=Barron–Welsh Art Scale; ACL-CPS=Adjective Check List Creative Personality Scale; TTCT-F, TTCT-V=Torrance Tests of Creative Thinking – Figural and Verbal versions.

wise comparisons failed to demonstrate age differences between groups (Table 1).

The study included more women than men, with women accounting for 63% of BP, 68% of MDD, 53% of CC and 62% of HC, with no significant differences in gender balance among groups ($F(3,149)=.48$, $p=.70$). Subjects were highly educated, averaging greater than a 4-year college degree. There was a statistically significant group effect for education ($F(3,146)=13.54$, $p<.0001$), with CC being significantly more educated than all of the other groups (p ranging from 0.0008 to 0.0001), but even the least educated group (HC) had, on average, two years of college.

Although all subjects had BDI scores lower than encountered in clinical depression (range 0 to 12, overall mean 4.0±3.8), group differences were noted ($F(3,149)=31.70$, $p<.0001$), as HC had significantly lower BDI scores than the other three groups ($p<0.0001$), and MDD had higher BDI scores than BP ($p<0.001$).

3.2. Creativity measures compared across groups

ANOVA showed highly significant differences in BWAS-Total scores among groups ($F(3,148)=7.36$, $p=0.0001$). In subsequent pair-wise comparisons, compared to HC, BWAS-Total was significantly increased 45% in BP ($t(94)=3.77$, $p=0.0003$) and 48% in CC ($t(77)=4.26$, $p<0.0001$), but not in MDD (Table 2, Figs. 1, 2). A similar but more robust pattern of findings emerged for BWAS-Dislike scores, which in pair-wise comparisons were, compared to HC, significantly increased 90% in BP ($t(94)=4.06$, $p=0.0001$) and 88% in CC ($t(77)=3.60$, $p=0.0006$), but not in MDD. In contrast, BWAS-Like scores did not differ significantly among groups.

ANOVA revealed no significant differences among groups for ACL-CPS scores ($F(3,148)=1.99$, $p=.12$), with mean scores for all groups being modestly higher than the general population estimate of 50±11 (Gough and Heilbrun, 1983), and varying by less than 8% from one another. ANOVA revealed no significant differences among groups for TTCT-F scores ($F(3,124)=2.31$, $p=.08$), with mean scores being modestly higher than the general population estimate of 100±20 (Torrance, 1974, 1990). However, the mean score in CC (117.2) was approximately one standard deviation above the general population estimate, and in pair-wise comparison exceeded that of MDD by 12% ($t(45)=2.79$, $p=0.0076$). ANOVA revealed no significant differences among groups for TTCT-V scores ($F(3,123)=.29$, $p=.83$), with mean scores for all groups being similar to general population estimate of 100±20 (Torrance, 1974, 1990), and varying by less than 4% from one another.

Restricting the above analyses to subjects no older than age 40 years retained the entire CC group (mean age 29.7), yielded HC, BP, and MDD subgroups with

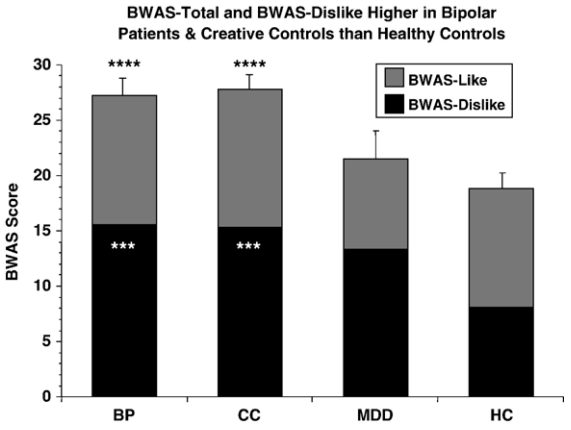

Fig. 1. Increased BWAS-Total and BWAS-Dislike in bipolar disorder patients and creative controls compared to healthy controls. Bars indicate mean BWAS-Dislike (black) and BWAS-Like (gray) scores in bipolar disorder (BP), creative control (CC), major depressive disorder (MDD), and healthy control (HC) groups. Error bars indicate standard errors of means. BWAS=Barron–Welsh Art Scale. ****$p<0.0001$ versus HC BWAS-Total; ***$p<0.0007$ versus HC BWAS-Dislike.

