

THE UNIVERSITY OF HULL

‘Risk taking in bipolar disorder’

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by

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A. Overview

The portfolio has three parts:

- Part one is a systematic literature review, in which the theoretical, conceptual and empirical literature relating to decision making processes in bipolar disorder is reviewed.
- Part two is an empirical paper, which explores the effect of mood and trait sensitivity to reward on risk taking in bipolar 1 disorder.
- Part three comprises the appendices.

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Decision making Processes in Bipolar Disorder: A systematic review

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This paper is written in the format ready for submission to Clinical Psychology Review.
Please see Appendix 2.1 for the Guideline for Authors.

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Abstract

Background: People with a diagnosis of bipolar disorder can make suboptimal decisions during manic and depressive episodes which can have negative long-term consequences. This review aims to explore individual factors, including mood state and personality traits, which could affect decision making processes of individuals with bipolar disorder.

Methods: A systematic search of three databases, plus hand searching relevant reference sections, identified twenty five relevant studies, nineteen of which met the inclusion criteria for the review.

Results: Mania and severe depression are associated with poorer performance on computerised tasks designed to measure risk decision making. There is tentative evidence for altered decision making processes even during euthymic and remitted phases of bipolar disorder, but little difference in overall decision making outcomes.

Limitations: The evidence base is small and centred around a few computerised tasks, which may have limited ecological validity in the assessment of decision making. Complex decision making tasks are difficult to interpret in terms of underlying processes.

Conclusions: Both mood episode and trait factors, such as impulsivity, may have some predictive value of decision making in people with a diagnosis of bipolar disorder, although trait factors are largely unexplored in this population. Further research is needed to develop a psychological model for understanding the relative impact of individual factors, plus social and environmental factors which can influence the decision making process.

Introduction

Both mania and depression are characterised, in part, by poor decision making. Decision making has been defined as a process where a person chooses an action with either certain or uncertain outcomes (Tversky & Kahneman, 1981). The DSM-IV criteria for a manic episode, includes “*excessive involvement in pleasurable activities that have a high potential for painful consequences*” suggesting that during mania, people make unwise behavioural decisions which put themselves at increased risk. In contrast, a major symptom of a depressive episode is indecisiveness, suggesting a different type of disruption to the decision making process. However, some forms of risk taking behaviour can also be elevated in clinical depression, such as substance use, highlighted by the high co-morbidity of depression and substance use disorders (Swendsen & Merikangas, 2000).

The consequences of poor behavioural risk decisions can be devastating for the individual with bipolar disorder, leading to long term health problems, addictive disorders and increased suicidality. For instance, substance abuse disorders are more prevalent in bipolar disorder than in the general population (Regier, Farmer, Rae, Locke, Keith, Judd & Goodwin, 1990), and attempted suicide rates have been found to lie between 21-54% (Fajutrao, Locklear, Prialx, & Hayes, 2009). Mood disorders have also been associated with pathological gambling (Kim, Grant, Eckert, Faris, & Hartman, 2006) and increased risk of HIV infection (Carey, Carey, Maisto, Gleason, Gordon, & Brewer, 1999; Carey, Carey, Maisto, Gordon & Venable, 2001). There is therefore much clinical value in identifying the factors which affect the decision making processes of individuals with bipolar disorder, in order to contribute to current understanding of how these often self-defeating behaviours might develop.

There is evidence to suggest that specific risky behaviours are associated with mania and depression. Prospective studies of substance use across the course of illness in bipolar disorder have sought to describe the relationship between substance use and symptom

development. Several studies have found marijuana use to be associated with manic symptoms, and alcohol use with depressive symptoms (Baethge, Baldessarini, Khalsa, Hennen, Salvatore, & Tohen, 2005; Baethge, Hennen, Khalsa, Tohen, & Baldessarini, 2008; Strakowski, DelBollo, Fleck, & Arndt, 2000), suggesting that different mood episodes are associated with different types of risk taking behaviour. From these studies the direction of causality is not clear, although clinically one could expect a bi-directional relationship, as substance use may exacerbate symptoms, but clinical symptoms may also lead to increased substance use. In terms of other risky behaviours, Meade, Graff, Griffin and Weiss (2008) found recent manic episode was associated with total HIV risk (including risky sexual behaviours and injection drug use) among individuals with co-morbid bipolar disorder and substance abuse. Therefore these findings raise the question of whether all risk taking behaviours are elevated during mania, or whether specific behaviours are more affected, e.g. those which offer an immediate high.

While there is evidence that mood episode is a factor which can alter decision making processes in bipolar disorder, the mechanisms underlying this relationship are largely unknown. There is no single psychological model which accounts for all symptoms of bipolar disorder (Power, 2005). Literature on risk taking and risk decision making in the general population identifies a wide range of factors which could impact upon decision making, from neuropsychological (Rahman, Sahakian, Cardinal, Rogers, & Robbins, 2001) to personality and affect (Cooper, Agocha, & Sheldon, 2000). Neuropsychological processes may be particularly relevant to decision making in bipolar disorder as there is evidence of reduced performance in some areas of cognitive functioning, in and out of mood episodes. One review has found evidence for poor verbal memory and sustained attention across all mood states of bipolar (Quraishi & Frangou, 2002) although Clark and Sahakian (2006) present evidence that sustained attention deficits are worse in mania than euthymia. Visual

memory and executive functioning deficits have been identified during acute phases of bipolar illness (Qurishi & Frangou, 2002), although there is also evidence of executive functioning deficits during euthymia as well (Martinez-Aran, Vieta, Reinares, Colom, Torrent, Sanchez-Moreno, Benabarre, Goikolea, Comes & Salamero, 2004). There is also evidence for poor impulse control during mania (Swann, Anderson, Dougherty, & Moeller, 2001; Swann, Pazzaglia, Nicholls, Dougherty, & Moeller, 2003). Deficits in executive function, sustained attention, memory and impulse control, could all impact on quality of decision making, suggesting there could be deficits even during euthymic phases of bipolar.

Cognitive and motivational factors may also be relevant to decision making in bipolar disorder. Leahy (1999) has proposed a cognitive model of bipolar disorder where people with mania and depression are conceptualised as having mirroring cognitive styles, with manic individuals being “risk lovers” and biased towards maximising gain and depressed individuals being “risk averse” and aiming to minimise loss. Manic symptoms of grandiosity, increased self-esteem, belief in individual special powers, may lead a person to have a greater confidence in chances of success, leading to greater risk taking. Depressive symptoms such as loss of energy, apathy and feeling sad lead to a decrease in motivation and activity, and therefore one could predict there would be reduced levels of risk taking. A major hypothesis of bipolar disorder concerns the “Behavioural Activation System” (BAS), a hypothetical motivational system thought to drive approach of reward (Gray, 1990). The BAS hypothesis suggests that people with a diagnosis of bipolar disorder have a dysregulated BAS, which fluctuates to a greater extent than in the general population, leading to symptom development (Depue & Iacono, 1989; Depue, Krauss, & Spoont, 1987). Once activated, the theory also proposes that individuals are less able to regulate this activation and therefore continue to strive for goals for longer. This process may affect decision making as

individuals may have altered drive for reward during mood states, compared to the general population.

This paper seeks to systematically review the literature investigating decision making processes in people with a diagnosis of bipolar disorder. The primary aim is to explore illness-related factors such as mood episode, and personality traits, which could contribute to decision making deficits. It is beyond the scope of this review to explore social and environmental factors affecting decision making and behavioural choices, these factors may not be unique to individuals with bipolar disorder, and have been explored in previous reviews elsewhere (e.g. Meade & Sikkhema, 2005). However, these are clearly important factors which must be considered alongside personality and psychiatric diagnosis in an individual formulation of the decision making process. The specific research questions which will be addressed are as follows:

1. Are there differences in decision making quality across mania, depression and euthymic mood states in bipolar disorder?
2. Is there evidence for altered decision making processes across the mood states of bipolar disorder?
3. Are there any trait factors which have been identified as predictors of decision making deficits in bipolar disorder?

Method

A systematic review of the literature was conducted of papers investigating risk taking behaviour in people with a diagnosis of bipolar disorder.

Search strategy

Three databases: Medline, PsychInfo, and Cinahl were searched for relevant articles. The search terms were (“*risk taking*” or “*decision making*” or “*decision task*” or *gambling*) and (*mani** or *depress** or “*bipolar disorder*”). Further studies were obtained through hand searching the reference sections of the articles that were deemed suitable for inclusion. The advice of key researchers in the field of bipolar disorder was sought regarding recent publications.

The abstracts from all of the studies retrieved from the initial search were read and contents assessed by the author (SC) for relevance to the review question. The full texts of all relevant studies were then accessed and the author hand searched through the reference sections for relevant studies. Articles retrieved from hand searches were then assessed for relevance.

Data extraction

The full text of each study was thoroughly assessed for suitability for inclusion in the review.

The inclusion criteria for the review were as follows:

1. Studies of people with a primary diagnosis of Bipolar Disorder, determined by system criteria such as DSM-IV criteria.
2. Studies of risk decision making, using methods which involved participants choosing between options with uncertain outcomes, where there is potential for reward and loss.
3. Studies that have been published in a peer review journal.

4. Studies that were published in English.
5. Studies published since 1950
6. Studies which met a minimum research quality standard.

Studies were excluded if they had the following characteristics:

1. Studies which do not measure behavioural decision making (e.g. using personality measures / decisional capacity measures)
2. Studies of individuals where bipolar disorder was secondary to another psychiatric or substance abuse disorder.
3. Review articles.

A flowchart of the selection process of studies is presented in Figure 1 below. In total 19 studies met the inclusion criteria. A list of excluded studies is presented in Table 1.

