Research report

Does risk for bipolar disorder heighten the disconnect between objective and subjective appraisals of cognition?

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1. Background

Bipolar disorder has consistently been ranked among the leading causes of disability worldwide (Ayuso-Mateos et al., 2006; Murray and Lopez, 1997). Episodes of depression and mania can cause serious disruption, but functional impairments occur even during periods of symptomatic remission (Dean et al., 2004; Tohen et al., 2000; Zarate et al., 2000).

Associated with such impairments are deficits in cognitive functioning, particularly during episodes of depression and mania (Martinez-Aran et al., 2004). During depressive periods, cognitive deficits have been found in attention (Burdick et al., 2009; Jongen et al., 2007; Tavares et al., 2003), executive functioning (Maalouf et al., 2010), working memory (Ali et al., 2000; Martinez-Aran et al., 2004), psychomotor functioning (Burdick et al., 2009), and memory (Fossati et al., 2004). Similar cognitive difficulties have been identified during manic phases of bipolar disorder (Bulbena and Berrios, 1993; Martinez-Aran et al., 2004; Murphy and Sahakian, 2001). Cognitive impairments tend to alleviate between episodes (Tohen et al., 2000), but may not entirely disappear (Dittmann et al., 2008; Maalouf et al., 2010; Rubinsztein et al., 2000; Torres et al., 2010; Yates et al., 2011).

The existence of cognitive impairments outside of episodes in people with bipolar disorder has led some to argue that they may represent endophenotypes for the disorder (Arts et al., 2008). A meta-analysis by Bora et al. (2009) found a series of cognitive impairments that could potentially represent cognitive endophenotypes, with impaired response inhibition being among the more prominent impairments. Other studies have found similar cognitive deficits in family members of individuals diagnosed with bipolar disorder (Christensen et al., 2006; Glahn et al., 2010), supporting the argument that they may be linked to a vulnerability to the disorder. The degree to which such deficits represent prodromes appearing early in the course of the disorder has been less studied.

Despite evidence that cognitive deficits occur in individuals with bipolar disorder during all phases of the illness, a parallel literature suggests that patients may lack awareness of these deficits. Burdick et al. (2005) found that patients with severe symptoms of bipolar disorder had difficulties in verbal learning and memory tasks, yet...
their self-rating of these deficits was uncorrelated with their actual performance. van der Werf-Eldering et al. (2011) looked at the association between cognitive performance in multiple domains and cognitive complaints about their performance in 108 patients with bipolar disorder experiencing different phases of the illness. They found no association between self-report complaints and objective performance.

Findings of a disconnect between perceived functioning and actual performance may be part of a broader profile among individuals at risk for bipolar disorder in which self-appraisals may at times be overly optimistic. Johnson et al. (2005, 2009) have argued that individuals at risk for bipolar disorder intermittently set excessively high goals for themselves and overestimate their ability to achieve them. Several studies have found exaggerated expectancies of success among individuals at risk for bipolar disorder in the presence of reward (Johnson et al., 2005; Stern and Berrenberg, 1979).

These two literatures, one noting cognitive impairments and the other indicating unrealistic self-appraisals, have not been tested simultaneously in younger individuals at risk for the disorder. The latter is important: it can help to clarify the extent to which this profile represents a prodromal marker for the disorder versus a consequence of it. The present study, therefore, sought to test whether risk for bipolar disorder in a younger cohort of individuals would be associated with this twin profile (i.e., lower performance on an objective measure of cognitive ability, yet higher self-appraisal of cognitive functioning).

For the present study, risk for bipolar disorder was assessed using a Hypomanic Personality Scale (HPS; Eckblad and Chapman, 1986), a self-report measure shown to have predictive validity with respect to the development of bipolar disorder (Kwapil et al., 2000). With respect to cognition, multiple domains have been proposed to be linked to bipolar disorder, but the present study focused on potential deficits in working memory, which has been implicated in numerous studies of bipolar disorder (Barrett and Russell, 1998; Diwadkar et al., 2011; Gourovitch et al., 1999; MacQueen et al., 2005; Pan et al., 2011). We sought to compare the objective measure of working memory with a more subjective self-appraisal of cognitive functioning as reflected on the Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982), which asks individuals to rate errors in their everyday cognitive functioning including their memory.

Two specific hypotheses were tested: the first hypothesis was that risk for bipolar disorder as measured by the HPS would be associated with lower working memory scores, consistent with the claim that deficits in some cognitive functioning might represent endophenotypic markers for the disorder. The second hypothesis was that despite being associated with lower working memory scores, risk for bipolar disorder would be associated with over-estimation on self-appraisal of cognitive abilities as seen on the CFQ. Finding either effect in a younger, college-aged cohort would provide indirect support for the argument that these characteristics may represent a prodrome for the disorder.

