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ORIGINAL ARTICLE

Executive dysfunction and memory impairment in schizoaffective disorder: a comparison with bipolar disorder, schizophrenia and healthy controls

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Background. Deficits in memory and executive performance are well-established features of bipolar disorder and schizophrenia. By contrast, data on cognitive impairment in schizoaffective disorder are scarce and the findings are conflicting.

Method. We used the Wechsler Memory Scale (WMS-III) and the Behavioural Assessment of the Dysexecutive Syndrome (BADS) to test memory and executive function in 45 schizophrenic patients, 26 schizomanic patients and 51 manic bipolar patients in comparison to 65 healthy controls. The patients were tested when acutely ill.

Results. All three patient groups performed significantly more poorly than the controls on global measures of memory and executive functioning, but there were no differences among the patient groups. There were few differences in memory and executive function subtest scores within the patient groups. There were no differences in any test scores between manic patients with and without psychotic symptoms.

Conclusions. Schizophrenic, schizomanic and manic patients show a broadly similar degree of executive and memory deficits in the acute phase of illness. Our results do not support a categorical differentiation across different psychotic categories with regard to neuropsychological deficits.

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Introduction

Schizoaffective disorder is a boundary condition that challenges the Kraepelinian dichotomy between schizophrenia and major affective disorder, and perhaps even the whole categorical classification of psychotic disorders. Arguments have been made that it is an independent entity (Procci, 1976), a subtype of schizophrenia (Lehman, 1975), a variant of bipolar disorder (Clayton *et al*. 1968) or the midpoint on a continuum of psychosis (Crow, 1986). These arguments have relied on two sources of evidence, follow-up studies and family history studies, neither of which have proved decisive. Patients diagnosed as schizoaffective tend to have an outcome intermediate between schizophrenia and bipolar disorder (for a review, see McKenna, 2007), and they show elevated rates of both schizophrenia and bipolar disorder in their first-degree relatives (for a review, see Coryell, 1986).

A further potential source of evidence is neuropsychological studies. In a review of the literature, Buchanan *et al*. (2005) concluded that schizophrenia and schizoaffective disorder shared a similar pattern of cognitive deficits which was distinct from that seen in major depression and bipolar disorder. However, this conclusion was based on only two studies, one comparing schizoaffective patients and schizophrenic patients (Miller *et al*. 1996) and the other comparing schizoaffective patients with groups with schizophrenia and non-psychotic mood disorder (Evans *et al*. 1999). More recently, Bora *et al*. (2009) have published a meta-analysis that compared neuropsychological

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test performance in patients with schizophrenia to those with schizoaffective psychosis and psychotic forms of affective disorder. Pooled differences on six measures of memory, executive function and mental speed were all in the direction of better performance in the schizoaffective patients, with the effect sizes being significant in five out of six cases (range 0.08 to 0.32). However, they also found that the pooled differences between schizophrenia and psychotic affective disorder were of the same magnitude in these domains.

Studies comparing schizoaffective disorder with bipolar disorder are fewer in number and have had conflicting findings. Evans *et al*. (1999) found that 29 schizoaffective and 154 schizophrenic patients were more impaired than 27 patients with non-psychotic mood disorder on a composite neuropsychological score, but there were no significant differences between the schizophrenic and schizoaffective groups. Torrent *et al*. (2007) found that 34 schizoaffective patients showed significantly more impairment than 41 patients with bipolar disorder on tests of short- and long-term verbal memory, and on two out of four executive measures. However, Studentkowski *et al*. (2010) had more mixed findings: 28 schizoaffective patients showed more impairment than 32 bipolar patients on tests of attention, psychomotor speed and memory, but there were no significant differences on measures of cognitive flexibility and emotional memory. Finally, Szoke *et al*. (2008) found no significant differences on two executive tests, the Wisconsin Card Sorting Test (WCST) and the Trail Making Test (TMT), in 26 schizoaffective patients compared to 52 and 40 patients with psychotic and non-psychotic forms of bipolar disorder respectively.