Insert figure 1 here

Quality control

Research quality of the remaining papers was assessed using relevant questions from a checklist designed for both randomised and non-randomised studies by Downs & Black (1998). Questions designed to measure quality of intervention effectiveness were removed from the checklist as the review question is not concerned with intervention studies. Two questions were added by the author (SC), concerning quality of case-control studies. A copy of the final checklist is presented in Appendix 4.1. As some questions were only applicable to specific study designs, a quality percentage score was calculated from all relevant questions. In order to test for reliability of quality assessment, seven of the papers were reviewed independently by another trained researcher. There was an 87% agreement in

ratings, suggesting good reliability. Differences in ratings were then discussed and a shared agreement was reached. All 19 papers were deemed to meet a minimum research quality standard, based upon these ratings.

Results

The key findings for all the studies included in the review can be found in Table 2. This table also highlights which of the review research questions each study contributes to. All of the studies used computerised tasks to measure decision making, with the exception of one study (Misra, Socherman, Hauser, & Ganzini, 2008a) which used survey responses to hypothetical research consent forms. The tasks and their outcome variables are described in detail in Table 3. The findings have been grouped under the headings of the three research questions.

Insert tables 2 and 3 here

Quality of risk decision making across mood states

Thirteen of the included studies had quality of decision making as a primary outcome (see Table 2). Five studies used the Iowa Gambling Task (Adida, Clark, Pomietto, Kaladjian, Besnier, Azorin, Jeanningros & Goodwin, 2008; Clark, Iverson & Goodwin, 2001; Clark, Iversen, & Goodwin, 2002; Jollant, Guillaume, Jausent, Bellivier, Leboyer, Castelnau, Malafosse & Courtet, 2007; Yechiam, Hayden, Bodkins, Donnell & Hetrick, 2008) as a primary measure, and five studies used the Cambridge Gamble Task as a primary measure (Murphy, Rubinsztein, Michael, Rogers, Robbins, Paykel and Sahakian, 2001; Tavares, Clark, Cannon, Erickson, Drevets & Sahakian, 2007; Rubinstein, Underwood, Tempest & Sahakian, 2006; Rubinstein, Paykel & Sahakian, 2000; Roiser, Farmer, Lam, Burke, O'Neill, Keating, Powell Smith, Sahakian & McGuffin, 2009), which enables inter-study comparisons of decision making in different mood episodes. The remaining three studies (Ernst, Dickstein, Munson, Eshel, Pradella, Jazbec, Pine & Leibenluft, 2004; Holmes, Bearden, Barguil, Fonseca, Monkul, Nery, Soares, Mintz & Glahn, 2009; Misra et al., 2008a) are unique in their application of each decision making task to a bipolar disorder population.

The Iowa Gambling Task essentially measures an individual's ability to learn that choosing cards from less risky decks represents an optimal overall strategy, although immediate rewards may be smaller (see Table 3). Three of these IGT studies compared the performance of people in a manic episode to healthy controls (Adida et al., 2008; Clark et al., 2001; Yechiam et al., 2008). Both Adida et al. (2008) and Clark et al. (2001) found that manic individuals selected more cards from 'disadvantageous decks' than controls. Adida et al. (2008) used factor analysis on the Young Mania Rating Scale (YMRS; Young, Biggs, Ziegler & Meyer, 1978) and the Hamilton Depression Rating Scale (HAM-D; Hamilton, 1960) to investigate the effect of specific symptoms on decision making. The only factor to significantly correlate with IGT score was lack of insight, suggesting this symptom can predict poor decision making. Yechiam et al. (2008), however, did not find a difference in IGT score between an 'acute' bipolar disorder group and controls. This discrepancy could be due to the fact both Adida et al. (2008) and Clark et al. (2001) studied inpatients, whereas Yechiam et al. (2008) recruited their 'acute' group from the community, therefore it is likely that the inpatients had more severe symptoms. Also, the 'acute' group included seven people with mania, three with hypomania, two with depression and two in a mixed episode, therefore the lack of homogeneity in the group may have accounted for these differences.

Yechiam et al. (2008) applied cognitive modelling framework to decompose IGT performance in bipolar disorder into three components: the relative tendency to attend to gains and losses, relative tendency to pay attention to recent versus past outcomes, and choice consistency during the task. There were no differences between a bipolar group and controls on the first two components, but the acute bipolar group showed significantly lower choice consistency than controls, suggesting they did not learn a consistent strategy.

Two of the IGT studies tested people with a diagnosis of bipolar disorder who were euthymic / remitted. Neither Clark et al. (2002) nor Yechiam et al. (2008) found a significant

difference in task performance between bipolar and control groups. In a study of IGT performance across a population of individuals with wide ranging psychiatric disorders, bipolar disorder was the only psychiatric condition to significantly predict abnormal risk taking (Jollant et al., 2007). The authors describe the sample as euthymic, however, as they only screened participants for depressive symptoms, it is possible that participants were experiencing some manic symptoms at the time of participation, which might account for their findings. Also this study did not include a healthy control group. No studies were found that measured IGT performance in a depressed bipolar group.

The Cambridge Gamble Task is less complex than the IGT as the probability ratio of success is presented to participants on every trial, therefore, there is no need for inter-trial learning. Murphy et al (2001) found impaired decision making on the CGT in manic inpatients with bipolar I disorder, with manic individuals being more likely to choose a box with unfavourable odds than healthy controls and a unipolar depressed group. This outcome correlated significantly with manic symptoms, measured on the Young Mania Rating Scale. They also found that both a manic and unipolar depressed group took longer to make decisions than controls, and employed suboptimal betting strategies, suggesting some different and some similar disruptions to decision making processes in mania and depression. Two studies using the CGT with bipolar depressed groups had conflicting results (Rubinsztein et al., 2006; Tevares et al., 2007). The depressed group in Rubinsztein et al.'s study demonstrated slower and lower quality decision making than controls, whereas Tevares et al.'s (2007) found no between group differences. Neither study reported suboptimal betting strategies in bipolar groups. These contrasting findings may be due to depression severity, as Rubinsztein et al. recruited individuals with bipolar I disorder who met the criteria for current depressive episode and whose mean score on the Beck Depression Inventory was in the 'severe depression' range, whereas Tevares et al. (2007) did not screen

participants for depressive episode, and on the Montgomery-Ashberg Depression Rating Scale (MADRS) the mean score was in the moderate range. Two studies applied the CGT to remitted / euthymic bipolar groups (Rubisztein et al., 2000; Rosier et al. 2009). The former found no differences between groups on any of the outcome measures. Rosier et al. (2009) induced positive mood through a rewarding activity prior to testing and found longer decision making times in the bipolar group, although overall performance was not impaired. This suggests that even small mood increases may affect decision making processes, but not quality, although the absence of a baseline CGT score prior to mood induction makes any interpretation tentative.

Therefore, it seems that on a task measuring an individual's ability to use the information available to choose a likely outcome, and to adjust risk taking accordingly, these processes are disrupted by mania, and severe depression, but are generally intact during milder depression or euthymia.

Only one study was found (Misra et al., 2008) which did not use a computerised task in the assessment of decision making. Instead the authors measured likelihood to participate in hypothetical research studies with varying degrees of risk. The findings indicated that manic individuals (mostly inpatients) were just as able to discern risk in hypothetical research scenarios as well as euthymic bipolar individuals, and rated themselves as equally likely to participate. However, these outcomes were measured on a five point Likert scale, which would be much less sensitive to individual variation than task outcomes. Therefore, in this scenario, decision making was not impaired in mania, although the absence of a healthy control group means the possibility cannot be ruled out that decision making was impaired overall.

In a study of risk taking in a paediatric bipolar sample, no differences were found in selection of risky choices on a Wheel of Fortune task (Ernst et al., 2004). This was a mixed, but mostly depressed sample, as only one of the twenty two children with bipolar disorder did not have significant depressive symptoms and four children had significant manic symptoms. Thirteen of the children also had co-morbid ADHD, and thirteen had co-morbid anxiety, although neither of these subgroups were associated with altered task performance compared to children without each co-morbidity. Holmes et al. (2009) did not find any differences in risk taking on the Balloon Analogue Risk Task (BART) between mood states, when they divided their sample into depressed (n=28), remitted (n=24) and (hypo)manic (n=3) groups. Information about depression severity within the depressed group was not presented (as this was not the primary research question, but a secondary analysis).

Therefore there is some evidence for poor quality decision making during mania, although the only study measuring decision making in a “real world” scenario indicated no increased difficulties with understanding risk, and making appropriate decisions (Misra et al., 2008). However, there is little evidence of poor decision making in bipolar depression, unless the individual is severely clinically depressed (Rubinsztein et al., 2006), and there were no examples of poor decision making quality during euthymic or remitted phases.

Decision making processes across mood states

The studies included in this section of the review have all presented data on specific processes which contribute to decision making during different phases of bipolar illness. They can be grouped into studies of neurological processes of decision making (Frangou, Kington, Raymont, & Shergill, 2008; Rubinsztein, Fletcher, Rogers, Ho, Aigbihio, Paykel, Robbins, & Sahakian, 2001), behavioural and emotional responses to performance feedback (Ernst et al., 2004; Gorrindo, Blair, Budhani, Dickstein, Pine, & Leibenluft, 2005; Holmes et

al., 2009; Minassian, Paulus, & Perry, 2004), and advice taking prior to decision making (Mansell & Lam, 2006).