2. Methods

2.1. Participants

One hundred and twenty-eight undergraduates from a large public university participated in the study for course credit. Participants were primarily female (65.6%) and young (Mean age = 21.28 years, SD = 4.93). The majority (51.6%) were Caucasian, although a significant number of participants were African-American (14.8%) or Asian (13.3%), as well as Hispanic (15.6%). Participants met individually with an experimenter, who obtained written informed consent. Participants then completed the working memory tasks described below in a counter balanced order. They then completed the self-report measures. All procedures were reviewed and approved by the university’s institutional review board.

2.2. Measures

2.2.1. Hypomanic Personality Scale (HPS)

The HPS (Eckblad and Chapman, 1986) is a 48-item self-report measure designed to identify individuals at risk of developing a manic episode. The instrument has good reliability (r = .87; test–retest reliability r = .81), good convergent validity with other measures of bipolar disorder and good discriminant validity with measures of social desirability (Eckblad and Chapman, 1986). Previous studies have found that high scores on the HPS were associated with increased risk of having had a hypomanic episode, with over 75% of scorers in the top 95th percentile meeting criteria for a bipolar spectrum disorder (Eckblad and Chapman, 1986). Moreover, HPS scores could predict onset of manic symptoms across a 10-year period (Kwapil et al., 2000).

More recent work has suggested that the HPS measures multiple dimensions (Schlaet et al., 2011). Among them, the dimension of mood volatility, comprising 14 of the 48 original items, has been found to be most associated with psychopathology (Schlaet et al., 2011). Items from this dimension measure negative emotion and hypomanic cognitions, including mood swings, irritability and racing thoughts and may be the most indicative of a risk for affective episodes.

2.2.2. Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982)

The CFQ is a 25-item questionnaire that measures the self-reported tendency of making cognitive errors in everyday life. Participants respond to each question by indicating how often they make an error for that item on a 5-point Likert scale, from 0 (never) to 4 (often). The CFQ is scored by summing the ratings for the 25 items, so that a higher score indicates a higher self-reported incidence of cognitive failures. The CFQ has been shown to have high internal consistency (r = .91) and is reliable over time (test–retest reliability r = .82; Wallace et al., 2002). High internal consistency was found in the current sample (r = .92). Disagreement exists over whether the CFQ is best analyzed as a single dimension (Broadbent et al., 1982; Merckelbach et al., 1996) or as composed of several distinct factors of cognitive failures (Rast et al., 2009; Wallace, 2004; Wallace et al., 2002). For the current study, the total score of the measure was used as a proxy for self-appraisal of everyday cognitive functioning.

2.2.3. Working memory capacity (WMC)

Two automated tasks, the Automated Operation Span Task (AOSPAN, Unsworth et al., 2005) and the Automated Reading Span Task (RSPAN, Daneman and Carpenter, 1980), were used to measure working memory capacity (WMC). Both tasks have been widely used and shown to have good psychometric properties. The AOSPAN has been shown to have high test–retest reliability (r = .83) and internal consistency (r = .78; Unsworth et al., 2005). The Automated RSPAN has been shown to have high test–retest reliability (r = .82; Redick et al. (2011)). The tasks required participants to maintain memory of a series of letters while completing a secondary task. In the AOSPAN task participants are required to verify the correctness of the solution to a simple mathematical equation (i.e., (3 × 2) + 1 = 6). In the RSPAN task participants are required to verify the meaningfulness of sentences (i.e., “The ship sailed across the dishwasher”). In the AOSPAN and the RSPAN,
a capital letter (out of a list of 12 possible letters) appears for 250 ms, 200 ms after the reading or operation verification response. After a set of between 3 and 7 verification-letter pairs, a grid containing all 12 possible letters appears on the screen. The participant was instructed to indicate all of the letters from that set in the order presented by entering the number corresponding to the order in which the letter was presented. Participants were presented with each set length (three to seven items) three times for a total of 15 sets per task.

The tasks were scored by summing the total number of items recalled in the correct serial position (Conway et al., 2005). The AOSPAN and RSPAN scores were converted to z-scores and the z-scores were averaged to create a single composite WMC score.

### 2.2.4. Statistical analyses

Prior to running analyses, all variables were standardized and data were screened to test for assumptions and outliers (no cases were removed). Data were also screened to assess for the potential that effects were confounded by age or gender (neither was significantly associated with outcomes).