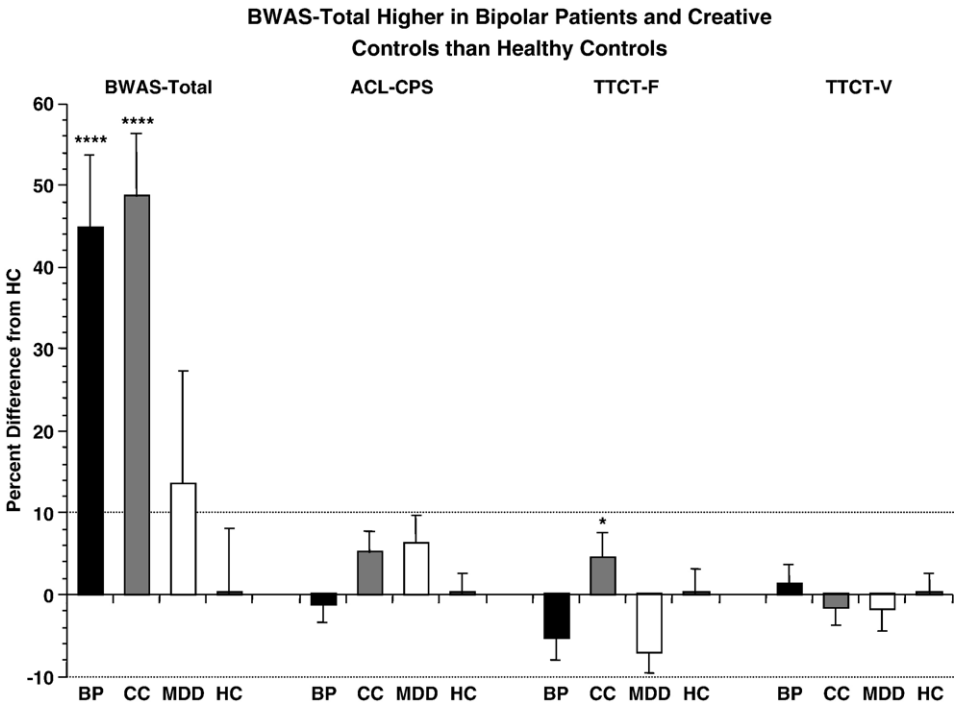

Fig. 2. Increased BWAS-Total in bipolar disorder patients and creative controls compared to healthy controls. Bars indicate mean percentage differences of bipolar disorder (BP, black bars), creative control (CC. gray bars), and major depressive disorder (MDD, white bars) groups from healthy control (HC) group. Error bars indicate standard errors of means. BWAS = Barron–Welsh Art Scale. ACL CPS = Adjective Check List Creative Personality Scale. TTCT-F, TTCT-V = Torrance Tests of Creative Thinking – Figural and Verbal versions. ****$p<0.0004$ versus HC, *$p=0.0076$ versus MDD.

similar mean ages (27.4, 30.7, and 27.8), and did not alter the above pattern of findings. Restricting the above analyses to subjects with education scores of at least 7 retained the entire CC group (mean education 7.6), yielded HC, BP, and MDD subgroups with similar mean education scores (8.0, 7.8, and 7.6), and did not alter the above pattern of findings.

CC with a history of mood disorder (or any psychiatric disorder) did not differ significantly compared to CC without such history with respect to age, gender, BDI, or any creativity parameter. For example, mean BWAS scores were 28.0 and 27.8 in CC with and without a history of mood disorder, respectively, and 27.9 and 27.9 in CC with and without a history of any psychiatric disorder, respectively. The pattern of between-group creativity findings was not altered by restricting the analyses to CC with or without a history of mood disorder, or CC with or without a history of any psychiatric disorder.

3.3. Creativity measure correlations with one another

Examination of correlations among different creativity measures revealed a significant correlation (r (126) = 0.41, $p<0.0001$) only between the TTCT-V and TTCT-F. This is consistent with measures reflecting independent facets of creativity or independent constructs separately related to creativity.