Neurological findings: Two studies reported neurological findings. Rubinsztein et al. (2001) used Positron Emission Tomography (PET) to investigate brain activation during the CGT in manic bipolar group compared to a unipolar depressed group and controls, whereas Frangou et al. (2008) used functional Magnetic Resonance Imaging (fMRI) technology to measure brain activity during the IGT in a remitted bipolar group and controls. Both studies found abnormal patterns of activation in bipolar groups, and neither study reported between group differences in task performance, although sample sizes were small. Rubinsztein et al. (2001) found manic participants demonstrated significantly greater activation in the dorsal anterior cingulate cortex, and decreased activation in the left frontal polar region, and right inferior frontal gyrus (both regions of the ventromedial prefrontal cortex (vPFC)). The authors highlight that these regions are interconnected, therefore the differences could reflect overall differences in neural circuitry. Frangou et al (2008) found no significant activity in the vPFC during the IGT in the bipolar group, whilst this region was activated in controls, and also reduced activity compared to controls in the dorsal prefrontal cortex (dPFC). The bipolar and control groups were matched by age, gender, and IQ and the clinical group had monotherapy with mood stabilisers, which reduces the chance of demographic and clinical variability confounding the results. The findings infer poor interaction between the ventral and dorsal prefrontal cortices in remitted bipolar disorder, and suggest the participants may have been somehow compensating for this using other areas of the brain to maintain performance. Therefore these neuroimaging studies tentatively suggest there may be differences in patterns of brain activity during decision making in bipolar disorder in both manic and remitted phases of illness, although this difference in activity may not always lead to poorer decisional outcomes.

Responses to feedback: Minassian et al. (2004) investigated the impact of error feedback upon the decision making process. They found as the error rate increased to 80%, bipolar patients with psychotic mania demonstrated a greater rate of switching than controls. There was no difference between groups in the influence of the previous response made to each decision made, nor location of the previous stimulus. Performance did not correlate with severity of manic symptoms, nor IQ, however, authors did not control for medication effects. The findings suggest individuals with psychotic mania have increased sensitivity to high error rates. However, this may not generalise to manic patients without psychosis. Gorrindo et al. (2004) also investigated response to feedback in children using a probabilistic response reversal task, and found a 'euthymic' bipolar group demonstrated reduced learning compared to controls during the reversal phase of the task. The authors did not apply a cut-off for participant inclusion based on manic and depressive symptoms, therefore, the participants, although described as euthymic, may not have been entirely out of an acute episode. Also ADHD symptom levels may have confounded the results as these were not factored into the primary analysis, but were found to correlate with likelihood of meeting the learning criteria on the task. Holmes et al (2009) measured balloon pumping following a popped balloon on the BART as an indicator of learning from previous failure. They found that a bipolar group with a history of substance abuse did not exhibit learning, whereas controls and a bipolar disorder group without a history of substance abuse did show learning. They did not compare mood state groups in this analysis, but both groups consisted of individuals in mostly depressed and remitted states. Together these findings tentatively suggest that people with a diagnosis of bipolar disorder may have difficulty making optimal use of error feedback across mood states, and history of substance could be a predictor of poor learning from feedback.

Ernst et al. (2004) present findings which indicate increased emotional engagement in the bipolar group during the 'Wheel of Fortune' task. The authors found greater dissatisfaction in the bipolar group with not winning during the win-no win section of the task, and greater satisfaction with not losing on the lose-no lose section, suggesting that the bipolar group placed greater value on outcomes than controls. The sample were also found to have lower confidence in a positive outcome during the lose-no lose phase, perhaps reflecting the high frequency of depressive symptoms in the sample. Therefore tasks of reward and loss, may evoke stronger feelings in depressed individuals with bipolar than the general population.

Advice taking: Mansell & Lam (2006) studied willingness to take advice, on a task where taking advice led to a positive outcome 50% of the time. The authors found that following positive mood induction, individuals with euthymic bipolar disorder significantly opposed advice compared to controls and a unipolar depressed group. This implies even small mood changes during euthymic phases of illness could lead to suboptimal decision making, as the individual may be more likely to discount the opinions of those around them.

Trait factors relevant to decision making in bipolar disorder

Two studies investigated the impact of trait impulsivity on decision making (Christodolou, Lewis, Ploubidis, & Frangou, 2006; Holmes et al, 2009). Christodolou et al. (2006) found performance on the IGT correlated significantly with the Non-planning subscale of the Barrett Impulsiveness Scales in a remitted bipolar group. Holmes et al. (2009) found the Motor subscale of the BIS correlated significantly with number of balloons popped on the BART, across all participants (mostly in depressed or remitted mood states). This suggests that specific aspects of trait impulsivity affect specific decisions to be made. As IGT performance requires the individual to develop a long-term strategy which overrides the immediate impulse to go for higher rewards at risk of higher losses, it seems logical that those who generally struggle with weighing up short and long term outcomes will have worse

performance on this task. The BART measures risk taking with greater uncertainty regarding outcomes, therefore on such decision making tasks, Motor Impulsivity (e.g. “I act on the spur of the moment”) would impair performance, but nonplanning might have less of an effect. None of the other included studies measured the relationship of trait variables to decision making in bipolar disorder.

Discussion

This literature review set out to explore decision making quality and processes across the mood states of bipolar disorder, and identify trait factors which impact upon these processes. The areas for discussion have been grouped into three main sections: the findings and implications of these findings, the limitations of the current research base, and directions for future research.

Findings

Decision making during bipolar remission

Among the tasks used in this review, there was little evidence for poor decision making quality during euthymic / remitted evidence of bipolar disorder. In tasks involving evaluation of risk, such as the IGT and CGT, euthymic / remitted individuals were found to demonstrate normal performance (Clark et al., 2002; Rosier et al., 2009; Rubinsztein et al., 2000; Yechiam et al., 2008). However, the only neuroimaging study of decision making in people with remitted bipolar disorder suggested altered neural processing of task information (Frangou et al., 2008). In addition, Gorrindo et al (2005) found slower learning from error feedback. Gorrindo et al.’s (2005) findings refer to a paediatric bipolar disorder sample, but impaired learning from error feedback during euthymia has also been demonstrated in adult populations on the Wisconsin Card Sorting Task (WCST) (Martinez-Aran et al., 2004; Van Gorp, Altshuler, Theberge, Wilkins, & Dixon, 1998). The WCST is a similar task to the

probabilistic response reversal task, but with no explicit reward / loss. This is interesting as decision making tasks, such as the IGT, require participants to learn from feedback, but overall performance was not found to be abnormal in all studies apart from Jollant et al (2007) who did not measure a healthy control group. This suggests that any difficulties with learning may be task specific, or may be too minor to have an impact on decision making.

Furthermore, following positive mood change, remitted bipolar groups have been found to significantly oppose advice (Mansell & Lam, 2006) and demonstrate slower decision making (Rosier et al., 2009) than healthy controls. In Mansell & Lam's (2006) study the advice was only correct 50% of the time, therefore does not suggest that people with a diagnosis of bipolar disorder would oppose sensible advice, which was clearly in their best interests. Therefore, these few studies suggest that very specific aspects of the decision making process could be disrupted, or sensitive to disruption through small mood change, when people with bipolar disorder are out of an acute episode. However, due to small sample sizes, and limited ecological validity of the study designs, there is clearly need for further investigation in this area.

Decision making during mania

There was certainly evidence for impaired decision making quality and altered processes during a manic episode. Mania is associated with suboptimal decision making in tasks involving assessment of probabilities and choosing the most likely outcome (Murphy et al., 2001), finding and / or maintaining a long-term strategy in the face of immediate reward / loss (Adida et al., 2008; Clark et al., 2001), and increased sensitivity to error feedback (Minassian et al., 2004). There is evidence of altered neural circuitry during mania, with reduced activation in the vPFC and increased activation in the dorsal anterior cingulate (Rubinsztein et al., 2001). These findings suggest that altered decision making processes are

a considerable contributing factor to excessive risk taking behaviour, which is a known characteristic of mania. In particular, lack of insight can predict poor decision making (Adida et al., 2008). Decision making is likely to be impaired due to poor cognitive functioning during mania (see introduction for a summary), although the studies in this review do not directly test the relationship of specific cognitive functions to decision making. The dysregulated BAS hypothesis (see introduction) which postulates that during mania, individuals show increased goal striving and continue to pursue rewards for longer was partly tested by Yechiam et al., (2008), who used cognitive modelling to identify specific processes during the IGT. The authors found individuals with acute bipolar did not show elevated attention to rewards, however, this group was not a purely manic group therefore the evidence is insufficient to counter the hypothesis. None of the other studies tested the impact of goal striving on performance during mania.

Decision making during depression

The findings regarding decision making during bipolar depression seem to depend upon severity of depression. Three out of the four studies of decision making in bipolar depression did not find any impaired risk decision making (Ernst et al., 2004; Tevares et al., 2007; Holmes et al., 2009), although, the only study to use DSM-IV depressive episode criteria for inclusion did find that people with bipolar depression were impaired in assessing probabilities and choosing the most likely outcome (Rubinsztein et al., 2006).

These findings are similar to findings of with people with unipolar depression. Must, Szabo, Bodi, Szasz, Janka and Keri (2006) found impaired performance, i.e. increased selections from risky decks on the IGT in a clinically depressed group compared with controls. The authors found that while there was impaired executive functioning on the WCST in the depressed group, this did not correlate with IGT performance suggesting the results were not

only due to executive functioning deficits. However, Smoski, Lynch, Rosenthal, Cheavens, Chapman and Krishnan (2008) reported that depressive participants made more choices from less risky decks than controls, leading to better overall performance on the IGT. These participants were screened with the HAM-D for at least moderate depression, but clinical diagnosis was unknown. Smoski et al.'s (2008) results suggest that the depressed individuals had greater risk aversion leading to better overall performance, whereas Must et al. (2006) suggested that participants with MDD may show increased risky selections to compensate for emotional blunting or as a result of increased behavioural impulsivity.