One possible reason for the divergent findings in this latter group of studies might be the presence or absence of psychotic symptoms in the bipolar comparison group. For example, Simonsen *et al*. (2011) found no differences between 27 schizoaffective and 75 bipolar patients with a history of psychotic symptoms on a battery of seven tests covering memory, processing speed and executive function; however, there were significant differences compared to 61 patients with non-psychotic forms of bipolar disorder on four of these tests. Glahn *et al*. (2006) found that 15 schizoaffective patients did not differ from 11 psychotic bipolar patients on three tests of short-term and working memory. Greater differences from non-psychotic bipolar patients were evident on all the tests, but the authors did not state whether these reached significance.

A further issue that might affect cognitive performance in groups of psychotic patients is the degree to which they are symptomatic at the time of testing. This applies particularly to affective disorder, where, in the words of Murray *et al*. (2004): 'Many studies have noted cognitive deficits in acutely psychotic patients with affective disorder, but the crucial question is whether, in contrast to schizophrenia, these deficits completely resolve with remission.' Even allowing for the fact that a proportion of bipolar patients will continue to show cognitive impairment when they are euthymic (e.g. Robinson *et al*. 2006), it is still possible that studies comparing schizophrenia, schizoaffective disorder and bipolar disorder will have different findings depending on whether the bipolar (and perhaps also the schizoaffective) patients are examined when they were acutely ill or recovered.

The aim of this study was to further examine the question of whether there is a pattern of decreasing cognitive impairment from schizophrenia to schizoaffective disorder to bipolar disorder. We also addressed the two problems identified above, testing all patients when they were in an active phase of illness, and carrying out a comparison between manic patients with and without psychotic symptoms.

Method

Subjects

The patient sample ($n=122$) consisted of three different diagnostic groups (schizomanic patients, $n=26$; manic patients, $n=51$; and schizophrenic patients, $n=45$) recruited from three Spanish psychiatric hospitals (Hospital Benito Menni, Sant Boi de Llobregat; the psychiatric ward of Hospital General de Granollers; and Hospital Clínic in Barcelona), where they had been admitted for a relapse of illness. Patients were excluded if: (*a*) they were aged <18 years or >65 years, (*b*) had a history of brain trauma or neurological disease, and (*c*) had shown alcohol/substance abuse within 12 months prior to participation. All patients were also required to have an IQ in the normal range: Wechsler Adult Intelligence Scale III (WAIS-III) score $\geqslant 70$.

All patients were diagnosed using DSM-IV criteria. This was based on an interview with a psychiatrist, with a second psychiatrist being involved in cases of doubt. The schizoaffective patients also met the more rigorous Research Diagnostic Criteria (RDC) for this disorder (Spitzer *et al*. 1978).

All patients were taking medication. In the bipolar patients, 43/51 were on one or more mood stabilizers and 46/51 were taking typical and/or atypical antipsychotics. In the schizoaffective group, 19/26 patients were taking mood stabilizers and all of them were on typical and/or atypical antipsychotic drugs. Three of the 45 schizophrenic patients were taking a mood stabilizer and all but one were receiving

antipsychotic medication. There was no difference between the groups with regard to antipsychotic dose, calculated in chlorpromazine equivalents (bipolar mean: 653.04 ± 491.26; schizoaffective mean: 776.30 ± 529.50; schizophrenia mean: 793.90 ± 510.28; $F_{2,119} = 1.06$, $p = 0.35$).

All patients were tested when acutely ill, as defined as a score of >18 on the Young Mania Rating Scale (YMRS; Young *et al*. 1978) in the bipolar manic and schizomanic patients. Psychotic symptoms were required to be present in the schizophrenic and schizomanic patients, defined on the basis of the following Positive and Negative Symptom Scale (PANSS; Kay *et al*. 1967) items: P1 ⩾4, P3 ⩾4, P5 ⩾5, P6 ⩾6 or PG9 ⩾5. Symptoms in all patients were rated on the day of the neuropsychological assessment.