3.4. Relationships between creativity measures and demographics and mood

Age correlated inversely with BWAS-Total (r (151) = −0.30, $p=0.0001$) in the entire sample, and in HC (r (45) = −0.38, $p=0.0075$), but not in any other diagnostic group. Similarly, age correlated inversely with BWAS-Dislike (r (151) = −0.23, $p=0.0045$) in the entire sample, and in HC (r (45) = −0.39, $p=0.0069$), but not in any other diagnostic group. Also, age correlated inversely with BWAS-Like (r (23) = −0.53, $p=0.0062$) in MDD, but not in the entire sample, or any other diagnostic group. In contrast, age did not correlate significantly with ACL-CPS, TTCT-F, or TTCT-V in the entire sample or in any diagnostic group. Education correlated directly with TTCT-F in BP (r (47) = 0.34, $p=0.039$) and inversely with ACL-CPS in CC (r (30) = −0.37, $p=0.039$), but did not correlate with these measures in the entire sample or in any other diagnostic

group. Education did not correlate significantly with BWAS, BWAS-Dislike, BWAS-Like, or TTCT-V in the entire sample or in any diagnostic group. BDI correlated directly with BWAS-Dislike (r (151)=0.32, $p<0.0001$) in the entire sample, but not in any diagnostic group. Also, BDI did not correlate significantly with BWAS-Total, BWAS-Like, ACL-CPS, TTCT-F, or TTCT-V in the entire sample, or any diagnostic group. For all creativity measures, scores did not differ significantly in female compared to male subjects in the entire sample or in any diagnostic group.

4. Discussion

Euthymic BP, three-quarters of whom were taking medication(s), had a 45% higher mean BWAS-Total score than HC. The mean BWAS-Total score in BP was similar to CC and similar to scores previously observed in architects (29.4±10.6) and creative writers (32.9±11.1) (Gough et al., 1996). The BWAS-Total score in our HC was similar to that reported in the general population (18.0±12.4) (Gough et al., 1996). The differences in BWAS-Total scores appeared to be driven by differences in the BWAS-Dislike subscale scores. Euthymic BP scored 90% higher than HC on BWAS-Dislike (p=0.0003), but only 9% higher on BWAS-Like (p=NS).

In contrast, BP and HC had similar TTCT-V, TTCT-F, and CPS-ACL scores, which were close to general population estimates. With the exception of a modest correlation between TTCT-V and TTCT-F, the creativity measures were not related to one another. Other studies have reported absence of correlations between BWAS and TTCT-F (Goolsby and Helwig, 1975) and between BWAS and CPS-ACL (Schuldberg, 1990).

We found a negative BWAS-age correlation in the entire sample, and in HC, but not in any other diagnostic group. Negative correlations between BWAS and age have been reported in male and female teachers not selected for creativity (Alpaugh and Birren, 1977), and in women not selected for creativity (Crosson and Robertson-Tchabo, 1983), but not in women selected for creativity (Crosson and Robertson-Tchabo, 1983). Further studies are required to assess the relationship between age and preference for complexity/asymmetry.

It is noteworthy that BP (and not MDD) patients had enhanced creativity. It is feasible that temperamental/personality differences could contribute to enhanced creativity in BP but not MDD. Indeed, as previously reported in the sample in the current study, BP compared to MDD had increased cyclothymia, and BP (but not MDD) compared to HC had increased openness to experience (Nowakowska et al., 2005). Moreover, these parameters were related to enhanced creativity (BWAS-Dislike and BWAS-Like scores, respectively) as noted in the accompanying article (Strong et al., in press). It is unlikely that the modest (mean 2.4 point) but statistically significantly higher BDI scores in the MDD compared to the BP group accounted for BP but not MDD having enhanced creativity, as BDI correlated directly with BWAS.