Therefore, perhaps the symptoms usually present in mild-moderate depression are associated with cautious but largely intact decision making, but additional or more severe symptoms which are associated with moderate-severe depression impair decision making. Possible symptoms, which at the severe end could impair decision making, could be poor concentration, indecisiveness, hopelessness and suicidal ideation and behaviour. For instance, in Jollant et al.'s (2007) study psychiatric participants with a history of suicide attempt demonstrated worse IGT performance, suggesting decision making deficits in depression may predict suicidal behaviour.

Trait factors affecting decision making in bipolar disorder

The impact of trait factors which might be relevant to bipolar disorder, such as impulsivity and sensitivity to reward, on decision making processes, is largely unexplored by the literature in this review. However, the two studies which included a measure of trait impulsivity, both found that specific elements of impulsivity have some predictive value of risk decision making. These findings highlight that impulsivity is an umbrella term which includes a number of different patterns of behaviour, and specific elements of impulsivity

may be associated with suboptimal decision making, depending on the nature of the decision to be made.

In summary, the findings suggest that both state and trait factors influence risk decision making in bipolar disorder, as there are some processes which can be disrupted across mood states, and some which are mood state specific. However, this is clearly a relatively new field of research, as all of the studies included in this review were completed during the last 10 years. There are, therefore, many questions left unanswered regarding the mechanisms of how mood state can disrupt decision making, leaving huge scope for future research in this area.

Limitations of findings

Due to the difficulties associated with measuring decision making in a naturalistic setting, all but one of the studies of decision making in bipolar disorder use computerised tasks to create decision making outcomes. The primary limitation of the findings is the largely unknown generalisability of performance on computerised risk taking tasks to “real world” risk decision making. As each task reflects a specific process, or collection of processes, they offer insight into specific internal processes, which may have some predictive value, although the tasks neglect social and environmental factors which may also influence behaviour. There is, however, evidence suggesting people who abuse substances perform worse on the IGT (Bechera, Dolan, Denburg, Hines, Anderson & Nathan, 2001), the CGT (Rogers, Everitt, Baldacchino, Blackshaw, Swainson, Wynne, Baker, Hunter, Carthy, Booker, London, Deaking, Sahakian & Robbins, 1999) and the BART (Bernalova, Daughters, Hernandez, Richards & Lejuez, 2005). The authors of the BART have also found BART scores can predict smoking (Lejuez, Aklin, Jones, Richards, Strong, Kahler & Read, 2003a), adolescent risk taking behaviours (Lejuez, Aklin, Zvolensky & Pedulla, 2003b; Aklin, Lejuez, Zvolensky, Kahler & Gwadz, 2005) and risky sexual behaviours among residents in a

substance abuse treatment unit (Lejuez, Simmons, Aklin, Daughters & Dvir, 2004). Some predictions can be made about other behavioural correlates of IGT and CGT performance as these tasks have been found to be significantly impaired in subjects with lesions in specific parts of the brain, specifically the vPFC (and the orbitofrontal PFC (Rogers et al., 1999). Therefore it could be hypothesised that people with impaired performance on these tasks will show behaviours associated with lesions in these areas, such as poor social judgements (Bechera, Damasio, Tranel, & Damasio, 1997). The real world behavioural correlates of the other tasks included in the review are unknown. Therefore, while there is some evidence of external validity of computerised tasks, the current evidence base offers limited predictive value to real life scenarios.

Complex tasks, such as the IGT are valuable because they reflect the “real world” complexity of weighing up decisions and choosing outcomes. However, they also have the limitation of being difficult to interpret in terms of underlying processes, as task performance could be determined by motivational and/or cognitive processes. This limitation has been raised previously in relation to the IGT (Busemeyer & Stout, 2002). One of the studies (Yechiam et al, 2008) used cognitive modelling to decompose IGT performance, and suggested that only choice consistency was impaired in bipolar disorder, but without this information from the other IGT studies, it is impossible to compare findings. Similarly, BART performance in Holmes et al’s (2009) study could reflect the cognitive ability to learn an optimal strategy over time, or individual motivation to achieve or both. The authors address this partially, by presenting data regarding learning following a popped balloon, but the exact mechanisms which underlie abnormal performance in the group with a history of substance abuse can only be speculated. Cognitive modelling has been applied to this task as well (e.g. Wallsten, Pleskac & Lejuez, 2005), and could be a valuable component of future research into bipolar disorder to aid interpretation of results. Other tasks included in the review, such as the CGT,

or Minassian et al's (2004) two choice prediction task are easier to interpret as they evaluate simpler processes, but then face the counter limitation of having reduced external validity.

Another limitation of the existing literature is the lack of studies comparing groups of individuals in different bipolar mood states with controls, as this would be a provide clearer evidence of whether any impaired performance in bipolar disorder was a trait or state factor. Furthermore, the literature focuses mostly on pure manic and depressive episodes, but decision making during mixed episodes or rapid cycling bipolar disorder is largely unexplored. Finally this review included two studies of paediatric bipolar groups. As adolescence is a time of elevated risky decision making across the general population (Boyer, 2006), the findings may not be generalisable to adults, as the control group may have exhibited elevated risk decision making.

Review limitations

Many of the studies were conducted by either of two main research groups, and often with the same authors, (for example Murphy et al, 2001 and Rubinstein et al. 2000; 2001; 2006 belong to the same group). This has the advantage of making the studies directly comparable, but potentially limits the generalisability of the findings, due to the same / similar experimental conditions being created for each study. The evidence base is small, with only 19 studies found which investigated this issue. The search strategy was limited to published material, from peer review journals, which can improve quality of the findings, but which may have omitted some valuable evidence from unpublished doctoral theses, or other unpublished sources.

Directions for Future research

This review has highlighted many areas for future research. Firstly, further information is needed on the precise nature of the decision making deficit across different mood states. It

would be particularly interesting to apply cognitive modelling to IGT performance of a purely manic sample, in order to highlight the processes which underlie the impairment. It would also be important to explore further which cognitive functions might disrupt decision making on different tasks.

Further research could measure the ability of trait personality variables to predict variance in decision making within different mood states. In particular it would be interesting to test further how motivation and drive for reward impacts upon decision making, and whether this can lead to suboptimal decision making in bipolar disorder. Suggested methodologies could be using the BIS/BAS scales as a measure of trait sensitivity to reward, or, as in Yechiam et al. (2008), using cognitive modelling approaches to tease out an individual's tendency to pay attention to rewards.

It is possible that participants also gain an emotional reward from the tasks, but this has been largely neglected by the current literature, except in Ernst et al.'s (2004) study, where children with bipolar disorder were found to have greater emotional responses than controls to certain task outcomes. This suggests there is value in future research measuring emotional response to tasks as it could offer further information regarding the underlying processes.

Finally, it must be recognised that use of computerised tasks to measure decision making processes is just one methodology for exploring this complex area and that there is also great clinical value in qualitative methodologies. For example, Healey et al. (2009) conducted a qualitative study of reasons for substance use among people with co-morbid bipolar and substance use disorder and identified five major themes why these individuals used substances, but concluded that reasons for substance use were unique to the individual and evolve through personal experience. This reminds us that while decision making processes are clearly an important factor in the development of risky behaviours, there are other

environmental and social factors which can influence behaviour, and can cause an individual who is capable of making good quality decisions to make suboptimal choices.

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Figure 1. A flowchart of the study selection process

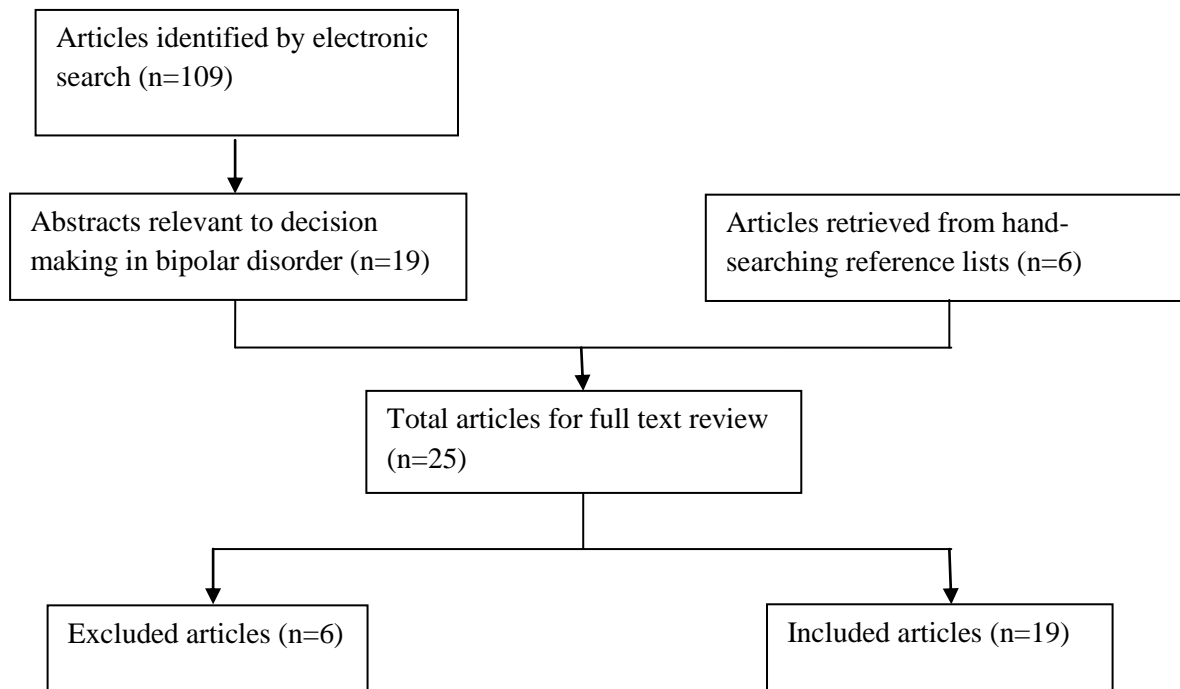


Table 1. Table of excluded studies

Reason for exclusion	Author(s)
Uses a questionnaire measure of risk taking	Thomas et al (2007)
Task was not a decision making task	Benedetti et al (2007) Corwin et al (1990)
Measured decisional capacity but not actual decision making	Palmer et al (2007)
Did not measure actual decision making, just understanding of information / hypothetical decision making	Misra et al (2008b)
Task did not have uncertain outcomes (each picture had a fixed value which participants had to learn)	Rau et al (2008)

Table 2. Table of included studies.

