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Metacognitive knowledge and experience in recently diagnosed patients with bipolar disorder

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ABSTRACT

Introduction. Metacognition, which refers to an individual's ability to assess their own cognitive ability or performance, is poorly understood in bipolar disorder. This study was conducted to evaluate two aspects of metacognitive ability in recently diagnosed patients with bipolar disorder: (a) metacognitive knowledge, pertaining to awareness of one's own general cognitive functioning; and (b) metacognitive experience, referring to awareness of one's cognitive performance on a specific, online cognitive task. *Method*. Participants consisted of 50 clinically euthymic patients recently diagnosed with *Diagnostic and Statistical Manual of Mental Disorders–Fourth Edition* (DSM–IV) bipolar I disorder who were within three months of resolution of their first manic episode, and a comparison group of 38 demographically similar healthy volunteers. To assess metacognitive knowledge, participants provided a general rating of their estimated cognitive ability prior to completing a neuropsychological battery, and self-ratings were compared to actual ability based on a composite score of overall cognitive functioning. To assess metacognitive experience, subjects provided a postdiction rating of their perceived memory performance after completing a list learning verbal memory test, and self-ratings were compared to actual memory performance. Measures of both relative and absolute accuracy of ratings were obtained. *Results*. Results indicated that patients showed diminished accuracy in rating their general cognitive ability, implying deficits in metacognitive knowledge. In contrast, patients were accurate in rating their online memory performance, suggesting intact metacognitive experience. *Conclusions*. Findings suggest that in patients with bipolar disorder, intact task-specific cognitive self-appraisals may fail to generalize to or to modify inaccurate global cognitive self-appraisals. Further research using more comprehensive metacognitive tasks is warranted in bipolar disorder.

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Metacognition refers to the study of one's self-cognitive processes, or to knowing about knowing (Koriat, 2007; Metcalfe & Shimamura, 1994). This broad term initially emerged from the tradition of experimental psychology and referred to "the study of one's knowledge concerning one's own cognitive processes or anything related to them" (Flavell, 1976). In contemporary neuropsychology, metacognitive research frequently focuses on an individual's self-assessment of their own cognitive skills or performance. From an alternative perspective, the term "metacognition" has also been used in psychopathology research to describe how individuals understand their experience with mental illness, and their representations of their own and others' mental states, such that in this field metacognition is considered rather to mean "thinking about thinking" (Lysaker & Dimaggio, 2014). Although this alternative perspective represents an important and fruitful area of research with its own methodology (Semerari et al., 2012) and findings in bipolar disorder (Tas, Brown, Aydemir, Brüne, & Lysaker, 2014), it is not the topic of the present report, as our use of the term

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"metacognition" aligns with the more traditional study of an individual's assessment of their own cognitive ability or performance.

Awareness of cognitive function can occur at multiple levels (Stuss, Picton, & Alexander, 2001). Two key components of metacognition that have been identified include metacognitive knowledge and metacognitive experience (Flavell, 1979; Perfect & Schwartz, 2002). Metacognitive knowledge refers to the beliefs that an individual has about their own cognitive functioning and cognitive functioning in general. The typical way of assessing metacognitive knowledge is through evaluation of a person's perceived cognitive skills or problems, often through the use of general ratings or self-report questionnaires (Bacon, Huet, & Danion, 2011; Dixon, Hultsch, & Hertzog, 1988; Goverover, Genova, Griswold, Chiaravalloti, & DeLuca, 2014). In contrast, metacognitive experience is more tied to a person's ability to monitor their ongoing or online cognitive performance on a specific task. Measurement of metacognitive experience thus involves assessment of a person's perceived performance on a specific task (Chiou, Carlson, Arnett, Cosentino, & Hillary, 2011; Chiou & Hillary, 2012).

Investigation of metacognitive problems in clinical populations is important because poor awareness of cognition can disrupt daily functioning (Al-Aloucy et al., 2011; Kervick & Kaemingk, 2005; Koren, Seidman, Goldsmith, & Harvey, 2006). Individuals who tend to overestimate their cognitive ability or who show poor awareness of limitations may be more likely to engage in behaviors that lead to failure, result in negative consequences, or that compromise safety. These outcomes may in turn contribute to diminished self-esteem or increased affective symptomatology. On the other hand, persons who underestimate their cognitive ability may avoid engaging in behaviors or tasks that have potentially successful or rewarding outcomes, and which could have a positive impact on well-being (Clare, Whitaker, & Nelis, 2010). Recognition of the functional implications of poor awareness has thus helped fuel metacognitive research in neurological and neurodegenerative disorders (Clare et al., 2010; Ecklund-Johnson & Torres, 2005; Pannu & Kaszniak, 2005; Souchay, 2007), and to a lesser extent in psychiatric disorders (David, Bedford, Wiffen, & Gilleen, 2012; Koren et al., 2006). To date, most of the psychiatric research on metacognition has been conducted in patients with schizophrenia. This is not surprising, as patients with the illness exhibit clear disruptions in insight into their illness/symptoms (Amador et al., 1994), and therefore metacognitive impairments are highly implicated. Prior research shows that patients with schizophrenia indeed display some abnormalities in both metacognitive knowledge and experience (Cella, Swan, Medin, Reeder, & Wykes, 2014; Danion, Gokalsing, Robert, Massin-Krauss, & Bacon, 2001; Medalia & Thysen, 2008; Moritz & Woodward, 2006).

In contrast, very little metacognitive research has been conducted in bipolar disorder, despite the fact that poor awareness of cognition is highly implicated in the disorder for multiple reasons. First, parallels in the genetic, biological, and clinical characteristics of patients with schizophrenia and bipolar disorder are recognized (Craddock, O'Donovan, & Owen, 2006; Murray et al., 2004), and the similarities between the two disorders extend into the neuropsychological domain. Although cognitive deficits are more severe in schizophrenia, the relative profile of deficits is comparable in both disorders (Krabbendam, Arts, van Os, & Aleman, 2005; Stefanopoulou et al., 2009; Yatham et al., 2010). Moreover, as in schizophrenia, it is now established that patients with bipolar disorder show prominent impairments in clinical insight into their illness and symptoms (Amador et al., 1994; Varga, Magnusson, Flekkoy, Ronneberg, & Opjordsmoen, 2006). Although impaired insight is heightened during mood episodes (de Assis da Silva et al., 2015; Ghaemi & Rosenquist, 2004), it is also highly prevalent in remitted patients (Dias, Brissos, & Carita, 2008; Varga et al., 2006; Yen, Chung, & Chen, 2002). Given that insight into illness is a construct that involves an element of self-awareness, it suggests that metacognitive deficits, which also involve self-awareness, are also likely present.

To date, only a few studies have evaluated awareness of cognitive functioning in bipolar disorder. These studies have generally investigated the relationship between patient self-ratings on questionnaires of cognitive symptoms experienced in daily life and objective neuropsychological test performance. Because patients provide general ratings of their perceived ability rather than ratings of their perceived performance on a specific task, these studies can be considered to preferentially assess metacognitive knowledge rather than experience. These

studies uniformly report weak to absent correlations between cognitive symptom ratings and cognitive test performance in both patients with euthymia (Aydemir & Kaya, 2009; Rosa et al., 2013) and those with mood symptoms (Burdick, Endick, & Goldberg, 2005; Martinez-Aran et al., 2005; Svendsen, Kessing, Munkholm, Vinberg, & Miskowiak, 2012). Moreover, even though subjective cognitive ratings can correlate with depressive symptoms (Miskowiak, Vinberg, Christensen, & Kessing, 2012), the lack of association between subjective complaints and objective performance occurs irrespective of depression (Van der Werf-Eldering et al., 2011). In sum, the finding that patient self-reports of cognitive functioning correspond poorly to actual cognitive functioning supports the hypothesis of diminished metacognitive knowledge in bipolar disorder. However, the question of whether patients tend to over- or underestimate their ability or performance has typically not been addressed, as correlations between ratings and performance only provide information about relative accuracy of ratings, rather than absolute accuracy of ratings.