Hypotheses were tested using simple regression for the first hypothesis and multiple regression for the second hypothesis. The second hypothesis implicates a main effect (i.e., HPS predicts CFQ) as well as a moderation effect (i.e., HPS moderates the relationship between WMC and CFQ). Therefore, an interaction term was computed and the effect tested using multiple regression. Finally, given that recent work has implicated the mood volatility dimension of the HPS with respect to risk for psychopathology, we carried out exploratory analyses that replicated the above analyses but used the HPS mood volatility items of the HPS instead of the HPS total score.

### 3. Results

The first hypothesis was that a person’s risk for bipolar disorder would be associated with deficits in working memory. Contrary to expectation, HPS scores did not significantly predict working memory scores, $R^2 = .01, p = .22, b = -.10, SE = .08$.

Exploratory analyses focused on whether the mood volatility dimension of the HPS was associated with working memory deficits. Results were almost identical to previous analyses, $R^2 = .01, p = .21, b = -.10, SE = .08$, suggesting that risk for bipolar disorder, as measured by the HPS mood volatility dimension (or the total HPS), is not associated with impairments in working memory among a young, college-aged cohort.

The second hypothesis was that the risk for bipolar disorder (HPS) would be associated with lower endorsement of everyday cognitive errors (CFQ), even among those with poor working memory scores (WMC). In other words, high HPS scores would be associated with more positive self-appraisal on the CFQ, especially among those with low WMC scores.

Table 1 shows results from the multiple regression. There was a significant main effect for HPS, indicating that the higher a person’s risk for bipolar disorder on the HPS, the more likely they were to deny cognitive failures on the CFQ (i.e., the more likely they were to more positively self-appraise). There was also a significant interaction between bipolar risk (i.e., HPS) and working memory (i.e., WMC). Fig. 1 graphs the interaction pattern for those with high (i.e., +1 SD above the mean) versus average (i.e., at or below the mean) HPS scores. As seen there, higher bipolar risk on the HPS led to more positive self-appraisals on the CFQ among individuals with average or high working memory. It was only when working memory scores were below average that the high HPS scorers showed no difference in self-appraisal on the CFQ from the rest of the sample. A similar pattern emerged when HPS mood volatility scores were used instead of total HPS scores, as seen in Table 2.

![Fig. 1. WMC and HPS scores as predictors of self-appraisal on the CFQ (lower CFQ scores reflect greater denial of cognitive errors). CFQ=Cognitive Failures Questionnaire total score, standardized. WMC=working memory composite total score, standardized. HPS-Hypomanic Personality Scale Mood Volatility score, standardized.](image)

### 4. Discussion

The extent to which cognitive impairment and self-appraisal represent prodromal markers for bipolar disorder can provide significant clinical and theoretical implications for understanding the illness. Identification of a cognitive endophenotype may provide for a better understanding of the course of the disorder, which may aid preventive measures, inform the treatment of severe functional deficits, and enhance treatment compliance. The current study did not find evidence of cognitive impairment among younger individuals at risk for bipolar disorder. However, a person’s risk for bipolar disorder was found to be associated with an over-estimation of everyday cognitive functioning relative to those with lower risk.

Given the nature of the sample and its youth, such an effect may be part of a broader prodromal profile of people at risk for the disorder. Specifically, results add to a growing body of evidence that individuals at risk for bipolar disorder may have a tendency to more highly appraise their functioning and/or
minimize their limitations relative to those with low risk for the disorder. In the present study, such a tendency was seen in their evaluation of mistakes in their everyday cognitive functioning. Despite performing similarly to others on a measure of cognitive ability (a working memory task), individuals at risk for bipolar disorder tended to minimize or deny cognitive disruptions in their daily life. No relationship was found between actual cognitive ability and self-rated tendency to make minor cognitive mistakes on the CFQ for those with low or average HPS scores. This is consistent with previous literature that did not find an association between the CFQ and working memory (Burdick et al., 2005; Willert et al., 2010; Wright and Osborne, 2005). However, there was a significant (negative) relationship between HPS scores and the CFQ, demonstrating a tendency to minimize cognitive failures in those with higher HPS scores. High test–retest reliability of the CFQ suggests that the measure targets a relatively stable tendency of self-reported cognitive mistakes as opposed to being state-specific (Broadbent et al., 1982). This suggests that if a low endorsement of cognitive failures is an enduring characteristic of individuals prone to bipolar disorder, then this tendency may exist prior to the emergence of clinical symptoms.