Author (s)	Participants	Mean Age in years	% male	Risk taking measure	Key findings	Decision Quality	Decision Process	Personality / temperament	Paper quality %
Adida et al (2008)	45 BP manic 45 controls	37.8 37.3	51.11 51.11	IGT	Manic patients chose a higher proportion of cards from risky decks than controls Decision making in manic patients was strongly related to lack of insight	√			88.9
Christodoulou et al (2006)	25 BP remitted	48.3	40	IGT	Positive correlation between performance on IGT and non-planning impulsivity on BIS			Impulsivity (BIS)	64.3
Clark et al 2002	30 BPI euthymic 30 controls	35.9 37.6	56.7 53.3	IGT	No difference in IGT score between groups	√			94.4
Clark et al 2001	15 BP manic 30 controls	35.4 37.6	66.7 53.3	IGT	Manic patients chose a higher proportion of cards from risky decks than controls	√			83.3
Ernst et al (2004)	22 BP mixed 22 controls	13.8 13.6	68.2 50	Wheel of Fortune	No difference in selection patterns between groups. BP group less confident than controls in lose- no lose task BP group had greater dissatisfaction with not winning on win – no win task BP group had greater satisfaction at not losing on lose – no lose task	√	√		83.3
Frangou et al (2008)	7 BP remitted 7 controls	37 39	71.4 71.4	IGT	During IGT, BP group showed attenuated activation in ventral and dorsal pre-frontal cortices. BP group showed increased activation in lateral and polar temporal regions compared to controls.		√		88.9
Gorrindo et	24 BP	13.6	58.3	Probabilistic	BP group made more errors than controls		√		77.7

al (2005)	euthymic 25 controls	14.5	48	response reversal task	during reversal phase of task. BP group less likely to learn the reward object, only in the 80:20 reversal phase.				
Holmes et al (2009)	31 BP (A) mixed 24 BP (N) mixed 25 Controls	42.4 39.5 38.3	51.6 20.8 44	BART	Only BP group with a history of substance abuse (A) exploded more balloons than BP (N) and controls. Both BP groups had higher BIS scores than controls.	√	√	Impulsivity (BIS)	88.2
Jollant et al (2007)	66 BP euthymic 251 patients with other psychiatric diagnosis	N	N	IGT	BP group chose a significantly higher proportion of cards from risky decks than patients with other psychiatric diagnoses.	√			62.5
Mansell et al (2006)	32 BP1 euthymic 32 UP remitted 32 controls	45.47 39.97 43.56	34.4 34.4 34.4	Advice task	BP1 group significantly opposed the advice given in the task after the high mood induction. This pattern of behaviour was significantly different to controls, and remained significant when controlling for possible confounds.		√		83.3
Minassian et al (2004)	14 BP psychotic manic 14 controls	36.5 32.4	64.3 42.9	Two choice prediction task using 3 error rates (20, 50, 80%)	BP patients showed an increased sensitivity to error rate changes and switched more frequently at high error rates than controls. There were no differences between groups on the degree to which each response could be predicted by previous response or stimulus.		√		58.8
Misra et al (2008a)	26 BP manic 25 BP euthymic	47.7 53.4	80.8 84	Hypothetica l research consent forms	There were no significant differences between groups on likelihood to participate in any of the 3 studies, nor appreciation of risk of each study.	√			77.7
Murphy et al (2001)	18 BP manic 22 UP depressed	36.3 39.4	44.4 40.9	CGT	Both BP and UP groups demonstrated impaired performance on CGT, with slower deliberation times, performance (points	√			83.3

	26 controls	36.4	46.2		collected) and less effective betting strategies compared to controls. BP group made 'suboptimal' decisions (chose least likely option) more often than UP or control group.		
Rosier et al (2009)	15 BP euthymic 19 controls	44.4 35.4	33.3 84.2	CGT	Following positive mood induction, BP group performed more slowly on CGT than controls, particularly at lower probabilities of success. BP group did not differ from controls on quality of decision making, nor percentage of points bet on a positive outcome.	√	83.3
Rubinsztein et al (2000)	18 BP remitted 18 controls	42 38	N	CGT	No difference between BP and controls on quality of decision making or betting strategies. Response latencies were greater in BP group, and this difference tended towards significance.	√	77.7
Rubinsztein et al (2001)	6 BP manic 6 UP depressed 10 controls	34 32 31	100 100 100	CGT	BP group showed greater activation in left dorsal anterior cingulate, and decreased activation in right frontal polar region and inferior frontal gyrus compared to controls. UP group did not show different patterns of activation compared to controls in these regions. Activation in anterior cingulate was correlated with severity of manic symptoms.	√	83.3
Rubinsztein et al (2006)	24 BP depressed 26 Controls	43.7 39.3	N	CGT	BP group made 'suboptimal' choices more often than controls, and had significantly longer response latencies. There were no differences between groups on betting strategy	√	83.3

Tavares et al (2007)	22 MDD depressed	38.6	22.7	CGT	BDII group did not differ from controls on quality of decision making, speed of decision making nor betting strategies. MDD group showed impaired decision making following a loss compared to BP and controls.	√		77.8
	17 BPII depressed	32.6	29.4					
	25 controls	34.8	28					
Yechiam et al (2008)	28 BP			IGT	No difference between groups in proportion of choices from risky decks. Cognitive modeling indicated significantly lower choice consistency in BP acute group than BP remitted or control groups, but no increased attention to gains.	√	√	82.4
	14 Acute	43.1	50					
	14 Remitted	45	57.1					
	25 controls	39.2	36					

Abbreviations

BP = participants with bipolar disorder, MDD = participants with major depressive disorder, UP = participants with unipolar depression, BPII = participants with bipolar II disorder, BP (A) = participants with bipolar disorder and a history of alcohol abuse, BP (N) = participants with bipolar disorder and no history of alcohol abuse, IGT = Iowa Gambling Task, BART = Balloon Analogue Risk Task, CGT = Cambridge Gamble Task (also known as Decision Task), BIS = Barrett Impulsiveness Scales

Table 3. Summary of decision making tasks

Test	Authors	Description	Measures
Advice task	Mansell & Lam (2006)	Two choice decision task, where participants guess the location of a token. In each trial a computerised face appears and offers advice as to the location of a token. The advice is correct 50% of the time. Face valence varies across trials from positive, to negative to neutral.	Number of trials that individual takes advice
Balloon Analogue Risk Task (BART)	Lejuez et al. (2002)	Subjects are asked to pump up a balloon and win a small monetary reward for each pump. Subjects can collect the money earned at any point. If the balloon pops before subject collects, subject loses all money for that trial. Subjects typically complete blocks of 30 trials (30 balloons) with a mean explosion point of 64 pumps.	Adjusted pumps (mean number of pumps across unexploded balloons) Number of exploded balloons can also be used as an outcome measure
Cambridge Gamble Task* (CGT)	Rogers et al. (1999)	Subjects decide on whether a token is hidden under a red or blue box from 10 boxes. Different ratios of red and blue boxes are presented (6:4, 7:3, 8:2, 9:1). Subjects then bet a percentage of current points total on whether their choice is correct. Points won / lost are added to total, then subject continues to next trial.	<i>Quality of decision making</i> (Number of times a subject chose the most likely outcome) <i>Speed of decision making</i> (Response latency) <i>Risk adjustment</i> (rate at which betting increases with more favourable outcomes)
Iowa Gambling Task	Bechera et al. (1994)	On each trial, subjects make a card selection from one of four packs and can win or lose money depending on their choice. Two packs (A and B) associated with high wins but high losses, and two packs (C and D) associated with low wins but low losses. Over time, decks C and D are more profitable.	Proportion of overall choices from risky decks (A and B)
Two choice prediction task	Paulus et al. (1997)	Subjects predict whether a car will appear to the right or left of a house. Error rates are fixed at 50% (128 trials), 20% (64 trials), 80% (64 trials).	Response biases (right / left or switch / stay)
Wheel of Fortune Task	Ernst et al. (2004)	Subjects choose between 2 options on a Wheel of Fortune. Subjects are given information about likelihood of winning in each option and amount to be won. If the subject wins, points are accumulated. Subjects are then asked to rate on a 5 point Likert scale how sure they are of winning. Following feedback, subjects are asked how they feel on a 5 point scale.	Frequency of risky selections Confidence Ratings Response to feedback (win / lose)

*also known as the Decision Task

*The effect of mood and trait sensitivity to reward on risk taking in
bipolar 1 disorder*

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Please see Appendix 2.1 for the Guideline for Authors.