In contrast to metacognitive knowledge, there have been no investigations of metacognitive experience in bipolar disorder. Therefore, further understanding of metacognitive experience is necessary to better characterize metacognitive problems associated with the illness, to provide potential insights into clinical/functional limitations, and to develop future interventions for identified problems. For example, if patients show poor metacognitive knowledge, therapies could be aimed at improving more global self-concepts about cognitive functioning. On the other hand, evidence of poor metacognitive experience could direct treatment toward helping patients evaluate immediate, online task performance and improving their task-related self-assessments. Additionally, if difficulties in either metacognitive knowledge or experience exist, it would be important to know whether patients systematically over- or underestimate their performance, as this could further guide rehabilitative strategies.

The purpose of the present study was to investigate both metacognitive knowledge and metacognitive experience in a sample of patients with bipolar disorder compared to healthy volunteers. Additionally, if metacognitive difficulties are present in patients, we also sought to determine whether patients systematically over- or underestimate their cognitive ability. Unlike prior studies, we investigated these phenomena in a clinically euthymic post first-manic-episode patient sample in order to minimize the potential influence of acute mood symptoms and to determine whether metacognitive problems are present early in the course of illness. Based on existing evidence of metacognitive knowledge difficulties in more established patients with bipolar disorder, we hypothesized that such problems would also be present in early course patients, indicating this might be a core or stable feature of the illness. An absence of such difficulties early in the illness, however, would suggest that these problems might develop as the illness progresses. Although previously unstudied, we also hypothesized that patients would show deficits in metacognitive experience, similar to what has been observed in schizophrenia.

Method

Participants

The participants in the present study were drawn from the Systematic Treatment Optimization Program in Early Mania (STOP-EM) Program at the University of British Columbia, which represents a longitudinal study investigating clinical, neurobiological, and neuropsychological functioning in recently diagnosed patients with bipolar disorder (Torres et al., 2011; Torres et al., 2010; Yatham, Kauer-Sant'Anna, Bond, Lam, & Torres, 2009). Participants in the program were recruited from local hospitals and clinics and were required to meet the following criteria: (a) met *Diagnostic and Statistical Manual of Mental Disorders–Fourth Edition (DSM–IV*; American Psychiatric Association, 1994) criteria for bipolar I disorder, (b) experienced resolution of their first manic (or mixed) episode within the previous 3 months, (c) were clinically stable, and (d) had no major neurological or medical illness underlying symptoms of mania. In order to capture a sample that was representative of patients treated in a hospital setting, comorbidity such as history of substance use as well as history of psychosis was allowed. From an initial pool of 75 patients participating in the program, patients in the current study were further required to be (a) aged 17 or older, (b) fluent in English, and (c) clinically euthymic, defined as a 29-item Hamilton Depression Rating Score (HAMD-29; Hamilton, 1960) <12 and a Young Mania Rating Scale (YMRS; Young, Biggs, Ziegler, & Meyer, 1978) <8, yielding a sample of 52 patients. A final two patients were excluded due to strong evidence of insufficient effort as evidenced by both their clinical presentation during testing and their severity and inconsistent pattern of

performance, yielding a final sample of 50 patients. At the beginning of the study, patients were given a comprehensive clinical assessment that included symptom ratings, structured clinical interview, and other clinical measures according to a standardized protocol. All patients were diagnosed by trained psychiatrists using the Mini-International Neuropsychiatric Interview (MINI; Sheehan et al., 1998), and patients were treated individually based on clinically accepted standards (Yatham, Kennedy, et al., 2009).

A comparison group of healthy volunteers was also recruited from the community through online and other community postings. Control subjects were required to meet the following criteria: (a) age at least 17, (b) fluent in English, (c) no history of serious neurological disorder or brain injury, (d) no personal history of psychiatric disorder, and (e) no history of psychiatric disorder in first-degree relatives. Control subjects were screened using the MINI for presence of psychiatric disorders. Ethics approval was obtained from the University Clinical Research Ethics Board, and all subjects provided written informed consent prior to participation.

Measures

General cognitive performance

As previously described (Torres et al., 2011; Torres et al., 2010), participants completed a 2.5-hour neuropsychological battery consisting of the following tests: North American Adult Reading Test (Blair & Spreen, 1989); Kaufman Brief Intelligence Test (Kaufman & Kaufman, 1990); Trailmaking Test (Reitan & Wolfson, 1993); Stroop Test (Golden, 1978); Controlled Oral Word Association Test (Lezak, Howieson, & Loring, 2004); Benton Judgment of Line Orientation (JLO; Benton, Sivan, des Hamsher, Varney, & Spreen, 1994); Wechsler Memory Scale 3rd Edition Letter/Number Sequencing (Wechsler, 1997); California Verbal Learning Test 2nd Edition (CVLT–II; Delis, Kramer, Kaplan, & Ober, 2000); and Cambridge Neuropsychological Test Automated Battery (CANTAB; Robbins et al., 1994) Rapid Visual Information Processing (RVIP), Intra Extra Dimensional Set Shifting (IED), Stockings of Cambridge (SOC), Spatial Recognition Memory (SRM), Pattern Recognition Memory (PRM), and Paired Associate Learning (PAL) subtests.

From the tests within the neuropsychological battery, a large subset of measures was selected in order to create a composite score representing a person's overall cognitive functioning. The measures chosen for this purpose were selected a priori on the basis that at face validity they were judged to assess "general cognitive functioning," which was defined as an individual's "concentration, memory, and problem solving" as stated in the general global rating (see section below). The final subset of 10 measures that were judged to best assess "concentration, memory, and problem solving" were: Trailmaking Test A time; CVLT–II Trial 1 recall; CANTAB RVIP discriminability score; Letter/Number Sequencing; CANTAB IED number of extradimensional shifting errors; CANTAB SOC problems solved in the minimum number of moves; CVLT–II delayed free recall; CANTAB SRM percentage correct; CANTAB PRM percentage correct; and CANTAB PAL total errors adjusted score. For these 10 measures, demographics-corrected *z*-score obtained from test manuals were averaged to calculate a composite cognitive score, which was subsequently used for comparison to the person's general global rating (see below).

Memory performance

Based on CVLT–II performance, demographics-corrected *z*-score for Recall Trials 1 through 5 recall, long delay free recall, and long delay recognition were averaged to create a memory composite score that reflected overall memory performance. This measure was used for comparison to the person's postdiction memory rating (see below).

Metacognitive measures

Two global ratings, two signed difference scores, and two unsigned difference scores (one each for metacognitive knowledge and metacognitive experience) served as the primary metacognitive measures evaluated in this study and are described further below:

Metacognitive knowledge

Global metacognitive knowledge general rating (GR). At the beginning of the testing session, subjects were asked to rate their perceived general cognitive functioning before completing any cognitive task with the following question: "Compared to healthy people my age, I believe that my cognitive skills (concentration, memory, problem solving) are. . . . " Subjects answered the question using a Likert scale as follows: (–3) *profoundly below average*, (–2) *well below average*, (–1) *below average*, (0) *average*, (+1) *above average*,

(+2) *well above average*, and (+3) *superior*. The Likert rating was purposely scaled to correspond with the *z*-score values of the cognitive composite score described earlier. For example, a Likert rating scale score of –1 indicated that the subject rated their ability to be below average relative to same-age peers. Similarly, a *z*-score of –1 on the cognitive composite indicated low average cognitive ability relative to same-age peers. This parallel scaling allowed for the comparison of ratings to performance through the generation of difference scores. This methodology has been employed in prior metacognitive studies (Graham, Kunik, Doody, & Snow, 2005; Larrabee, West, & Crook, 1991; Schoo, van Zandvoortab, Biesselsb, Kappelleb, & Postmaab, 2013) and is further described below.