With respect to the possibility that deficits in working memory may also represent a prodrome for bipolar disorder, results were inconclusive. No relationship was found between risk for bipolar disorder and the measures of working memory, suggesting initially that this may be a consequence as opposed to a prodrome for the disorder. Specifically, intrusive thoughts and ruminations that often follow a mood episode (Nolen-Hoeksema et al., 2008) may be responsible for placing an additional cognitive load on individuals (see Ikonowska and Engle, 2010) and consuming attentional resources (Joormann et al., 2011). These effects may only follow rather than precede mood episodes. However, caution must be used before reaching this conclusion due to study limitations. Only a single cognitive domain was assessed. It may be possible that cognitive deficits do exist, but that they exist in other cognitive domains, or that they require other types of working memory tasks to be detected.

Other limitations also deserve mention. Among them, participants were a nonclinical sample, they were not formally diagnosed, and they were not followed over time. The HPS has been found to predict the development of bipolar disorder, but it may also be measuring other constructs that are less relevant to bipolar disorder. Moreover, current depressive and manic symptoms were not assessed, so it is unclear to what degree the effect is dependent on current symptoms. These limitations restrict our ability to conclusively generalize results. Future work needs to more broadly assess cognitive functioning and needs to do so with samples that are more clearly at risk for bipolar disorder (e.g., offspring).

Disagreement about the interpretation of the CFQ poses an additional limitation. It is possible that participants at risk for bipolar disorder in the current sample may truly experience fewer everyday cognitive errors, and that these self-reported errors may be specific enough to be unrelated to broader, or different, aspects of cognition. Increased endorsement of cognitive mistakes on the CFQ have been associated with exposure to high stress environments that were accompanied by related factors, including greater affective symptoms and cognitive deficits (Parkes, 1980; van der Linden et al., 2005). Although such findings were not in clinical populations, one explanation for the present results is that participants at increased risk of bipolar disorder in the current study may possess identifiable factors that buffer minor cognitive disruptions. For example, poor sustained attention has been associated with higher CFQ scores (van der Linden et al., 2005; Wallace and Vodanovich, 2003). Similarly, specific cognitive factors may confound certain measures of general cognitive functioning and insight.

Despite these limitations, findings from the present study have important clinical implications and are congruent with other lines of evidence pointing to over-estimation of abilities in individuals with bipolar disorder or who are at risk for the disorder. In one sense, this is not surprising; increased confidence is a key symptom of mania and hypomania. What is surprising, however, is that this feature is seen in a younger cohort, suggesting it may be part of a prodromal profile. Moreover, the degree to which bipolar patients can recognize disruptions in everyday cognitive functioning may have important clinical implications. Anosognosia, unawareness of a disability, has been associated with medication non-compliance for mental disorders (El-Mallakh, 2007; Yen et al., 2005). In a sample of patients diagnosed with bipolar I or bipolar II disorder, denial of illness severity was a significant contributor to negative attitude towards medication compliance (Sajatovic et al., 2011). Overconfident and optimistic self-evaluation of cognitive functioning may adversely affect every day cognitive tasks that determine functional outcomes, such as medication adherence, maintaining stable employment, remembering important appointments, or complying with psychotherapeutic treatment. Notably, other conditions commonly associated with anosognosia suggest that insight deficit may precede diagnosis (e.g., psychoses; Pia and Tamietto, 2006), further suggesting that self-appraisal incongruent with current functioning may be an important marker in the prodromal phase of the disorder. While the present study utilized endorsement of cognitive errors as a measure of self-appraisal, additional domains of insight, such as cognitive self-certainty and self-reflectiveness (Engl et al., 2007), should be investigated in individuals at risk for the disorder.

Investigation of cognitive functioning in combination with self-evaluation should be replicated across different phases of the disorder. Considering that a high endorsement of cognitive mistakes on the CFQ have been associated with low self-image (Harter et al., 1990) and depressive symptoms (Matthews et al., 1990; Merckelbach et al., 1999), it is possible that overconfidence in one's cognitive functioning may be more closely associated with manic symptoms in bipolar disorder than depression. An investigation of subjective and objective assessments of functioning in 120 manic, depressed, and euthymic bipolar I patients found that a lack of insight may be associated with mania as well (Gazelle et al., 2007), in which manic patients’ self-reported Quality of Life was similar to euthymic patients and to controls, despite a low objective functioning level as indicated on GAF measures. Given that this disparity between self-report and objective measures of functioning during acute mania may represent a lack of insight, research is needed to further investigate the interaction between insight and cognitive functioning across different phases of the illness.

In conclusion, individuals at high risk of bipolar disorder did not display cognitive deficits in working memory, but they did exhibit high self-appraisal of cognitive functioning. Given the severity of disability associated with bipolar disorder, it is of high clinical importance to better understand the early phases of the illness in order to guide prevention efforts and improve treatment compliance.

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Conflict of interest
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