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Abstract

‘Excessive’ risk taking behaviour is a clinical characteristic of a manic episode, which can lead to harmful consequences for the individual with bipolar disorder. This study investigated the hypothesis that risk taking behaviour may be more sensitive to change following mood induction in people with bipolar disorder than in controls. Participants were 26 people with bipolar I disorder who were out of an acute episode and 28 healthy controls. Risk taking was measured using the Balloon Analogue Risk Task (BART; Lejuez et al, 2002), a computerised task that has been found to correlate with real world risky behaviours. After baseline measures, participants were randomly assigned positive or negative mood induction and completed two sets of BART trials, before and after mood induction. Trait sensitivity to reward was also measured, as a potential factor underlying BART performance.

The primary hypothesis was not supported by the findings, nor could the variance in risk taking before or after mood induction be explained by trait sensitivity to the Behavioural Activation System. The bipolar group demonstrated less risk taking at baseline than controls. The results suggest excessive risk taking behaviour may be specifically associated with manic symptoms other than positive affect. However people with bipolar disorder may make poorer quality risk decisions out of an acute episode than controls.

Introduction

Risk taking in bipolar disorder

Risk taking behaviour is a symptom of mania, which can have negative long-term consequences for individuals with bipolar disorder. Risk taking can be defined as behaviour that could cause the individual to experience danger or harm, but which also offers some form of reward (Leigh, 1999). The diagnostic criteria for a manic episode includes “*excessive involvement in pleasurable activities that have a high potential for painful consequences*” (DSM-IV-TR; American Psychiatric Association, 2000). Examples of such activities include risky sexual behaviour, going out on spending sprees, and investing money unwisely (Lam & Jones, 2006), as well as substance abuse. These behaviours can have emotional, financial, social and health costs to the individual, as well as to family / friends and the wider community. For instance, people with bipolar disorder are much more likely to develop a substance abuse disorder than the general population (Regier, Farmer, Rae, Locke, Judd & Goodwin, 1990), with a recent systematic review estimating that 21-34% (Fajutrao, Locklear, Priaulx & Hayes, 2009) of people with a diagnosis of bipolar disorder have a co-morbid substance abuse disorder.

While it is understood that risk taking behaviour is associated with mania, there is no single psychological model of risk taking in bipolar disorder (e.g. Power, 2005), that explains how these behaviours develop. Leahy (1999) conceptualises differences in processing of risk decision making between mania and depression, suggesting that manic individuals are “risk lovers” with the aim of maximising gains, whereas depressed individuals are “risk averse”, with a primary goal of minimising losses. An alternative theory is the “depression avoidance” hypothesis, which states that individuals with bipolar disorder develop mania as a result of ineffective coping strategies to avoid depressive symptoms. Risk taking is thought to be one set of behaviours that manic individuals use to avoid depression. Thomas,

Knowles, Tai and Bentall (2007) found that people with bipolar disorder in a manic episode scored significantly higher on the risk taking items of the Responses to Depression scale than depressed and remitted bipolar groups, and controls. Both of these theories suggest that risk decision making processes are mood state dependent.

Factors affecting risk taking: mood state

Recent research has aimed to understand the impact of mood episode on risk decision making processes in people with a diagnosis of bipolar disorder. Studies using the Iowa Gambling Task (Bechera, Damasio, Damasio & Anderson, 1994) have found that manic individuals are more likely than controls to select cards from “risky” decks than controls (Adida, Clark, Pomietto, Kaladijan, Besnier, Azorin, Jeanninjgros & Goodwin, 2008; Clark, Iversen & Goodwin, 2001a), but that euthymic bipolar individuals demonstrate no difference in task performance to controls (Clark, Iversen & Goodwin, 2002; Yechiam, Hayden, Bodkins, O’Donnell & Hetrick, 2008). Several studies have investigated performance on the Cambridge Gamble Task in each of the mood states of bipolar disorder. The outcome variable that is relevant to risk taking is the percentage of accumulated points participants are willing to bet on correctly identifying the location of a token. Murphy, Szabo, Bodi, Szasz, Janka and Keri (2001) found manic individuals had betting strategies which lead to greater losses compared with controls, however, studies of depressed bipolar groups have found no significant differences from controls in percentage bets (Rubinsztein, Michael, Underwood, Tempest & Sahakian, 2006; Tavares, Clark, Cannon, Erickson, Drevets & Sahakian, 2007) nor between euthymic bipolar individuals and controls (Rubinsztein, Michael, Paykel & Sahakian, 2000). This suggests that people with a diagnosis of bipolar disorder may have a reduced ability to calculate risk, or adapt their behaviour in relation to the size of the risk during mania, but these effects are not noticeable at during depression or euthymic states. However, performance on both of these tasks could represent a number of different cognitive

processes, including responses to previous trial feedback, understanding of the task and ability to use ratios to work out the optimal strategy. Indeed Yechiam et al. (2008) found that acute bipolar patients demonstrated low choice consistency on the IGT but did not demonstrate differences in their attention to rewards and losses, nor were they differentially influenced by previous outcomes. Therefore these tasks measure a combination of complex processes, and cannot be interpreted purely as a measure of an individual's preference for taking risks.

Holmes et al. (2009) used the Balloon Analogue Risk Task (BART) to measure risk taking propensity in bipolar disorder. The benefits of this task are that participants cannot work out the likely outcome of each individual trial, whereas in the IGT and CGT, the participant can use ratios to work out the likelihood of success. This means there is a greater risk taking component to the task. The authors did not set out to investigate the impact of mood state on risk taking, but in a post hoc analysis, found no differences between groups of depressed, remitted and (hypo) manic patients. However, the very small numbers of (hypo) manic individuals in the group (n=3) make it impossible to conclude anything about the effect of mania on this task.

Mood induction procedures with euthymic bipolar groups have been used as a means of separating trait from state processes affecting the symptoms of bipolar disorder. Wright, Lam and Newsom-Davis (2005) found that following positive mood induction, scores on the items of the Dysfunctional Attitudes Scale relating to goal attainment and achievement decreased by a lesser amount than in a unipolar depressed group and healthy controls. Mansell and Lam (2006) found that following positive mood induction, a bipolar group significantly opposed advice offered for a task which was designed so that the advice led to a correct response 50% of the time. Two studies have investigated mood induction on tasks involving risk taking. In a sample of individuals with previous subclinical hypomania, Clark, Iverson

and Goodwin (2001b) found no differences in performance on the IGT between positive and negative mood induction groups, nor between this group and a control group who had never experienced hypomania. Recently, Rosier, Farmer, Lam, Burke, O'Neill and Keating (2009) found no difference in percentage bets on the Cambridge Gamble Task post positive mood induction between a bipolar group and controls. Neither of these studies measured risk taking at baseline, which makes it difficult to gauge the effect of the mood induction procedure on behaviour. Therefore, there is some evidence for mood state-related differences in cognition in bipolar disorder. However, research to date has not found that mood induction has a significant impact on risk decision making.

Factors affecting risk taking: trait factors

There may also be trait factors which predispose bipolar individuals to risk taking. Several studies have found increased impulsivity in bipolar disorder even during euthymic phases (Peluso, Hatch, Glahn, Monkul, Sanches, Najt, Bowden, Barratt & Soares, 2007; Swann, Anderson, Dougherty & Moeller, 2001) which could predispose an individual towards risk taking. However, recent research has found that performance on the BART only correlated with the motor impulsivity subscale of the Barrett Impulsiveness Scale indicating that impulsivity and risk taking are two distinct constructs (Holmes et al., 2009).

Another trait construct which is thought to be relevant to bipolar disorder is the "Behavioural Activation System". The Behavioural Activation System (BAS) was proposed by Gray (1990) as one of three hypothetical systems which govern behaviour. It is thought to be activated by signals of reward and non-punishment (Gray, 1990). High activation of the BAS is associated with approach of rewards, as well as positive affect, or anger, and high motivation (see Urosevic, Abramson, Harmon-Jones & Alloy, 2008). The BAS is thought to

work alongside a second system, the Behavioural Inhibition System (BIS) which is activated by signals of potential punishment and conversely inhibits goal-directed behaviour.

It has been theorised that the symptoms of bipolar disorder reflect a dysfunctional Behavioural Activation System (Depue & Iacono, 1989; Depue, Krauss & Spont, 1987). Initially, the theory proposed that high activation of the BAS led to the increased “approach” behaviour demonstrated in mania. Low activation of the BAS was thought to contribute to depression. However, this does not explain why people with a diagnosis of bipolar disorder experience both mania and depression. More recently it has been proposed that the system regulating the BAS is dysfunctional in people with a diagnosis of bipolar disorder (Depue & Zald, 1993). Therefore once activated, people with bipolar disorder are thought to experience greater positive affect and drive for further reward than the general population in situations with the potential for reward. It is also hypothesised that a dysregulated BAS takes longer to return to its natural state (Holzwarth & Meyer, 2006; Wright, Lam & Brown, 2008).

However, there is also evidence to suggest that trait sensitivity to the BAS, measured by a self-report instrument known as the BIS/BAS scales (Carver & White, 1994) may be elevated in bipolar groups compared to control groups. Meyer, Johnson and Winters (2001) used the BIS / BAS scales and Salavert, Caseras, Torrubia, Furest, Arranz, Duenas and San (2007) used the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (Torrubia, Avila, Molto, & Caseras, 2001) as a measure of BIS and BAS sensitivity, and both found elevated trait sensitivity to BAS in euthymic bipolar groups compared to controls. The authors also found that BAS sensitivity could predict symptoms of bipolar disorder over time. Meyer et al. (2001) found that BAS scores on the BIS/BAS scales predicted size of increase in manic symptoms over time. The authors also found that the BIS scores predicted depressive symptoms during a depressive episode but did not predict the course of development of these symptoms. Salavert et al. (2007) found that 18 months following an assessment of BAS

sensitivity in euthymic individuals with bipolar I disorder, those patients who had experienced a depressive relapse had lower scores on the BAS than those who had a manic / hypomanic relapse. It would therefore be interesting to explore whether trait and state drive for reward and sensitivity to punishment play a role in the development of risk taking behaviour, given that there is evidence that the system underlying drive for reward is disrupted in bipolar disorder.