Signed difference score for GR. Although the GR assesses a person's perceived ability, it does so without regard to the person's actual ability/performance. The purpose of utilizing difference scores is to assess self-estimates in reference to actual ability, as this provides a measure of the absolute accuracy of self-reports. For each subject, a signed difference score was calculated by subtracting the subject's composite cognitive score from their GR (GR – cognitive composite score). For this difference score, a value of zero theoretically represents a perfectly accurate estimate of cognitive ability, as in this situation there is no discrepancy between the self-rating of ability and actual ability. However, increasingly positive difference scores represent a greater level of overestimation of one's own ability, whereas negative scores reflect underestimation of one's ability.

Unsigned difference score for GR. An unsigned difference score was generated by calculating the absolute value of the GR signed difference score. This score provides an index of the degree of discrepancy between a subject's self-estimated ability and their actual ability, regardless of whether the individual is over- or underestimating. Unsigned difference scores provide a purer measure of the accuracy of a person's self-rating by quantifying the relative divergence from "perfect" self-estimation (Devolder, Brigham, & Pressley, 1990; Hertzog, Saylor, Fleece, & Dixon, 1994). Thus, a score of zero represents an accurate self-rating, and increasing scores reflect increasingly inaccurate ratings.

Metacognitive experience

Global metacognitive experience postdiction rating (PR). After completing the CVLT–II, subjects provided a postdiction rating of their perceived memory performance (using the same Likert scale as that described above) with the following question: "Compared to healthy people my age, my ability to remember words on this previous memory test was. . . . " In order to maintain consistency with the general rating (metacognitive knowledge) task described above, we labelled our postdiction rating task with the more general term "metacognitive experience." However, it should be noted that the postdiction task can also, more specifically, be referred to as a metamemory task given the requirement to rate memory performance.

Signed difference score for PR. Signed difference scores for postdiction ratings were calculated by subtracting each subject's memory composite score from their PR (PR – memory composite score). Increasingly positive scores reflected overestimation of one's own ability, and negative scores reflected underestimation.

Unsigned difference score for PR. The absolute value of the PR signed difference score was calculated to provide a measure of accuracy regardless of over- or underestimation.

Statistical analysis

Statistical analyses were conducted using SPSS 19.0 (SPSS Inc., Chicago, IL). Distributions of cognitive composite, memory composite, and metacognitive scores were examined through statistical and visual graphic inspection. Patient–control differences in demographic variables were assessed using *t* tests or chi-square statistics as appropriate. The first strategy for evaluating metacognitive differences between patients and controls involved subjecting scores to a mixed analysis of variance (ANOVA) with group (patient vs. control) as a between-subjects factor, and score type (self-rating vs. composite score) and domain [general cognitive functioning (metacognitive knowledge) vs. memory functioning (metacognitive experience)] as within-subject factors. Because testing of the primary hypotheses concerned evaluation of group differences in the discrepancy between self-ratings and objective test performance (i.e., metacognition), we focused on the group by score type interaction and the group by score type by domain interactions from the ANOVA. To further evaluate

potential metacognitive differences between groups, *t* tests were used to assess patient–control differences in GR, PR, and all difference scores. Patient–control differences in the proportion of accurate, overestimating, and underestimating individuals on both metacognitive tasks were evaluated using chi-square. Pearson correlations were used to evaluate the association between GR and the cognitive composite score, and between PR and the memory composite score, within patients and controls. Pearson correlations were also used to assess test–retest reliabilities.

The association between metacognitive variables and several key clinical variables was also explored, and selection of these clinical variables was based on the finding that neuropsychological deficits can be associated with mood symptoms, illness course variables such as duration of illness, and medication effects (Robinson & Ferrier, 2006; Torres & Malhi, 2010). Because these variables have shown the potential to associate with cognitive ability in the illness, we elected to determine whether they might also associate with metacognitive ability. Pearson correlations were used to evaluate the relationship between metacognitive measures and these clinical variables. Because multiple comparisons were involved in these latter analyses, a Bonferroni adjustment was applied to the alpha level for these correlations.

Results

Demographic and clinical variables

Demographics and clinical characteristics are summarized in Table 1 for patients and controls. Table 1 shows that there were no significant differences between patients and controls on major demographics including age, education, premorbid IQ, and sex.

Not surprisingly, there was a higher proportion of patients who were currently unemployed or on a leave of absence ($\chi^2 = 18.1$, $p < .01$).

Test–retest reliability

Test–retest reliabilities for the primary measures were calculated on a subset of the healthy controls who were reevaluated after 6-months (n= 33). For the second assessment, the same tests were repeated, and alternate forms were used if available (CVLT–II and CANTAB measures). Overall, reliabilities for the metacognitive knowledge measures tended to be somewhat higher than those for the metacognitive experience measures. Specifically, the reliabilities for the GR, GR signed difference score, and GR unsigned difference score were r = .79, r = .73, and r = .69, respectively. In contrast, the reliabilities for the metacognitive experience measures tended to be somewhat lower, ranging from r = .55 for the PR to r = .59 for the PR signed difference score. The exception was the PR unsigned difference score, which had a test–retest correlation of r = –.02. The reliabilities for the composite cognitive score (r = .74) and memory score (r = .62) were generally within the same range as the majority of the metacognitive measures.

Self-rating versus composite score discrepancies across groups

General cognitive and memory composite scores as well as all metacognitive scores for patients and controls, along with associated patient–control effect sizes, are presented in Table 2.

The group (patient vs. control) by score type (self-rating vs. composite score) by domain (general cognitive function vs. memory) ANOVA failed to reveal a significant Group × Score Type interaction (Λ = .99), $F(1, 85) = 1.19$, p = .28, or a Group × Score Type × Domain interaction (Λ = 1.0), $F(1, 85) = 0.10$, p = .75.

General cognitive and memory performance

Table 2 reveals that, as expected, patients showed poorer general cognitive functioning, $t(83.196) = -4.22$, $p < .001$, as well as poorer memory performance, $t(86) = -3.60$, p = .001, than healthy controls.

Metacognitive knowledge measures

Figure 1 (Panel A) shows the distribution of GRs for patients and controls.

Additionally, mean metacognitive knowledge scores (GR, GR signed difference score, GR unsigned difference score) are summarized in Table 2. There was a trend toward lower GRs in patients than in controls, $t(86) = -1.73$, p = .09, consistent with the finding that patients showed poorer overall cognitive ability than controls. Regarding accuracy, patients showed comparable signed GR difference scores compared to controls, $t(86) = 0.76$, p = .45, consistent

Table 1. Demographic and illness characteristics of the sample.

		Patients (n = 50)				Controls (n = 38)						
Variable		*M*	*SD*	*N*	%	*M*	*SD*	*N*	%	*t*	X^2	*p*
Continuous												
	Age, years	22.7	4.4			23.6	5.3			−0.90		.37
	Education, years	13.8	2.4			14.5	2.1			−1.36		.18
	Premorbid IQ	106.2	7.7			107.6	6.7			−0.93		.36
	IQ	105.1[a]	8.8			108.5	9.5			−1.73		.09
	GAF	68.6	14.1			—	—			—		—
	Age at depression onset, years	18.7	5.1			—	—			—		—
	Length of illness, years	1.96	2.75			—	—			—		—
	YMRS (<8)	0.7	1.3			—	—			—		—
	HAMD-29 (<12)	3.2	3.4			—	—			—		—
Categorical												
	Gender										0.24	.62
	Female			25	50			21	55			
	Ethnicity										0.39	.53
	Caucasian			36	72			25	66			
	Non-Caucasian			14	28			13	34			
	Primary language										0.26	.61
	English			44	88			32	84			
	Other			6	12			6	16			
	Employment status										18.06	.001
	Student			20	40			25	66			
	Employed			8	16			11	29			
	Unemployed			11	22			1	3			
	Disability			1	2			1	3			
	Leave of absence			10	20			0	0			
	Medications											
	Mood stabilizers			44	88	—	—					
	Lithium			23	46	—	—					
	Valproate			22	44	—	—					
	Antipsychotics			39	78	—	—					
	Antidepressants			1	2	—	—					
	History of substance use			18	39[b]	—	—					
	History of previous depression			18	39[b]	—	—					
	History of psychosis			41	87[c]	—	—					

Note. Premorbid IQ = North American Adult Reading Test (Blair & Spreen, 1989); IQ = Kaufman Brief Intelligence Test (Kaufman & Kaufman, 1990); GAF = Global Assessment of Functioning scale; length of illness = age of onset of mania minus age of onset of initial depression in years; YMRS = Young Mania Rating Scale; HAMD-29 = Hamilton Depression Rating Scale.
[a]Based on n= 49. [b]Based on n= 46. [c]Based on n= 47.