To our knowledge, the BWAS is the only one of the four creativity measures used in this study to be previously administered in clinical psychiatric samples. King and associates found that cluster B personality disorder (King et al., 1995) but not substance abuse disorder (King et al., 1991) patients had higher BWAS scores than controls. Our results are consistent with the former finding given the symptomatic overlap and high rate of comorbidity between bipolar disorders and cluster B personality disorders (O'Connell et al., 1991). However, up to 60% of bipolar disorder patients have a lifetime history of substance abuse (Regier et al., 1990). It is worth noting, however, that our sample excluded patients in whom current substance use disorders or personality disorders were the primary diagnoses. Perhaps substance abuse adversely affects creativity or is less crucial to creativity than emotionality. Indeed, in substance abuse disorder patients and healthy controls, King and associates found that emotionality, as measured by the Test of Emotional Styles, correlated with complexity preference (King et al., 1991), and they speculated that for individuals with cluster B personality disorders, more asymmetrical and complex figures may be more emotionally charged than more symmetrical and simple figures. Facial and non-facial visual stimuli have affective content, and consensus regarding emotional attribution can be achieved even for abstract drawings (Mayer et al., 1990).

Our finding of enhanced BWAS-Total (driven by BWAS-Dislike) scores in BP may be related to altered visual and affective processing in BP. Individual visual preferences (like/dislike) may be determined by objective structural features of stimuli as well as subjective interpretations (Rentschler et al., 1999). How a simple like/dislike dichotomy relates to salience of stimuli or dimensions of emotional responses remains to be established, but the underlying perceptual and affective processes may have overlapping neuroanatomical substrates. Structures implicated in affect attribution for visual stimuli include the basal forebrain, thalamus (pulvinar), amygdala, and orbital cortex (LeDoux, 1996; Morris et al., 1997). Partially independent systems may

encode and process affective and nonaffective attributes of images. Affective discriminations may occur without extensive cognitive processing, or even without conscious perception (Kunst-Wilson and Zajonc, 1980). The relatively simple nature of the BWAS figures and the short preference response time (on the order of one second or less per item) suggest that the BWAS may involve innate perceptual and preference mechanisms without extensive participation of cognitive systems.

The role of the amygdala in visual preference processing is of particular interest, as this structure is considered important in conferring affective valence to stimuli (Adolphs, 1999). Patients with bilateral amygdala damage have a positive bias for preferring simple black and white figures (i.e., they disliked such figures less than healthy controls) (Adolphs and Tranel, 1999). In contrast, our bipolar disorder patients had a negative bias against simple/symmetric "Dislike" figures. The latter could be related to increased amygdalar function. Depressed medication-free bipolar disorder patients compared to healthy controls appear to have increased resting amygdalar cerebral blood flow and glucose metabolism (Drevets, 1999; Ketter et al., 2001). However, patients in the current study were euthymic, and three-quarters were taking medication(s) at the time of testing. Studies of affective valence attribution for figures and the role of the amygdala in BWAS task performance might yield important insights into the neurobiology of affective processing and image preference.

Limitations of this study include the use of a highly educated sample, and the mixture of unmedicated and heterogeneously medicated patients in the sample. Lithium has been reported to decrease associative productivity (Shaw et al., 1986; Kocsis et al., 1993), and to have variable effects on artistic productivity (Schou, 1979) in patients with BP. In healthy volunteers, although lithium yielded deficits on some cognitive and motor tasks, it did not alter performance on tests of semantic fluency or aesthetic perception (Meier Art Tests of Aesthetic Perception and Art Judgment) (Judd et al., 1977). Our bipolar disorder patients (one-quarter of whom were taking lithium) performed better than healthy controls on the BWAS, and similar to healthy controls on three other creativity measures. Although performance could have been different had all patients been unmedicated, we did not find significant differences in scores for patients taking compared to not taking medications for any of the creativity measures. The BP group consisted of subjects with bipolar I disorder, bipolar II disorder, and bipolar disorder not otherwise specified. However, as there were no significant differences between these bipolar subgroups with respect to demographic parameters, creativity measures, or temperament/personality measures, and the pattern of findings of comparisons of these bipolar subgroups with MDD, HC, and CC was the same as that seen when comparing the entire bipolar group to the other groups, it does not appear that combining these subgroups into a single BP group was problematic. Our CC group was younger and more educated than other groups. As BWAS correlated inversely with age in the entire group, an age effect could have yielded an overestimate of CC BWAS scores compared to other groups. However, restricting the analyses to subjects no older than age 40 years yielded subgroups with similar mean ages, and did not alter the pattern of findings, suggesting that our findings involving comparisons with the CC group are valid in subjects up to age 40 years. Additional studies are needed to confirm the results of our comparisons between CC and other groups apply to subjects over age 40 years. As BWAS did not correlate with education in the entire group, it is less likely that this could have confounded comparisons of BWAS in CC compared to other groups. Also, restricting the analyses to subjects with the most education yielded subgroups with similar mean education scores, and did not alter the pattern of findings. Nevertheless, additional studies are needed to confirm the results of our comparisons between CC and other groups apply to subjects with less education. Indeed, given the high education level of all subgroups, additional studies are needed to confirm our findings comparing BP, MDD, and HC apply to subjects with less education. Our CC group was heterogeneous with respect to history of mood disorder (or any psychiatric disorder). However, CC with compared to CC without such history did not differ significantly with respect to any creativity parameter, and the pattern of between-group creativity findings was not altered by restricting analyses to CC with or without a history of mood disorder, or CC with or without a history of any psychiatric disorder. Although the sample included a substantial number of participants, statistical power limitations could account for the some of our negative findings, and particularly limit our ability to assess creativity in the subgroups of the CC and BP groups. Finally, although limiting the sample to euthymic subjects removed the confound of mood state, the current study cannot inform us of the effect of mood state on relationships between bipolar disorder and creativity.