The controls consisted of 65 Spanish Caucasian healthy individuals. They were recruited to be age- and sex-matched to the patients and met the same exclusion criteria. All controls were recruited from non-medical staff working in the hospital, their relatives and acquaintances, plus independent sources in the community. They were questioned and excluded if they reported a history of mental illness and/or treatment with psychotropic medication.

All participants gave written informed consent and the study was approved by the hospital research ethics committee.

Cognitive and neuropsychological assessment

Neuropsychological assessments were carried out by three psychologists who had no knowledge of the patients' diagnoses. Pre-morbid IQ was estimated using the Word Accentuation Test (Test de Acentuación de Palabras, TAP; Del Ser *et al*. 1997; Gomar *et al*. 2011). This is analogous to the English National Adult Reading Test (NART; Nelson & Willison, 1991) and requires pronunciation of low-frequency Spanish words whose accents have been removed. Current IQ was measured using four subtests of the Spanish version of the WAIS-III: Vocabulary, Similarities, Matrix Reasoning, and Block Design. Raw scores were converted into scaled scores for the relevant age group, and then pro-rated to calculate full-scale IQ.

Memory was assessed using four subtests of the Spanish version of the Wechsler Memory Scale-III (WMS-III; Wechsler, 1997; Pereña *et al*. 2004): verbal long-term memory (Logical Memory I), visual memory (Faces I), short-term memory (Digit Span) and working memory (Letter–Number Sequencing). Raw scores on these tests are converted into age-related scaled scores. The scaled scores can then be arithmetically summed.

Executive function was tested using the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson *et al*. 1996; Vargas *et al*. 2009). This is a wide-ranging battery of executive tests that has been standardized on groups of normal subjects and patients with head injury. It has also been adapted for use in Spanish populations (Vargas *et al*. 2009). It consists of six subtests. Rule Shift Cards examines set shifting ability. The Action Programme Test requires the subject to devise a strategy to remove a cork from a container, using simple tools such as a stick and water. In the Key Search Test, the subject has to devise an efficient plan to search a field for a lost object. The Temporal Judgement Test is a variant of the Cognitive Estimates Test of Shallice & Evans (1978); the subject has to respond to questions they are unlikely to know the exact answer to, such as, for example, how long it takes to clean a window, or how long a dog lives. The Zoo Map Test requires strategic planning of a route in a diagram of a zoo, while following certain rules. Finally, the Modified Six Elements Test is a task requiring multi-tasking in which the subject has to carry out various elements of six different activities according to a set of rules. Performance on the individual tests can be combined to give an overall 'profile' score that can also be adjusted for age (the standardized score).

Statistical analyses

Analyses of variance (ANOVAs) were carried out to compare overall WMS and BADS scores and WMS subtests among the patient and control groups. For the BADS subtests, non-parametric Kruskal–Wallis tests were used because scores were not normally distributed. *Post-hoc* tests with Bonferroni correction were applied when significant main effects were found. In a subanalysis we divided the bipolar sample into a group of manic patients with or without psychotic symptoms. The presence of psychotic symptoms was defined based on PANSS scores as described above. The impact of demographic and clinical variables on neuropsychological performance was investigated through regression analyses modelling a backward stepwise method.

Results

Sample characteristics

The patient groups and healthy controls did not differ in age, sex or estimated pre-morbid IQ. However, the healthy controls had a significantly higher mean current IQ than the other groups (see Table 1). There was no difference in duration of illness among the patient groups ($F_{2,112} = 2.18$, $p = 0.118$), although this was numerically shorter in the bipolar patients.