Table 2. Descriptive statistics of cognitive, memory, and metacognitive scores.

	Patients (n = 50)		Controls (n = 38)				
Cognitive measure	*M*	*SD*	*M*	*SD*	*t*	*p*	Cohen's *d*
General cognitive composite score	−0.17	0.63	0.29	0.39	−4.22	.00	0.88
Memory composite score	−0.13	0.93	0.55	0.79	−3.60	.00	0.79
Metacognitive knowledge							
General rating	0.58	0.88	0.89	0.80	−1.73	.09	0.37
SDS	0.75	1.02	0.60	0.75	0.76	.45	−0.17
UDS	1.02	0.75	0.71	0.64	1.98	.05	−0.44
Metacognitive experience							
Postdiction rating	−0.04[a]	0.80	0.39	0.79	−2.51	.01	0.54
SDS	0.06[a]	1.01	−0.15	0.84	1.06	.29	−0.23
UDS	0.81[a]	0.59	0.73	0.42	0.69	.49	−0.16

Note. General cognitive composite score = composite score of selected neuropsychological tests; memory composite score = California Verbal Learning Test–II composite score; SDS= signed difference score; UDS= unsigned difference score. Cohen's d = patient versus control effect size.
[a]Based on n= 49.

with the ANOVA results reported above. However, patients showed higher GR unsigned scores than healthy controls, $t(86) = 1.98$, $p = .05$. This pattern indicates that although patients showed less accurate ratings, the inaccuracy was not due to systematic over- or underestimation.

To further reveal the nature of the inaccuracy in patient ratings, we arbitrarily classified subjects into underconfident (GR difference score below −.5), accurate (GR difference score between −.5 and .5), and overconfident (GR difference score above .5) groups and then evaluated whether the proportion

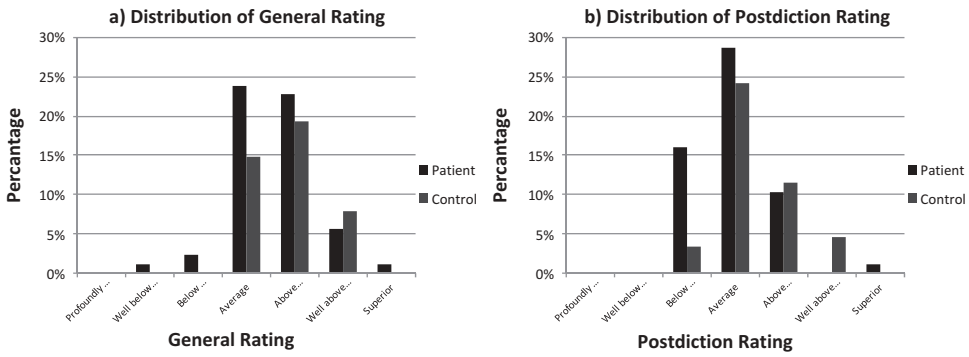

Figure 1. Distribution of general and postdiction raw ratings.

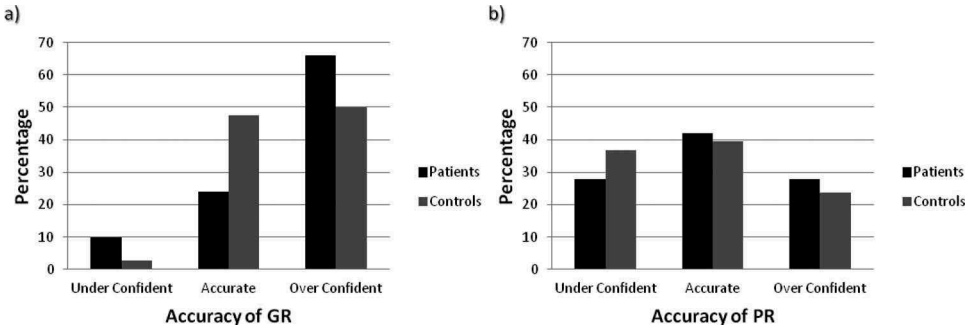

Figure 2. Accuracy of general ratings (GR) and postdiction ratings (PR).

of individuals falling within these classifications differed between patient and control groups. Results revealed a significant difference in the proportion of individuals in each of these three categories (χ^2 = 6.11, $p < .05$). Specifically, Figure 2 (Panel A) shows that there was a smaller proportion of patients in the "accurate" group, but a larger proportion of patients in the underconfident and overconfident groups.

Metacognitive experience measures

Figure 1 (Panel B) shows the distribution of PRs for patients and controls, and mean metacognitive experience scores (PR, PR difference scores, PR unsigned difference scores) are presented in Table 2. PR ratings were significantly lower in patients than in controls, t (85) = –2.51, p = .01, consistent with the poorer memory performance in patients. However, there was no significant difference between patient and controls on either the PR signed difference scores, t (85) = 1.06, p = .29, or the PR unsigned difference scores, t(85) = 0.69, p = .49. Similarly, when subjects were classified into underconfident, accurate, and overconfident groups (Figure 2, Panel B), there was no significant difference in the proportion of patients or controls falling into each of the three categories (χ^2 = 0.71, p = .70).

Relative accuracy of patient and control ratings

In addition to assessing absolute accuracy as above, it is possible to evaluate relative accuracy of ratings at the group level. This was done by assessing the correlation between GR and cognitive ability, and between PR and memory ability, in patients and controls. High correlations between ratings and actual performance measures would indicate high relative metacognitive accuracy within a given group. Results revealed a significant correlation between GR and general cognitive functioning in controls, r =.36,p =.03, n = 38, but not in patients r = .13; p = .37, n = 50. Based on Fisher's z, the difference between the correlation coefficients above did not reach statistical significance, z= 1.1, p = .14 (one-tailed). For postdiction ratings, there was a significant correlation between PR and memory functioning in both controls, r = .44, p = .006, n= 38, and patients, r = .33, p = .02, n= 49.

Figure 3 reveals the resulting scatterplots.

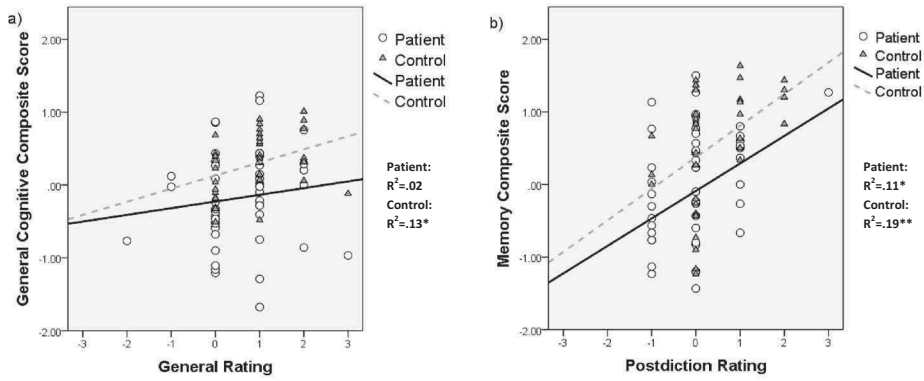

Figure 3. Relationship between performance and general and postdiction ratings. *$p < .05$. **$p < .01$.