In spite of these limitations, our findings suggest enhanced creativity in BP compared to HC. Further studies are needed to determine the mechanisms of

enhanced creativity and how it relates to clinical (e.g. temperament, mood, and medication status) and pre-clinical (e.g. visual and affective processing substrates) parameters.

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References

Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR). American Psychiatric Association, Washington.

Adolphs, R., 1999. The human amygdala and emotion. Neurosci. 5, 125–137.

Adolphs, R., Tranel, D., 1999. Preferences for visual stimuli following amygdala damage. J. Cogn. Neurosci. 11 (6), 610–616.

Alpaugh, P.K., Birren, J.E., 1977. Variables affecting creative contributions across the adult life span. Hum. Dev. 20 (4), 240–248.

Andreasen, N.C., 1987. Creativity and mental illness: prevalence rates in writers and their first-degree relatives. Am. J. Psychiatry 144 (10), 1288–1292.

Andreasen, N.C., 2005. The Creating Brain: The Neuroscience of Genius. Dana Press, Washington, DC.

Andreasen, N.J.C., Powers, P.S., 1975. Creativity and psychosis. An examination of conceptual style. Arch. Gen. Psychiatry 32 (1), 70–73.

Barron, F., 1963. Barron–Welsh Art Scale, A Portion of the Welsh Figure Preference Test. Consulting Psychologists Press, Palo Alto, CA.

Barron, F., 1972. Artists in the Making. Seminar Press, New York.

Beck, A.T., Ward, C.H., et al., 1961. An inventory for measuring depression. Arch. Gen. Psychiatry 4, 561–571.

Crosson, C.W., Robertson-Tchabo, E.A., 1983. Age and preference for complexity among manifestly creative women. Hum. Dev. 26 (3), 149–155.

Drevets, W.C., 1999. Prefrontal cortical–amygdalar metabolism in major depression. Ann. N. Y. Acad. Sci. 877, 614–637.

First, M.B., Spitzer, R.L., et al., 1997. Structured Clinical Interview for DSM-IV Axis I Disorders. American Psychiatric Press, Washington, DC.

Goolsby, T.M., Helwig, L.D., 1975. Concurrent validity of the Torrance Tests of Creative Thinking and the Welsh Figural Preference Test. Educ. Psychol. Meas. 35 (2), 507–508.

Gough, H.G., 1979. A creative personality scale for the Adjective Check List. J. Pers. Soc. Psychol. 37, 1398–1405.

Gough, H.G., Heilbrun, A.B., 1983. The Adjective Checklist Manual. Consulting Psychologists Press Inc.

Gough, H.G., Hall, W.B., et al., 1996. Forty years of experience with the Barron–Welsh Art Scale. In: Montuori, A. (Ed.), Unusual Associates: A Festschrift for Frank Barron. Hampton Press, Cresskill, NJ, pp. 252–301.

Jamison, K.R., 1989. Mood disorders and patterns of creativity in British writers and artists. Psychiatry 52 (2), 125–134.