Research aims

This study aims to use a mood induction procedure to investigate the impact of mood change on risk taking among individuals with bipolar disorder who are out of an acute episode. The study will extend previous research by measuring risk taking pre and post mood induction in order to compare the relative change in risk taking between bipolar and control groups. The effect of individual understanding of task on task performance will be minimised by informing participants of the optimal strategy on the task. A second aim of the study is to investigate whether trait sensitivity to the BAS or BIS are associated with risk taking behaviour on the BART, as dysregulation of the BAS is a major theory of bipolar disorder (Urosevic et al., 2008). As high BAS sensitivity is associated with high drive to approach rewards, and high BIS sensitivity is associated with fear of failure, anxiety and increased sensitivity to punishment, these trait vulnerabilities may predict some of the variance across all participants in BART performance.

Research Hypotheses

1. Mood changes following mood induction will have a greater impact upon participants with a diagnosis of bipolar disorder than controls, with larger increases in risk taking following positive mood induction, and larger decreases in risk taking following negative mood induction.

2. Across the whole sample of participants, those who have a high BAS sensitivity will take greater risks on the tasks, to achieve the reward, whereas those who have a high BIS sensitivity will be more sensitive to the balloon popping and will take fewer risks.

Method

Design

The primary research question had a mixed design with two between subjects variables (positive / negative mood induction and clinical / control group) and one within subjects variable (pre and post mood induction).

Participants

Participants were aged between 18-70 years and spoke English as a first language.

Clinical participants were recruited from voluntary organisations and from a research volunteer list. All participants were screened using the Structured Clinical Interview for DSM-IV-TR (SCID-1; First, Gibbon, Spitzer & Williams, 2002) for history of and current Axis 1 disorders. Participants were included into the bipolar disorder group (BD) if they met the criteria for at least one past manic and past depressed episode, but not a current mood episode. Participants were excluded if they met the criteria for co-morbid substance dependence disorder or current schizoaffective disorder (with psychotic symptoms occurring outside of a bipolar episode).

Control participants were recruited using opportunity sampling in local community groups. Individuals were recruited who had no reported current or past diagnosis of psychiatric disorder. Participants were excluded from the control group (C) if they met the criteria for a current or past Axis 1 disorder on the SCID-1 (Spitzer, Williams, Gibbon & First, 1992).

All participants were screened for current symptom level with the Beck Depression Inventory-II (BDI-II; Beck, Steer & Brown, 1996) and Mania Rating Scale (Bech, Rafaelson, Kramp & Bolwig, 1978), and were excluded from the study if their BDI-II score exceeded

16, indicating current depressive symptoms, or their MRS score exceeded 9, indicating mild hypomania.

Instruments

Structured Clinical Interview for DSM-IV-TR (SCID-I; First et al., 2002): The SCID-I is a semi structured interview designed for use in the diagnosis of Axis I disorders in the DSM-IV-TR (American Psychiatric Association, 2000). Previous studies have found a good inter-rater reliability for the SCID-I for DSM-III-R in the diagnosis of bipolar disorder (Williams, Gibbon, First & Spitzer, 1992). The SCID-I is divided into six modules which measure mood episodes, psychotic symptoms, psychotic disorders, mood disorders, substance use disorders, and anxiety, adjustment and other disorders. The author was trained and supervised in administering the SCID-I by an experienced researcher in bipolar disorder. The SCID-I interviews were conducted by the author and another trained researcher, and were audio recorded. Recordings of four of the interviews conducted by the author were independently rated by the second researcher for primary diagnosis and past or present co-morbidities. There was 100% agreement in both primary and secondary diagnosis.

Beck Depression Inventory-II (BDI-II; Beck, Steer & Brown, 1996): The BDI-II is a 21 item self-report questionnaire designed to measure cognitive and behavioural depressive symptoms over the last two weeks. Items are scored out of 3, and a score of 14-19 is considered to indicate mild depression, 20-28 indicates moderate-severe depression, and 29-63 indicates severe depression. The BDI-II has been found to have high internal consistency (coefficient alpha = .91, Dozois, Dobson & Ahnberg, 1998).

Mania Rating Scale (MRS; Bech et al., 1978): This clinician-rated scale is designed to give an indication of current level of manic symptoms. It consists of 11 items, each scored out of

5. This measure has good internal consistency (Cronbach's Alpha= .90; Bech, 2002) and good inter-rater reliability (Bech et al., 1978).

Wechsler Test of Adult Reading (WTAR; The Psychological Corporation, 2001): The WTAR is used widely as a measure of pre-morbid IQ. It was developed and co-normed with the Wechsler Adult Intelligence Scales–III (Wechsler, 1997), therefore it is useful as a predictor of full scale IQ on the WAIS-III. Subjects are tested on their pronunciation of 50 words. In this study predicted full scale IQ scores were calculated using tables provided in the Handbook, which take into account participant age, educational demographics (i.e. the highest level qualification achieved) plus WTAR score.

Balloon Analogue Risk Task (Lejuez et al., 2002): The BART is a computerised task designed as a behavioural measure of risk taking propensity. Performance on the BART has been found to correlate with self-report measures which include elements related to risk taking, such as the Barrett Impulsiveness Scale, the Sensation Seeking Scale and Behavioural Constraint (from the Multidimensional Personality Questionnaire) (Lejuez et al., 2002) and to real world risk taking behaviours, such as drug and alcohol use (Bernalova, Daughters, Hernandez, Richards & Lejuez, 2005), smoking (Lejuez, Aklin, Jones, Richards, Strong, Kahler & Read, 2003a) and adolescent risk taking behaviours (Lejuez, Aklin, Zvolensky & Pedulla, 2003b; Aklin, Lejuez, Zvolensky, Kahler & Gwadz, 2005). Test-retest reliability was assessed by Lejuez et al (2002) within a set of 30 balloons, by dividing the balloons into sets of 10 trials, and comparing scores across each set. A high average correlation was found between mean score of each set of 10 and total score across 30 balloons (average $r = .82$), which suggests that while participant score did increase over the trials, this increase was at a relatively similar rate across participants. Therefore, relative performance was largely consistent over time. Test-retest reliability has not been reported for over 30 trials.

The task involves inflating a balloon by clicking on a 'pump' key. On this version of the BART participants earned 5 pence per pump. After a certain number of pumps, the balloon will explode and the participant will lose the money that was accrued. However, after each pump, the participant has the option of ending the trial and banking the money they have saved. Therefore, the more the participant pumps the balloon before banking, the more money they can earn, but the higher the risk. Explosion points range from 1 to 128 pumps, therefore the average explosion point is 64 pumps, but each balloon has a different probability of exploding. In this study, participants were informed that 64 pumps was the average explosion point, in order to assess their risk decision making after an optimal strategy has been explained to them. The full instructions are outlined in Appendix 5.1.

The most widely used outcome measure on this task is the adjusted number of pumps, which is the average number of pumps on all unexploded balloons. However, previous studies have also used the total money earned, and total number of explosions to indicate risk taking behaviour (Lejuez et al., 2003a).

All participants completed a fixed order practice set of 10 balloons to learn how to use the task. The main trials consisted of 30 balloons. These balloons were presented in a random order (with a mean explosion point of 64) in order to eliminate the possibility of learning the sequence of balloon explosion points between the two trials.

BIS / BAS scales (Carver & White, 1994): The BIS / BAS scales is a self report questionnaire designed to measure trait sensitivity of the Behavioural Activation System and the Behavioural Inhibition System (Gray, 1990). The questionnaire consists of 20 items and has four subscales. BIS sensitivity is measured by one subscale, and BAS sensitivity is measured by the combined scores of three subscales: Reward Responsiveness (response to reward cues), Drive (goal pursuit) and Fun Seeking (desire to approach new rewards). The scales

have been found to have acceptable psychometric properties by a number of studies (e.g. Carver & White, 1994; Jorm, Christensen, Henderson, Jacomb, Korten & Rodgers, 1999). The BIS / BAS scales have been used in a population of people with bipolar I disorder before and the internal consistencies were found to be satisfactory (Cronbach's alpha = .78), with high test-retest reliability for BIS scales ($r=.81$, $p<.001$) and moderate test-retest reliability for BAS scales ($r=.5$, $p<.01$; Meyer, Johnson & Winters, 2001).

Visual Analogue Scales of mood: Mood was rated using a 10cm visual analogue scale, with the labels 'happy' and 'sad' at either pole. This methodology has been used to record small mood changes in previous research (e.g. Farmer et al., 2006).

Mood induction materials

Two sets of video clips lasting 5 minutes were used to induce positive or negative mood in participants. Each clip consisted of three scenes from films. The clips were selected from a pool of clips that have been found to induce positive or negative moods (Wright, Lam & Newsom-Davis, 2005). The positive scenes included themes of comedy and the negative scenes included themes of poverty and separation.

Procedure

The researcher contacted people who had expressed an interest in research into bipolar disorder by telephone and offered further information about the study. Potential participants were posted an information sheet and BIS/BAS scales (Carver & White, 1994) prior to the day of testing. During the appointment there was an opportunity to read through the information leaflet and ask questions. Written informed consent was obtained for all participants. Participants were asked to complete the BIS/BAS Scales (Carver & White, 1994) in advance.