Table 3. Correlations between metacognitive and clinical variables.

	Metacognitive knowledge			Metacognitive experience		
	GR	SDS	UDS	PR	SDS	UDS
YMRS	.16	.04	.06	.05	−.09	.18
HAMD-29	−.01	.03	.21	−.11	.09	.17
Illness duration	.06	−.15	−.18	.19	.05	−.09
Lithium	.15	.11	.24	.26	.11	.03
Valproate	.08	.07	−.07	−.40	−.19	−.11
Antipsychotics	−.09	−.03	.00	.28	.30	.02

Note. GR = general rating; SDS= signed difference score; UDS= unsigned difference score; PR = postdiction rating; YMRS = Young Mania Rating Scale; HAMD-29 = Hamilton Depression Rating Scale; length of illness = age of onset of mania minus age of onset of initial depression in years.

Relationship Between metacognitive and clinical variables

Table 3 summarizes the correlation between each of the six metacognitive measures and mood symptom ratings, duration of illness, and medication status.

After applying a Bonferroni correction for multiple comparisons, there was no significant association between metacognition and these clinical variables.

Discussion

The purpose of the present study was to evaluate metacognitive skills in recently diagnosed euthymic patients with bipolar disorder by contrasting single-item global self-ratings with objective neuropsychological functioning. The main finding was that patients showed less accurate ratings of their overall cognitive ability, which suggests difficulties with metacognitive knowledge. In contrast, patients' ability to accurately rate their performance on a specific recent memory task was comparable to that of controls, suggesting relatively intact metacognitive experience.

Poor metacognitive knowledge in patients was demonstrated by reduced absolute and relative accuracy of self-ratings of general cognitive ability. Diminished absolute accuracy of ratings was indicated by a larger discrepancy between general ratings and cognitive ability in patients than in controls. Moreover, evaluation of signed and unsigned difference scores revealed that the discrepancies between ratings and ability did not follow a uniform pattern of either systematic overestimation or underestimation of ability in patients. Rather, the patient group had a higher proportion of both over- and underestimators than did controls. This finding raised the question of whether under- or overestimating status might have reflected the patient's current mood state (e.g., overestimators may have shown more residual manic symptoms, and underestimators more depressed symptoms). However, this is very unlikely because patients were euthymic and showed very low mood symptom levels, and because there was no significant correlation between depression or mania ratings and any of the metacognitive measures. In addition to diminished absolute accuracy, patients as a group also tended to show poorer relative accuracy in rating their general cognitive ability. This was revealed by a significant correlation between general

ratings and cognitive performance in controls, $r = .36$ (consistent with what is typically observed in healthy individuals; Freund & Kasten, 2012), but not in patients ($r = .13$). However, it should be noted that the test of the difference between these correlation coefficients did not quite reach statistical significance ($p = .14$).

The finding of diminished metacognitive knowledge in bipolar disorder is consistent with findings of prior studies that have reported poor correspondence between questionnaire-based self-ratings of general cognitive ability and objective neuropsychological performance (Aydemir & Kaya, 2009; Burdick et al., 2005; Svendsen et al., 2012; Van der Werf-Eldering et al., 2011). The data herein extend those findings by demonstrating that metacognitive knowledge difficulties are (a) present in euthymic patients, (b) evident early in the course of illness, and (c) characterized by both over- and underestimation across patients. Thus, diminished metacognitive knowledge is not likely attributed to illness chronicity or prolonged treatment effects and may represent a more stable feature of the illness. The potential trait-like nature of metacognition is further suggested by the general lack of association between either medication treatments or residual mood symptoms and metacognitive ability, and by previous evidence of the stability of global cognitive self-perceptions (Cruise, Lewis, & McGuckin, 2006).

Despite exhibiting problems with metacognitive knowledge, there was no evidence that patients showed diminished metacognitive experience. Thus, while patient's global self-concepts of general cognitive ability are inaccurate, they exhibit intact relative and absolute accuracy in evaluating their performance on a specific task. It is possible that patients' preserved accuracy in monitoring task performance may have been facilitated by the immediate performance feedback that is available during online tasks (McGlynn & Kaszniak, 1991; Pannu & Kaszniak, 2005). Metacognitive knowledge judgments, however, are not dependent on immediate task feedback, but are rather determined by cumulative past experiences (Toglia & Kirk, 2000) and a host of other factors including personality, interest, and motivation (Ackerman & Wolman, 2007; Freund & Kasten, 2012). Thus, it may be easier for patients to accurately construct task-related performance self-estimates than more abstract global cognitive self-estimates.

These findings highlight the multidimensionality of cognitive self-awareness and the idea that metacognitive knowledge and experience may represent distinct facets of awareness (Goverover et al., 2014; Hoerold, Pender, & Robertson, 2013; O'Keeffe, Dockree, Moloney, Carton, & Robertson, 2007; Toglia & Kirk, 2000). At the same time, these facets of metacognition are interrelated and can influence each other (Dockree, Tarleton, Carton, & Fitzgerald, 2015; Schraw, 1998; Toglia & Kirk, 2000). To the extent that global self-assessments are partly determined by more specific task-related self-assessments (Flavell, 1979; Toglia & Kirk, 2000), one possibility is that patient's (accurate) task-specific self-appraisals fail to generalize to or to modify global cognitive self-appraisals. Stated differently, in healthy individuals, self-appraisals of performance on specific tasks (e.g., "I performed above average on this task") are likely to have some influence on global cognitive self-concepts ("I have above average cognitive skills"). This connection, however, may be disrupted in bipolar disorder, such that local self-appraisals have less impact on more abstract, global self-appraisals. In partial support of this idea, it was observed that the correlation between global and postdiction ratings was $r = .32$ ($p < .02$) in patients, and $r = .50$ ($p < .002$) in controls.

Because self-estimates of cognitive ability can be associated with functional outcomes (Ackerman & Wolman, 2007), intervention efforts aimed at more closely aligning cognitive self-appraisals with actual abilities may be important. One strategy may be to capitalize on patient's accurate task-related self-appraisals. This might be achieved by more closely aligning experiential, task-related self-judgments to more enduring and global self-appraisals. Additionally, given that different patients may either over- or underestimate their general cognitive skills, any effort to remedy these inaccurate self-perceptions should adopt an individual rather than a "one-size fits all" approach. Clearly, these are tentative and preliminary implications of the present findings, which require further exploration and replication.

The present study should be viewed as a starting point in efforts to better understand metacognition in bipolar disorder, and several important caveats and limitations should be noted. First, the metacognitive tasks used in the present study are rather brief measures that involved only a single global self-rating. Inevitably, this compromised our ability to sufficiently or comprehensively assess the multifaceted constructs of metacognitive knowledge and experience. Nevertheless, despite their brevity, the single-item global self-ratings in this and other studies (for review see Freund & Kasten, 2012) show adequate reliability and

were sufficient to detect patient–control differences in the present study. With regard to metacognitive knowledge, our task only broadly assessed accuracy of self-appraisal; however, metacognitive knowledge also encompasses other elements such as general knowledge of how cognition works, knowledge of cognitive demands of a task, knowledge of strategies that could be employed to improve performance and how and when to employ them, ability to evaluate such strategies, and other features (Flavell, 1979). Clearly, future work should be conducted to assess these other components of metacognitive knowledge, which may also be relevant to bipolar disorder.