Table 1. *Demographic and clinical data for three patient groups and healthy controls*

	A HC	B BD	C SADM	D SZ	Statistical test	*Post-hoc* comparison
Sex ratio (F/M)	26/39	25/26	9/17	15/30	$\chi^2 = 3.66$ $p = 0.30$	
Age (years)	38.20 (14.24)	41.09 (11.49)	41.78 (8.55)	38.10 (9.27)	$F_{3,183} = 1.12$ $p = 0.34$	
Duration of illness (years)	N.A.	13.36 (10.73)	17.57 (9.59)	16.82 (7.93)	$F_{2,112} = 2.18$ $p = 0.12$	
Estimated pre-morbid IQ	102.06 (8.81)	101.20 (8.25)	102.08 (11.10)	100.39 (10.04)	$F_{3,179} = 0.33$ $p = 0.80$	
WAIS-III IQ	103.34 (13.82)	93.14 (14.46)	91.12(14.41)	89.27 (15.89)	$F_{3,181} = 10.19$ $p < 0.001$	A > B,C,D
GAF score	N.A.	47.06 (12.73)	49.62 (8.82)	46.28 (10.12)	$F_{2,117} = 0.76$ $p = 0.47$	
YMRS score	N.A.	22.65 (4.45)	22.28 (2.44)	N.A. $p = 0.70$	$T_{74} = 0.38$	
PANSS-P	N.A.	17.76 (5.05)	21.76 (3.65)	18.53 (5.06)	$F_{2,116} = 5.99$ $p = 0.003$	C > B,D
PANSS-N	N.A.	8.31 (1.59)	11.16 (5.44)	21.40 (7.10)	$F_{2,116} = 82.13$ $p < 0.001$	D > B,C
PANSS-GP	N.A.	25.78 (6.40)	28.36 (6.32)	34.26 (6.48)	$F_{2,116} = 20.77$ $P < 0.001$	D > B,C

HC, Healthy controls; BD, bipolar disorder; SADM, schizoaffective disorder, mania; SZ, schizophrenia; F, female; M, male; WAIS-III, Wechsler Adult Intelligence Scale-III; GAF, Global Assessment of Functioning; YMRS, Young Mania Rating Scale; PANSS, Positive and Negative Symptom Scale: P, Positive; N, Negative; GP, General Psychopathology; N.A., not applicable.
Values given as mean (standard deviation).

Regarding psychopathological status, the bipolar and schizoaffective patients scored similarly on the YMRS. Other findings were in the expected directions: the schizoaffective patients showed significantly higher scores on PANSS positive (PANSS-P) symptoms than the bipolar patients and schizophrenic patients whereas the schizophrenic patients showed higher scores on PANSS negative (PANSS-N) symptoms and PANSS general psychopathology (PANSS-GP) than the bipolar (and the schizoaffective) patients. There was no difference in overall functional impairment among the patient groups, as measured by Global Assessment of Functioning (GAF) scores over the past month (Table 1).

Memory

The control group performed significantly better than the schizophrenic, schizoaffective and bipolar patients on WMS composite score but there were no significant differences among the three patient groups (Table 2 and Fig. 1).

The significant differences between controls and patients on the WMS composite score remained significant when current (i.e. WAIS-III) IQ, which was significantly higher in the controls than in the three patient groups, was entered as a covariate in the analysis ($F_{3,180} = 14.05$, $p < 0.0001$). As can be seen in Fig. 1, one of the schizophrenic patients had an outlying high score on the WMS. Repeating the above analyses excluding this patient made no difference to the findings.

Concerning the individual WMS subtests, significant differences were found on verbal memory ($F_{3,183} = 22.44$, $p < 0.0001$) and working memory ($F_{3,183} = 20.33$, $p < 0.0001$), with the controls showing higher scores than each of the three patient groups (Table 2). On visual memory, a marginally significant effect ($F_{3,183} = 2.61$, $p = 0.05$) was due to a significant difference only between the controls and the schizophrenic patients ($p = 0.04$).

Executive function

All three patient groups showed statistically significant lower standardized BADS profile scores than the control group ($F_{3,183} = 24.79$, $p < 0.0001$) (Table 2 and Fig. 2). There were no significant differences between any of the patient groups on this measure.