Jamison, K.R., 1993. Touched With Fire: Manic-Depressive Illness and the Creative Temperament. The Free Press, New York.

Judd, L.L., Hubbard, B., et al., 1977. The effect of lithium carbonate on the cognitive functions of normal subjects. Arch. Gen. Psychiatry 34 (3), 355–357.

Ketter, T.A., Kimbrell, T.A., et al., 2001. Effects of mood and subtype on cerebral glucose metabolism in treatment-refractory bipolar disorders. Biol. Psychiatry 49 (2), 97–109.

King, R., Curtis, D., et al., 1991. Complexity preference in substance abusers and controls: relationships to diagnosis and personality variables. Percept. Mot. Skills 72 (1), 35–39.

King, R., Villeneuve, E., et al., 1995. Aesthetic preference and DSM-IIIR personality disorders. Pers. Individ. Differ. 18 (6), 797–799.

Kocsis, J.H., Shaw, E.D., et al., 1993. Neuropsychologic effects of lithium discontinuation. J. Clin. Psychopharmacol. 13 (4), 268–275.

Kunst-Wilson, W.R., Zajonc, R.B., 1980. Affective discrimination of stimuli that cannot be recognized. Science 207 (4430), 557–558.

LeDoux, J., 1996. The Emotional Brain: The Mysterious Underpinnings of Emotional Life. Simon & Schuster, New York.

Ludwig, A.M., 1992. Creative achievement and psychopathology: comparison among professions. Am. J. Psychother. 46 (3), 330–356.

Ludwig, A.M., 1995. The Price of Greatness. The Guilford Press, New York.

Mayer, J.D., DiPaolo, M., et al., 1990. Perceiving affective content in ambiguous visual stimuli: a component of emotional intelligence. J. Pers. Assess. 54 (3–4), 772–781.

Morris, J.S., Friston, K.J., et al., 1997. Neural responses to salient visual stimuli. Proc. Biol. Sci. 264 (1382), 769–775.

Nowakowska, C., Strong, C.M., et al., 2005. Temperamental commonalities and differences in euthymic mood disorder patients, creative controls, and healthy controls. J. Affect Disord. 85 (1–2), 207–215.

O'Connell, R.A., Mayo, J.A., et al., 1991. PDQ-R personality disorders in bipolar patients. J. Affect. Disord. 23 (4), 217–221.

Post, F., 1994. Creativity and psychopathology. A study of 291 world-famous men. Br. J. Psychiatry 165 (2), 22–34.

Regier, D.A., Farmer, M.E., et al., 1990. Comorbidity of mental disorders with alcohol and other drug abuse. Results from the Epidemiologic Catchment Area (ECA) Study. JAMA 264 (19), 2511–2518.

Rentschler, I., Juttner, M., et al., 1999. Innate and learned components of human visual preference. Curr. Biol. 9 (13), 665–671.

Richards, R., Kinney, D.K., et al., 1988a. Creativity in manic-depressives, cyclothymes, their normal relatives, and control subjects. J. Abnorm. Psychology 97 (3), 281–288.

Richards, R., Kinney, D.K., et al., 1988b. Assessing everyday creativity: characteristics of the lifetime creativity scales and validation with three large samples. J. Pers. Soc. Psychol. 54 (3), 476–485.

Schou, M., 1979. Artistic productivity and lithium prophylaxis in manic-depressive illness. Br. J. Psychiatry 135, 97–103.

Schuldberg, D., 1990. Schizotypal and hypomanic traits, creativity, and psychological health. Creat. Res. J. 3 (3), 218–230.

Shaw, E.D., Mann, J.J., et al., 1986. Effects of lithium carbonate on associative productivity and idiosyncrasy in bipolar outpatients. Am. J. Psychiatry 143 (9), 1166–1169.

Strong, C.M., Nowakowska, C., et al., in press. Temperament-creativity relationships in mood disorder patients, healthy controls and highly creative individuals. J. Affect. Disord.

Torrance, E.P., 1974. The Torrance Tests of Creative Thinking: Norms-Technical Manual. Personnel Press / Ginn, Princeton, NJ.

Torrance, E.P., 1990. Torrance Tests of Creative Thinking. Scholastic Testing Service, Bensenville, Illinois.