There are also limitations with the metacognitive experience measure that we employed. In particular, our measure can be appropriately classified as a global rating metacognitive (or in this case metamemory) task, in contrast to existing item-specific measures of metacognition (Pannu & Kaszniak, 2005; Souchay, 2007). In global rating tasks, subjects are required to provide a single global rating of perceived performance on a task, and the rating is compared to actual performance. Several potential disadvantages of these types of tasks include the reliance on a single rating (and thus potential for poorer reliability; Schraw, 2009), the possibility of ceiling, floor, or other psychometric artifacts that may be introduced when using difference scores (Clare et al., 2010; Trosset & Kaszniak, 1996), and the requirement that participants have to calibrate their self-ratings to performances when the basis for such decisions is unclear (Souchay, 2007). To overcome these problems, some investigators have advocated for the use of item-specific metacognitive tasks in which self-ratings of performance are conducted on each item of a multiple-item task, and then associations between item ratings and item performance are determined across all test items. In this way, multiple self-ratings are obtained, thus potentially improving the reliability of measures. Moreover, relative comparisons between self-ratings and performance can be made without the need for calibration, and without the need for generation of difference scores. Although extensive discussion of the pros and cons of the global versus item-specific approaches is beyond the scope of this paper, we believe studies using item-specific tasks will be necessary before clear conclusions can be made about the intactness of metacognitive experience in bipolar disorder. Thus, we cannot rule out the possibility that the negative metacognitive experience findings in this study may have been related to the somewhat lower reliabilities in our metacognitive experience measures (especially unsigned difference score) than in the metacognitive knowledge measures. In ongoing follow-up studies we are incorporating both global and item-specific metacognitive tasks, as the use of multiple metacognitive measures is more likely to capture the multidimensional nature of metacognition (Clare et al., 2010; Cosentino, Metcalfe, Butterfield & Stern, 2007; Gilleen, Greenwood, & David, 2011; Goverover et al., 2014; Howard et al., 2010; Wilbur, Wilk, Silver, & Parente, 2008).

A final limitation has to do with the potential confounds inherent in the tasks we employed. That is, although the two metacognitive ratings differed along the dimension of metacognitive knowledge versus metacognitive experience, they also differed with regard to the type of ability that was being rated (memory vs. general ability) and the number of abilities that were being rated (single vs. multiple abilities). Thus, it is conceivable that the findings may relate to these factors rather than to the metacognitive knowledge versus experience distinction. Although we are unable to address this possibility in the current study, in an ongoing follow-up study to the present report we are collecting multiple metacognitive global ratings in our participants across a wide range of cognitive tests/functions. Specifically, these ratings consist of prediction and postdiction ratings of perceived performance on a given task. Because accurate predictions are thought to preferentially rely on metacognitive knowledge, and accurate postdictions on metacognitive experience (e.g., Banks & Weintraub, 2008; Schoo et al., 2013), we will be able to address the confounds raised above directly. That is, we should be able to disentangle whether there is indeed a metacognitive knowledge deficit in patients because the metacognitive knowledge and metacognitive experience tasks will only differ in this regard.

To summarize, the present study suggests that euthymic patients with bipolar disorder early in the course of illness show diminished metacognitive knowledge but intact metacognitive experience. Future research aimed at further delineating the nature of metacognitive difficulties in bipolar disorder, as well as the clinical implications of these problems, is warranted.

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References

Ackerman, P. L., & Wolman, S. D. (2007). Determinants and validity of self-estimates of abilities and self-concept measures. *Journal of Experimental Psychology. Applied*, *13*(2), 57–78.

Al-Aloucy, M., Cotteret, R., Thomas, P., Volteau, M., Benmaou, I., & Dalla Barba, G. (2011). Unawareness of memory impairment and behavioral abnormalities in patients with Alzheimer's disease: Relation to professional health care burden. *The Journal of Nutrition, Health & Aging*, *15*(5), 356–360.

Amador, X. F., Flaum, M., Andreasen, N., C., Strauss, D. H., Yale, S. A., Clark, S. C., & Gorman, J. M. (1994). Awareness of illness in schizophrenia and schizoaffective and mood disorders. *Archives of General Psychiatry*, *51*(10), 826.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Aydemir, O., & Kaya, E. (2009). What does the subjective assessment of cognitive functioning measure in bipolar disorder? Correlation with the objective assessment of cognitive functioning. *Turkish Journal of Psychiatry*, *20*(4), 332–338.

Bacon, E., Huet, N., & Danion, J. (2011). Metamemory knowledge and beliefs in patients with schizophrenia and how these relate to objective cognitive abilities. *Consciousness and Cognition*, *20*(4), 1315–1326.

Banks, S., & Weintraub, S. (2008). Self-awareness and self-monitoring of cognitive and behavioral deficits in behavioral variant frontotemporal dementia, primary progressive aphasia and probable Alzheimer's disease. *Brain and Cognition*, *67*(1), 58–68. doi:10.1016/j.bandc.2007.11.004

Benton, A. L., Sivan, A. B., des Hamsher, K., Varney, N. R., & Spreen, O. (1994). *Contributions to neuropsychological assessment: A clinical manual* (2nd ed.). New York, NY: Oxford University Press.

Blair, J. R., & Spreen, O. (1989). Predicting premorbid IQ: A revision of the National Adult Reading Test. *Clinical Neuropsychologist*, *3*(2), 129–136. doi:10.1080/13854048908403285

Burdick, K. E., Endick, C. J., & Goldberg, J. F. (2005). Assessing cognitive deficits in bipolar disorder: Are self-reports valid? *Psychiatry Research*, *136*(1), 43–50. doi:10.1016/j.psychres.2004.12.009

Cella, M., Swan, S., Medin, E., Reeder, C., & Wykes, T. (2014). Metacognitive awareness of cognitive problems in schizophrenia: Exploring the role of symptoms and self-esteem. *Psychological Medicine*, *44*(3), 469–476.

Chiou, K. S., Carlson, R. A., Arnett, P. A., Cosentino, S. A., & Hillary, F. G. (2011). Metacognitive monitoring in moderate and severe traumatic brain injury. *Journal of the International Neuropsychological Society*, *17*(4), 720–731. doi:10.1017/S1355617711000658

Chiou, K. S., & Hillary, F. G. (2012). Benefits of order: The influence of item sequencing on metacognition in moderate and severe traumatic brain injury. *Journal of the International Neuropsychological Society*, *18*(2), 379–383. doi:10.1017/S1355617711001846

Clare, L., Whitaker, C. J., & Nelis, S. M. (2010). Appraisal of memory functioning and memory performance in healthy ageing and early-stage Alzheimer's disease. *Aging, Neuropsychology, and Cognition*, *17*(4), 462–491. doi:10.1080/13825580903581558

Cosentino, S., Metcalfe, J., Butterfield, B., & Stern, Y. (2007). Objective metamemory testing captures awareness of deficit in Alzheimer's disease. *Cortex*, *43*(7), 1004–1019.

Craddock, N., O'Donovan, M. C., & Owen, M. J. (2006). Genes for schizophrenia and bipolar disorder? Implications for psychiatric nosology. *Schizophrenia Bulletin*, *32*(1), 9–16. doi:10.1093/schbul/sbj033

Cruise, S. M., Lewis, C. A., & McGuckin, C. (2006). Test-retest reliability of self-estimated intelligence: Temporal stability over four time periods. *Social Behavior and Personality*, *34*(10), 1179–1188. doi:10.2224/sbp.2006.34.10.1179

Danion, J. M., Gokalsing, E., Robert, P., Massin-Krauss, M., & Bacon, E. (2001). Defective relationship between subjective experience and behavior in schizophrenia. *The American Journal of Psychiatry*, *158*(12), 2064–2066.