Table 2. *Neuropsychological performance on cognitive domains*

	A HC ($n=65$)	B BD ($n=51$)	C SAD ($n=26$)	D SZ ($n=45$)	Statistical test	*Post-hoc* comparison
WMS composite score	39.05 (7.31)	28.55 (6.64)	30.23 (6.22)	28.07 (8.39)	$F_{3,183}=26.73$ $p<0.001$	A > B,C,D
WMS Verbal Memory	9.71 (2.16)	6.71 (2.54)	7.15 (3.07)	6.03 (2.91)	$F_{3,183}=22.10$ $p<0.001$	A > B,C,D
WMS Working Memory	9.86 (2.44)	7.07 (1.96)	7.17 (2.08)	7.12 (2.54)	$F_{3,183}=20.33$ $p<0.001$	A > B,C,D
WMS Visual Memory	9.62 (2.83)	9.04 (2.83)	8.85 (2.34)	8.07 (3.22)	$F_{3,183}=2.61$ $p=0.05$	A > D
BADS: Total	96.58 (13.11)	73.45 (19.09)	71.27 (21.27)	73.78 (19.81)	$F_{3,183}=24.79$ $p<0.001$	A > B,C,D
BADS: Rule Shift Cards Test	4 (1–4)	3 (0–4)	3 (0–4)	3 (0–4)	$KW_3=42.26$ $p<0.001$	A > B,C,D
BADS: Action Programme Test	4 (2–4)	4 (0–4)	4 (0–4)	3 (0–4)	$KW_3=19.62$ $p<0.01$	A > D
BADS: Key Search Test	3 (0–4)	1 (0–4)	1 (0–4)	1 (0–4)	$KW_3=13.59$ $p<0.001$	A > B
BADS: Temporal Judgement Test	2 (1–4)	2 (1–4)	2 (0–3)	2 (1–4)	$KW_3=9.09$ $p=0.03$	
BADS: Zoo Map Test	2 (0–4)	1 (0–4)	1 (0–3)	1 (0–4)	$KW_3=32.23$ $p<0.001$	A > B,C,D
BADS: Modified Six Elements Test	4 (1–4)	3 (0–4)	2 (0–4)	3 (0–4)	$KW_3=27.84$ $p<0.001$	A > B,C,D

HC, Healthy controls; BD, bipolar disorder; SADM, schizoaffective disorder, mania; SZ, schizophrenia; WMS, Wechsler Memory Scale; BADS, Behavioural Assessment of the Dysexecutive Syndrome; KW, Kruskal–Wallis test.

Values given as mean (standard deviation) or median (range).

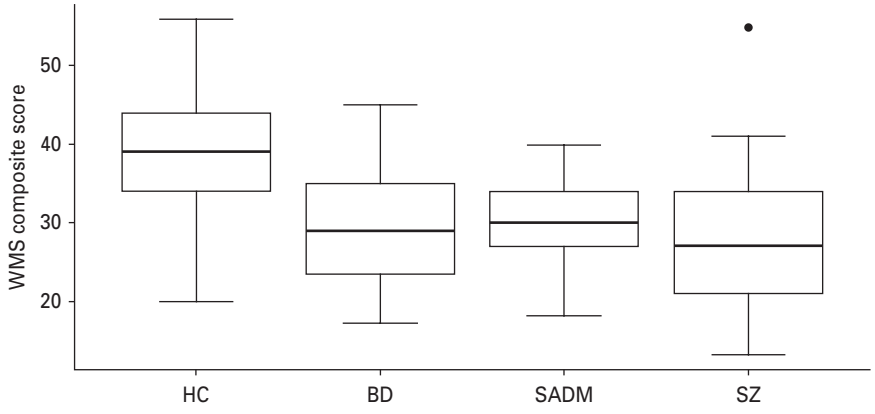

Fig. 1. Differences in Wechsler Memory Scale (WMS) composite scores of patient groups and healthy controls (HC). BD, Bipolar disorder; SADM, schizoaffective disorder, mania; SZ, schizophrenia. •, Represents individual outliers.