David, A. S., Bedford, N., Wiffen, B., & Gilleen, J. (2012). Failures of metacognition and lack of insight in neuropsychiatric disorders. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *367*(1594), 1379–1390.

de Assis da Silva, R., Mograbi, D. C., Silveira, L. S., Nunes, A. S., Novis, F. D., Landeira-Fernandez, J., & Cheniaux, E. (2015). Insight across the different mood states of bipolar disorder. *The Psychiatric Quarterly*, *86*, 395–405.

Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (2000). *California Verbal Learning Test* (2nd ed.). San Antonio, TX: The Psychological Corporation.

Devolder, P. A., Brigham, M. C., & Pressley, M. (1990). Memory performance awareness in younger and older adults. *Psychology and Aging*, *5*(2), 291–303.

Dias, V. V., Brissos, S., & Carita, A. I. (2008). Clinical and neurocognitive correlates of insight in patients with bipolar I disorder in remission. *Acta Psychiatrica Scandinavica*, *117*(1), 28–34. doi:10.1111/j.1600-0447.2007.01110.x

Dixon, R. A., Hultsch, D. F., & Hertzog, C. (1988). The Metamemory in Adulthood (MIA) questionnaire. *Psychopharmacology Bulletin*, *24*(4), 671–688.

Dockree, P. M., Tarleton, Y. M., Carton, S., & FitzGerald, M. C. (2015). Connecting self-awareness and error-awareness in patients with traumatic brain injury. *Journal of the International Neuropsychological Society: JINS*, *21*(7), 473–482. doi:10.1017/S1355617715000594

Ecklund-Johnson, E., & Torres, I. (2005). Unawareness of deficits in Alzheimer's disease and other dementias: Operational definitions and empirical findings. *Neuropsychology Review*, *15*(3), 147–166. doi:10.1007/s11065-005-9026-7

Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), *The nature of intelligence* (pp. 231–236). Hillsdale, NJ: Erlbaum.

Flavell, J. H. (1979). Meta-cognition and cognitive monitoring—New area of cognitive-developmental inquiry. *American Psychologist*, *34*(10), 906–911. doi:10.1037/0003-066X.34.10.906

Freund, P. A., & Kasten, N. (2012). How smart do you think you are? A meta-analysis on the validity of self-estimates of cognitive ability. *Psychological Bulletin*, *138*(2), 296–321.

Ghaemi, S. N., & Rosenquist, K. J. (2004). Is insight in mania state-dependent? A meta-analysis. *The Journal of Nervous and Mental Disease*, *192*(11), 771.

Gilleen, J., Greenwood, K., & David, A. S. (2011). Domains of awareness in schizophrenia. *Schizophrenia Bulletin*, *37*(1), 61–72.

Golden, C. J. (1978). *Stroop Color and Word Test*. Chicago, IL: Stoelting.

Goverover, Y., Genova, H., Griswold, H., Chiaravalloti, N., & DeLuca, J. (2014). Metacognitive knowledge and online awareness in persons with multiple sclerosis. *NeuroRehabilitation*, *35*(2), 315–323. doi:10.3233/NRE-141113.

Graham, D. P., Kunik, M. E., Doody, R., & Snow, A. L. (2005). Self-reported awareness of performance in dementia. *Brain Research. Cognitive Brain Research*, *25*(1), 144–152.

Hamilton, M. (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery, and Psychiatry*, *23*, 56–62.

Hertzog, C., Saylor, L. L., Fleece, A. M., & Dixon, R. A. (1994). Metamemory and aging: Relations between predicted, actual and perceived memory task performance. *Aging & Cognition*, *1*(3), 203–237. doi:10.1080/13825589408256577

Hoerold, D., Pender, N. P., & Robertson, I. H. (2013). Metacognitive and online error awareness deficits after prefrontal cortex lesions. *Neuropsychologia*, *51*(3), 385–391. doi:10.1016/j.neuropsychologia.2012.11.019

Howard, C. E., Andrés, P., Broks, P., Noad, R., Sadler, M., Coker, D., & Mazzoni, G. (2010). Memory, metamemory and their dissociation in temporal lobe epilepsy. *Neuropsychologia*, *48*(4), 921–932.

Kaufman, A. S., & Kaufman, N. L. (1990). *Kaufman Brief Intelligence Test* (2nd ed.). Circle Pines, MN: American Guidance Service.

Kervick, R. B., & Kaemingk, K. L. (2005). Cognitive appraisal accuracy moderates the relationship between injury severity and psychosocial outcomes in traumatic brain injury. *Brain Injury*, *19*(11), 881–889.

Koren, D., Seidman, L. J., Goldsmith, M., & Harvey, P. D. (2006). Real-world cognitive—and metacognitive—dysfunction in schizophrenia: A new approach for measuring (and remediating) more "right stuff." *Schizophrenia Bulletin*, *32*(2), 310–326. doi:10.1093/schbul/sbj035

Koriat, A. (2007). Metacognition and consciousness. In E. Thompson (Ed.), *The Cambridge handbook of consciousness* (pp. 289–325). New York, NY: Cambridge University Press.

Krabbendam, L., Arts, B., van Os, J., & Aleman, A. (2005). Cognitive functioning in patients with schizophrenia and bipolar disorder: A quantitative review. *Schizophrenia Research*, *80*(2–3), 137.

Larrabee, G. J., West, R. L., & Crook, T. H. (1991). The association of memory complaint with computer-simulated everyday memory performance. *Journal of Clinical and Experimental Neuropsychology*, *13*(4), 466–478. doi:10.1080/01688639108401064

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). New York: Oxford University Press.

Lysaker, P. H., & Dimaggio, G. (2014). Metacognitive capacities for reflection in schizophrenia: Implications for developing treatments. *Schizophrenia Bulletin*, *40*(3), 487–491. doi:10.1093/schbul/sbu038

Martinez-Aran, A., Vieta, E., Colom, F., Torrent, C., Reinares, M., Goikolea, J. M.,… Sanchez-Moreno, J. (2005). Do cognitive complaints in euthymic bipolar patients reflect objective cognitive impairment? *Psychotherapy and Psychosomatics*, *74*(5), 295–302. doi:10.1159/000086320

McGlynn, S. M., & Kaszniak, A. W. (1991). Unawareness of deficits in dementia and schizophrenia. In G. P. Prigatano & D. L. Schacter (Eds.), *Awareness of deficit after brain injury: Clinical and theoretical issues* (pp. 84–110). New York, NY: Oxford University Press.

Medalia, A., & Thysen, J. (2008). Insight into neurocognitive dysfunction in schizophrenia. *Schizophrenia Bulletin*, *34*(6), 1221–1230. doi:10.1093/schbul/sbm144

Metcalfe, J., & Shimamura, A. P. (1994). *Metacognition: Knowing about knowing*. Cambridge, MA: MIT Press.

Miskowiak, K., Vinberg, M., Christensen, E. M., & Kessing, L. V. (2012). Is there a difference in subjective experience of cognitive function in patients with unipolar disorder versus bipolar disorder? *Nordic Journal of Psychiatry*, *66*(6), 389–395. doi:10.3109/08039488.2012.658862

Moritz, S., & Woodward, T. S. (2006). The contribution of metamemory deficits to schizophrenia. *Journal of Abnormal Psychology*, *115*(1), 15–25. doi:10.1037/0021-843X.15.1.15

Murray, R. M., Sham, P., van Os, J., Zanelli, J., Cannon, M., & McDonald, C. (2004). A developmental model for similarities and dissimilarities between schizophrenia and bipolar disorder. *Schizophrenia Research*, *71*(2–3), 405–416. doi:10.1016/j.schres.2004.03.002

O'Keeffe, F., Dockree, P., Moloney, P., Carton, S., & Robertson, I. H. (2007). Awareness of deficits in

traumatic brain injury: A multidimensional approach to assessing metacognitive knowledge and online-awareness. *Journal of the International Neuropsychological Society*, *13*(1), 38–49. doi:10.1017/S1355617707070075

Pannu, J. K., & Kaszniak, A. W. (2005). Metamemory experiments in neurological populations: A review. *Neuropsychology Review*, *15*(3), 105–130. doi:10.1007/s11065-005-7091-6

Perfect, T. J., & Schwartz, B. L. (2002). In T. J. Perfect & B. L. Schwartz (Eds.), *Applied metacognition*. New York, NY: Cambridge University Press. doi:10.1017/CBO9780511489976

Reitan, R. M., & Wolfson, D. (1993). *The Halstead-Reitan Neuropsychological Test Battery: Theory and clinical applications* (2nd ed.). Tucson, AZ: Neuropsychology Press.

Robbins, T. W., James, M., Owen, A. M., Sahakian, B. J., McInnes, L., & Rabbitt, P. (1994). Cambridge Neuropsychological Test Automated Battery (CANTAB): A factor analytic study of a large sample of normal elderly volunteers. *Dementia*, *5*(5), 266–281.

Robinson, L. J., & Ferrier, I. N. (2006). Evolution of cognitive impairment in bipolar disorder: A systematic review of cross-sectional evidence. *Bipolar Disorders*, *8*(2), 103–116.

Rosa, A. R., Mercadé, C., Sánchez-Moreno, J., Solé, B., Mar Bonnin, C. D., Torrent, C., … Martinez-Aran, A. (2013). Validity and reliability of a rating scale on subjective cognitive deficits in bipolar disorder (COBRA). *Journal of Affective Disorders*, *150*(1), 29–36. doi:10.1016/j.jad.2013.02.022

Schoo, L. A., van Zandvoortab, M. J. E., Biesselsb, G. J., Kappelleb, L. J., & Postmaab, A. (2013). Insight in cognition: Self-awareness of performance across cognitive domains. *Applied Neuropsychology: Adult*, *20*, 95–102.

Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Science*, *26*(1–2), 113–125. doi:10.1023/A:1003044231033

Schraw, G. (2009). A conceptual analysis of five measures of metacognitive monitoring. *Metacognition and Learning*, *4*(1), 33–45. doi:10.1007/s11409-008-9031-3

Semerari, A., Cucchi, M., Dimaggio, G., Cavadini, D., Carcione, A., Battelli, V.,… Smeraldi, E. (2012). The development of the Metacognition Assessment interview: Instrument description, factor structure and reliability in a non-clinical sample. *Psychiatry Research*, *200*(2–3), 890–895. doi:10.1016/j.psychres.2012.07.015

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., … Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *The Journal of Clinical Psychiatry*, *59*(Suppl. 20), 22–33.

Souchay, C. (2007). Metamemory in Alzheimer's disease. *Cortex*, *43*(7), 987–1003.

Stefanopoulou, E., Manoharan, A., Landau, S., Geddes, J. R., Goodwin, G., & Frangou, S. (2009). Cognitive functioning in patients with affective disorders and schizophrenia: A meta-analysis. *International Review of Psychiatry*, *21*(4), 336–356.

Stuss, D. T., Picton, T. W., & Alexander, M. P. (2001). In S. P. Salloway, P. F. Malloy, & J. D. Duffy (Eds.), *Consciousness, self-awareness, and the frontal lobes*. Arlington, VA: American Psychiatric Publishing, Inc.

Svendsen, A. M., Kessing, L. V., Munkholm, K., Vinberg, M., & Miskowiak, K. W. (2012). Is there an association between subjective and objective measures of cognitive function in patients with affective disorders? *Nordic Journal of Psychiatry*, *66*(4), 248–253. doi:10.3109/08039488.2011.626870

Tas, C., Brown, E. C., Aydemir, O., Brüne, M., & Lysaker, P. H. (2014). Metacognition in psychosis: Comparison of schizophrenia with bipolar disorder. *Psychiatry Research*, *219*(3), 464–469. doi:10.1016/j.psychres.2014.06.040

Toglia, J., & Kirk, U. (2000). Understanding awareness deficits following brain injury. *Neurorehabilitation*, *15*(1), 57–70.

Torres, I. J., Defreitas, C. M., Defreitas, V. G., Bond, D. J., Kunz, M., Honer, W. G., … Yatham, L. N. (2011). Relationship between cognitive functioning and 6-month clinical and functional outcome in patients with first manic episode bipolar I disorder. *Psychological Medicine*, *41*(5), 971–982. doi:10.1017/S0033291710001613

Torres, I. J., Defreitas, V. G., Defreitas, C. M., Kauer-Sant'anna, M., Bond, D. J., Honer, W. G.,… Yatham, L. N. (2010). Neurocognitive functioning in patients with bipolar I disorder recently recovered from a first manic episode. *The Journal of Clinical Psychiatry*, 71(9), 1234–1242. doi:10.4088/JCP.08m04997yel

Torres, I. J., & Malhi, G. S. (2010). Neurocognition in bipolar disorder. In L. N. Yatham & M. Maj (Eds.), *Textbook of bipolar disorders*. London: John Wiley and Sons.

Trosset, M. W., & Kaszniak, A. W. (1996). Measures of deficit unawareness for predicted performance experiments. *Journal of the International Neuropsychological Society*, *2*(4), 315–322.

Van der Werf-Eldering, W., Burger, H., Jabben, N., Holthausen, E. A. E., Aleman, A., & Nolen, W. A. (2011). Is the lack of association between cognitive complaints and objective cognitive functioning in patients with bipolar disorder moderated by depressive symptoms? *Journal of Affective Disorders*, *130*(1–2), 306–311. doi:10.1016/j.jad.2010.10.005

Varga, M., Magnusson, A., Flekkoy, K., Ronneberg, U., & Opjordsmoen, S. (2006). Insight, symptoms and neurocognition in bipolar I patients. *Journal of Affective Disorders*, *91*(1), 1.

Wechsler, D. (1997). *The Wechsler Memory Scale* (3rd ed.). San Antonio, TX: The Psychological Corporation.

Wilbur, R., Wilk, C., Silver, R., & Parente, R. (2008). Validity and reliability of self-monitoring indices. *Brain Injury*, *22*(9), 685–690.

Yatham, L. N., Kauer-Sant'Anna, M., Bond, D. J., Lam, R. W., & Torres, I. (2009). Course and outcome after the first manic episode in patients with bipolar disorder: Prospective 12-month data from the systematic treatment optimization program for early mania project. *Canadian Journal of Psychiatry*, *54*(2), 105–112.

Yatham, L. N., Kennedy, S. H., Schaffer, A., Parikh, S. V., Beaulieu, S., O'Donovan, C., … Kapczinski, F. (2009). Canadian Network for Mood and Anxiety Treatments (CANMAT) and International Society for Bipolar Disorders (ISBD) collaborative update of CANMAT guidelines for the management of patients with bipolar disorder: Update 2009. *Bipolar Disorders*, *11*(3), 225–255. doi:10.1111/j.1399-5618.2009.00672.x

Yatham, L. N., Torres, I. J., Malhi, G. S., Frangou, S., Glahn, D. C., Bearden, C. E.,… Chengappa, K. N. (2010). The International Society for Bipolar Disorders–Battery for Assessment of Neurocognition (ISBD-BANC). *Bipolar Disorders*, *12*(4), 351–363. doi:10.1111/j.1399-5618.2010.00830.x

Yen, C. F., Chung, L. C., & Chen, C. S. (2002). Insight and neuropsychological functions in bipolar outpatients in remission. *The Journal of Nervous and Mental Disease*, *190*(10), 713–715. doi:10.1097/01.NMD.0000034518.52993.14

Young, R. C., Biggs, J. T., Ziegler, V. E., & Meyer, D. A. (1978). A rating scale for mania: Reliability, validity and sensitivity. *The British Journal of Psychiatry*, *133*, 429–435.