Differences between the controls and patients on the BADS standardized profile score remained significant after correcting for current (i.e. WAIS-III) IQ differences ($F_{3,180}=13.52$, $p<0.0001$). The schizophrenia patient who had an outlying high score on the WMS composite score also had a high BADS standardized profile score. Once again, however, repeating the analyses excluding this patient made no difference to the pattern of results (Fig. 2).

As shown in Table 2, the control group performed significantly better than each of the patient groups on three of the six BADS subtests, Rule Shift Cards, Zoo Map and the Modified Six Elements Test. The controls also performed significantly better than the

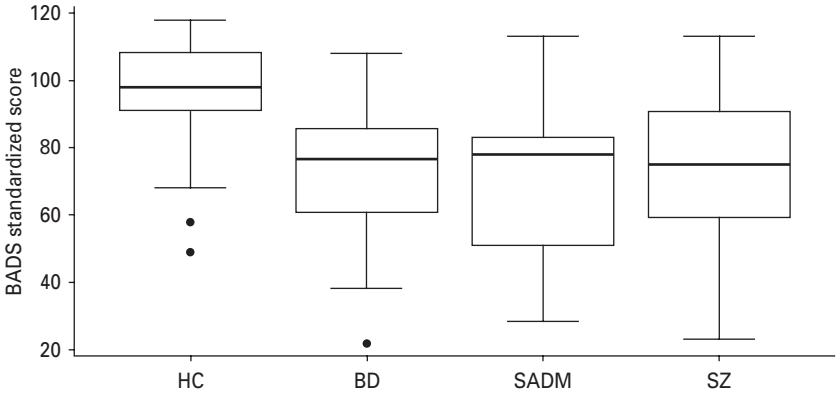

Fig. 2. Differences in Behavioral Assessment of the Dysexecutive Syndrome (BADS) standardized profile scores of patient groups and healthy controls (HC). BD, Bipolar disorder; SADM, schizoaffective disorder, mania; SZ, schizophrenia. •, Represents individual outliers.

schizophrenic patients on the Action Programme Test, and better than the bipolar patients on the Key Search Test.

Subanalysis of bipolar non-psychotic versus psychotic patients

There were 22 manic patients with psychotic symptoms and 29 without psychotic symptoms, as defined on the basis of PANSS psychotic symptom scores (see Method). The two groups did not differ statistically significantly in sex, age or TAP-estimated IQ (with psychotic symptoms 10 men/12 women, without psychotic symptoms 15 men/14 women, $\chi^2 = 0.2$, $p = 0.66$): age with psychotic symptoms 40.38 (S.D. = 10.94) years, without psychotic symptoms 41.63 (S.D. = 12.06) years ($t = 0.38$, $p = 0.70$); TAP IQ with psychotic symptoms 99.27 (S.D. = 8.47), without psychotic symptoms 102.78 (S.D. = 7.87; $t = 1.49$, $p = 0.14$).

No significant differences were found between the two groups on either of the two global neuropsychological measures (WMS composite score 28.09 *v.* 30.66, $t = 1.38$, $p = 0.17$; BADS profile score 69.41 *v.* 76.52, $t = 1.33$, $p = 0.19$). There were also no differences in any subtest scores (data not shown).

Association of demographic and clinical status variables with neuropsychological performance

Backward linear regression models for WMS composite and BADS standardized profile scores were fitted for each of the clinical groups using the following variables: age, gender, duration of illness, YMRS score and PANSS-P, PANSS-N and PANSS-GP scores. In the bipolar group, the WMS composite score was not predicted by any of the independent variables. However, age and PANSS-P scores were predictive of better BADS standardized profile scores in this group ($F_{2,44} = 7.78$, $p < 0.001$, adjusted $R^2 = 0.23$), with younger patients and those with lower PANSS-P scores performing better.

In the schizoaffective group, WMS composite score was predicted by PANSS-N and PANSS-P scores ($F_{2,21} = 6.42$, $p = 0.007$, adjusted $R^2 = 0.32$). Performance on the BADS was predicted by gender and YMRS score at trend level ($F_{2,21} = 2.73$, $p = 0.09$, adjusted $R^2 = 0.13$), with men and those with a lower YMRS score performing better.

In the schizophrenic group, WMS composite score was predicted by PANSS-P and PANSS-N symptom scores ($F_{2,39} = 6.03$, $p = 0.005$, adjusted $R^2 = 0.20$). With respect to executive functioning, duration of illness was found to be the only significant predictor ($F_{1,40} = 7.12$, $p = 0.011$, adjusted $R^2 = 0.13$).

Discussion

This study found little evidence of differences in memory and executive function among acutely ill patients with schizophrenia, schizoaffective disorder and bipolar disorder. Out of 10 tests, there was only one significant difference: the schizoaffective patients and the bipolar patients performed better than the schizophrenic patients on the Action Programme Test of the BADS, which tests problem-solving skills. These findings do not support the proposal that schizoaffective disorder resembles schizophrenia, but is distinct from affective disorder, at the cognitive level. Nor do they support a continuum of increasing cognitive impairment from bipolar disorder through schizoaffective disorder to schizophrenia. The failure to find differences among the three patient groups did not seem to be attributable to the presence of psychotic symptoms in bipolar patients because bipolar patients

with and without such symptoms showed a similar level of cognitive performance.

With respect to the comparison between schizophrenia and schizoaffective disorder, our findings differ from those of Bora *et al*.'s (2009) meta-analysis, which found less cognitive impairment in schizoaffective disorder in five out of six domains of function. Two factors may be relevant here. First, the effect sizes that Bora *et al*. (2009) reported were all in the small range. Second, Bora *et al*. (2009) also found that the presence of negative symptoms significantly moderated differences in memory, executive function and processing speed (at least in the meta-analysis of schizophrenia *versus* schizoaffective disorder plus psychotic affective disorder, they did not examine schizoaffective disorder and bipolar disorder separately). If negative symptoms are more severe in schizophrenia than in schizoaffective disorder, and it seems plausible to assume that they are, this by itself might account for the appearance of differences when a large pooled sample of patients with the two disorders is considered.

Our failure to find support for an intuitive alternative hypothesis, that cognitive impairment increases from bipolar disorder to schizoaffective disorder to schizophrenia, also seems surprising. Nevertheless, it is in line with the results of four other studies that have compared cognitive function across all three disorders, none of which found clear evidence for a continuum of impairment. Thus, Evans *et al*. (1999) found that overall performance on a neuropsychological test battery did not differ between 154 schizophrenic patients and 29 schizoaffective patients, but both groups were more impaired than 27 patients with non-psychotic mood disorder. Glahn *et al*. (2006) compared performance on three working memory tests in 15 schizophrenic patients, 15 with schizoaffective disorder, and 11 and 15 with psychotic and non-psychotic forms of bipolar disorder respectively. A stepwise pattern of impairment was evident in only one test, forward digit span, and even here the differences among the groups did not always reach significance. Szoke *et al*. (2008) compared 48 patients with schizophrenia, 26 with schizoaffective disorder, 52 with psychotic bipolar disorder and 40 with non-psychotic bipolar disorder. They found evidence for progressively less impairment on one measure, number of perseverative errors on the WCST, but not on the other test used, the TMT. Finally, Verdoux & Liraud (2000) compared 20 patients with schizophrenia, 29 with other psychotic disorders (including schizoaffective disorder), 33 with bipolar disorder and 19 with major depression. The patient groups did not differ in performance on two executive tests, the WCST and the Stroop. Nor were there any differences among the groups on most of the seven subtests of a memory battery; when differences were found, these were only between the schizophrenic patients and those with major depression.

Perhaps most surprising of all, our findings run counter to the prevailing view that cognitive impairment in major affective disorder is less marked than in schizophrenia. This view is exemplified by Buchanan *et al*. (2005), who compared meta-analyses of neuropsychological studies in schizophrenia, bipolar disorder and major depression and concluded that they differed in the severity, and perhaps also the pattern, of impairment. Studies that have directly compared schizophrenia and major affective disorder paint a rather different picture, however. Daban *et al*. (2006) reviewed 38 studies comparing neuropsychological test performance in groups of schizophrenic and bipolar patients (some of which also included a proportion of unipolar depressed patients) and noted that findings of no difference were approximately as frequent as those of significant difference. This pattern held true across several domains of cognitive function, including sustained attention, executive function and memory. The only exception was in studies of IQ, where seven out of eight studies found that schizophrenic patients had a significantly lower WAIS IQ than bipolar patients.

It is possible that the mixed findings of the studies in Daban *et al*.'s (2006) review may be related to this last finding. Thus, it is well established that patients with schizophrenia have a lower pre-morbid IQ than the population as a whole (Welham *et al*. 2009; Palmer *et al*. 2009). By contrast, studies of bipolar patients have found either no pre-morbid IQ disadvantage (Gilvarry *et al*. 2000; Zammit *et al*. 2004) or only a small decrement (Reichenberg *et al*. 2002). Because performance on all specific cognitive tests is by definition correlated with IQ, if pre-morbid IQ is not matched across the schizophrenic and affective samples, differences in test performance simply due to this factor are likely to be found.

As noted in the Introduction, another factor that needs to be taken into account when comparing cognitive function between schizophrenic and bipolar patients is phase of illness. If cognitive impairment is stable despite fluctuations in clinical state in schizophrenia, but improves with remission in bipolar disorder, differences between the two will be inflated if the bipolar patients are examined in remission. Our study, which tested all patient groups when they were acutely ill, suggests that this factor may be important. Additionally, the view that cognitive function fluctuates with clinical status in bipolar disorder may not be as robust as commonly thought. Thus, effect sizes for cognitive impairment in euthymia have been

found to be in the medium or large range in several areas of cognitive function, including particularly executive function and memory (Robinson *et al*. 2006). Furthermore, in one of the very few studies that directly compared groups of depressed, manic and euthymic bipolar patients, Martínez-Arán *et al*. (2004) found that significant differences were scarce, and there were no instances where the euthymic patients' performance clearly separated from that of the manic or depressed patients.

In summary, our findings support conclusions reached in imaging studies by Malhi *et al*. (2008) and genetic studies by Craddock *et al*. (2005) and Fallin *et al*. (2005) that the diagnostic categories of schizophrenia, schizoaffective disorder and bipolar disorder are not clearly demarcated by neurobiological findings. This could be considered in line with the current 'deconstruction' of the concepts of bipolar disorder, schizoaffective disorder and schizophrenia at the clinical level, which suggests that many of the differences between them may be better construed as dimensional in nature (Vieta & Phillips, 2007). Among the limitations of the study, one is that larger group sizes might have demonstrated more significant differences, especially on the subtests of the BADS. Additionally, we only studied bipolar I patients and no generalization can be made regarding bipolar II patients or patients within the so-called bipolar spectrum. Furthermore, the study was carried out on patients who were receiving treatment, and for obvious reasons this differed across the different groups. Finally, our findings cannot be generalized to schizoaffective disorder, depressive type.

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Declaration of Interest

None.

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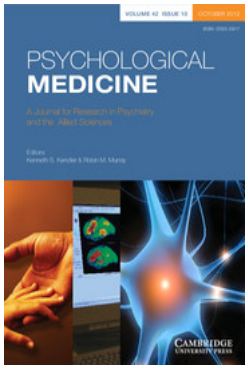

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The spelling of one author's name in this paper is incorrect for which the authors apologize.

For J. M. Giokolea please read: **J. M. Goikolea**

Reference

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