On the day of testing, the relevant sections of the SCID-1 were administered, followed by the BDI-II and MRS in order to ascertain suitability for the study. All participants were asked for demographic data and clinical variables were obtained from participants with bipolar disorder. All participants completed the WTAR and were randomly assigned to positive or negative mood induction condition. They were then asked to read the BART instructions (Appendix 5.1). The BART and mood induction video clips were presented on a laptop computer. Participants completed 10 practice balloons on the BART with an opportunity for questions. Participants then completed 30 balloons of the BART (BART 1) followed by either the positive or negative mood induction video clip (MI) depending on the random allocation prior to recruitment. This was followed by another 30 balloons of the BART (BART 2). Visual analogue scales of mood were completed at four timepoints: before BART 1, immediately after BART 1, immediately after MI, and immediately after BART 2.

Finally, participants were asked the question “what was your strategy each time you completed the balloon task?” and their responses were recorded by the researcher. Participants were given time for questions and for their mood to return to its original state before the session was completed.

Results

Insert Table 1 here

Demographic data, mean scores on BIS/BAS subscales and clinical features of participants are presented in Table 1. T tests and chi square tests were used to test for significant differences between groups. There were no significant differences in age, gender mix, ethnicity (% white British), and number achieving a grade at A level or equivalent. A chi square test indicated that a significantly greater percentage of controls were employed ($\chi^2=12.34$, $df = 1$, $p < .0005$) than people with a diagnosis of bipolar disorder. There were also significant differences between groups in predicted full scale IQ (based upon demographics and WTAR score) ($t = 2.142$, $df = 52$, $p = .037$), and on BDI-II ($t = 2.454$, $df = 52$, $p = .018$) and MRS ($t = 3.192$, $df = 52$, $p = .002$), although on the MRS the mean score in both groups was below 1, indicating a very low incidence of manic symptoms. There were no significant differences between groups on any of the subscales of the BAS, or total BIS and BAS scores.

There were no significant differences in baseline mood between the bipolar group and controls. BDI-II score was significantly correlated with mood at baseline across all participants ($r = -.396$, $p = .003$). The MRS did not significantly correlate with mood at baseline, nor did any of the BIS/BAS scales and subscales (see Table 6, Appendix 6.1).

Baseline risk taking

A between groups ANOVA highlighted a non-significant effect of group on risk taking ($F(1,52) = 3.499$, $p = .067$). The mean scores suggest people with a diagnosis of bipolar disorder pumped the balloons to a lower size than controls (Bipolar group $M = 40.74$, $SD=12.43$; Control group $M = 46.84$, $SD = 11.53$). An ANOVA using the secondary outcome variable of number of exploded balloons, indicated a significant difference between groups ($F(1,52) = 7.523$, $p = .008$). This shows that the bipolar group exploded significantly

fewer balloons than controls, and pumped the balloon to a smaller size across unexploded balloons.

In order to investigate the impact of other demographic information on risk taking, correlational analyses were run for all demographic data. Risk taking at baseline (adjusted pumps or exploded balloons), did not significantly correlate with age, BDI, MRS, predicted IQ, nor VAS mood at baseline (Table 6, Appendix 6.1). A t test indicated that men achieved higher mean scores than women on the BART and this difference approached significance ($t(52) = 1.945, p = .057$). Within the bipolar group, risk taking did not correlate significantly with age of onset, number of manic or depressive episodes or number of hospitalisations for mania or depression (see Table 7, Appendix 6.1).

Insert Table 2 here

Mood induction

It was observed during testing that the risk taking procedure had an effect on mood in some participants. Therefore in order to evaluate the effect of the all the research proceedings on mood, a Time x Group x Mood Induction ANOVA was run, with mood at all four timepoints added as levels. There was no significant Time x Group x Mood interaction ($F(3,150) = 1.264, p = .289$), as expected, but there was a significant interaction between Time and Mood Induction ($F(3,150) = 34.513, p < .0005$), indicating that mood changed significantly during the course of the study, depending on the valence of the mood induction condition. However, separate analyses for each stage of the study highlighted that there no significant change in mood before and after the first set of BART trials ($F(1,50) = .704, p = .405$), but there was a highly significant Mood x Time (pre and post mood induction) interaction following the mood induction procedure ($F(1,50) = 83.036, p < .0005$), plus a Mood x Time interaction before and after the second set of BART trials ($F(1,50) = 26.050, p < .0005$). This suggests

that both the mood induction videos and the second BART trials significantly changed mood, and this change could be predicted by mood induction valence. Separate repeated measures ANOVAs in each mood and group condition, indicated that mood changed significantly following mood induction (bipolar positive group ($F(1,12) = 27.237, p < .0005$), bipolar negative group ($F(1,12) = 40.076, p < .0005$), control positive group ($F(1,13) = 10.314, p=.007$), control negative group ($F(1,13) = 34.882, p < .0005$), although negative mood induction caused a greater change in mood than positive.

Change in risk taking following mood induction

Change in risk taking scores were calculated for the primary analysis by subtracting mean adjusted pumps from the first set of BART trials from the mean score from the second set of trials. The primary research question was investigated using a two way Group x Mood Induction Analysis of Covariance (ANCOVA). BDI-II score and risk taking (adjusted pumps) at baseline were entered as covariates, as both were (almost) significantly different between groups. Gender was also added as a covariate as there was an almost significant difference in risk taking at baseline between males and females. There was no significant interaction between Group and Mood induction condition on risk taking ($F(1,47) = .813, p=.242$). Risk taking at baseline was the only factor which approached significance as a predictor of change in risk taking ($F(1,47) = 3.391, p = .061$). A post hoc correlational analysis, indicated that there was a significant negative correlation between the risk taking at baseline and change in risk taking ($r(54) = -.327, p = .016$), suggesting that those who took more risks at baseline tended to decrease risk taking following mood induction, and vice versa.

Post hoc analyses

As it was observed that the negative mood induction procedure was more effective than the positive procedure, it was wondered whether risk taking change would differ between groups,

when degree of mood change was taken into account. A mood change score was devised calculating the difference between mood pre and post mood induction. Then risk taking change per unit of mood change score was calculated. A Group x Mood Change ANCOVA was run with risk taking per unit mood change as the dependent variable and BDI II, risk taking at baseline and gender as covariates. There was no significant interaction between Group and Mood ($F(1,47) = .775, p = .383$), indicating that there were no between group differences in behavioural response to a small mood change, in either a positive or negative direction.

The Behavioural Activation System and risk taking

The second research question was answered, firstly by running correlational analyses of BART adjusted pumps with BAS total, BIS total and each of the BAS subscales, in order to assess their relationship with risk taking at baseline. None of the scales significantly correlated with BART adjusted pumps (see Table 6, Appendix 6.1).

As gender and group both were almost significantly associated with risk taking at baseline, these variables were entered into a linear multiple regression analysis in the first block, and BIS and BAS sensitivity were entered into the second block. The model with all variables entered, just failed to reach significance ($F(4,49) = 2.526, p = .052, \text{adjusted } R^2 = .103$). Table 3 below shows that none of the individual variables were significant predictors in this model:

Post hoc analysis

As trait BIS and BAS sensitivity did not significantly predict the variance in risk taking, it was wondered whether these systems were activated by the task. BAS activation is associated with positive affect (Urosevic et al., 2008). Therefore, it would be expected that those with a high BAS sensitivity would experience an increase in positive affect if a task

was BAS-relevant. Correlational analyses were run between change in mood during the BART trials and the BAS scales. There was no significant correlation, BAS ($r(54) = -.192$, $p = .163$), further supporting the notion that the task performance did not involve this system at baseline.

Finally, as BAS activation is associated with positive affect, it was wondered whether mood induction itself could be a BAS-activating, or BAS-deactivating event. If positive mood was BAS activating, it would be expected that high trait BAS sensitivity would predict change in risk taking following positive mood induction. If negative mood induction was BAS deactivating, there would be no relationship expected between BAS sensitivity and risk taking change. Separate regression analyses were run for positive and negative mood induction conditions. Risk taking at baseline was entered into the first block, and BAS into the second. No other variables were entered, as none had been found to significantly predict change in risk taking following mood induction in previous analyses. The positive mood induction model was non-significant ($F(2,24) = 1.474$, $p = .249$, adjusted $R^2 = .035$), as was the model in the negative mood induction condition ($F(2,24) = 1.690$, $p = .206$, adjusted $R^2 = .050$) and BAS did not significantly predict change in risk taking in either condition (see Tables 4 and 5 below).

Insert Tables 4 and 5 here.

Discussion

The main finding was that there was no significant difference between a bipolar and healthy control group in the effect of positive or negative mood induction on risk taking propensity, measured by the BART. The results therefore do not support the primary hypothesis. The findings are consistent with findings by Clark et al. (2001b) and Rosier et al. (2009), neither of whom found an effect of positive or negative mood induction on quality of risk decision making (measured with the Iowa Gambling Task and the Cambridge Gamble Task) in a nonclinical group who had experienced hypomania, or in a remitted bipolar sample. However, mood induction has identified other cognitions and behaviours that are associated with bipolar disorder, such as opposition of advice, and dysfunctional attitudes regarding goal attainment (Mansell & Lam, 2006; Wright et al., 2005). It is possible that disruptions to risk taking behaviour are only evident when an individual is experiencing ‘full blown’ manic or depressive symptoms, rather than small changes in affect. Indeed, when degree of mood change was controlled for in this study, each unit of mood change was found to have a similar impact on both groups. These findings are supported by literature using other risk decision making tasks, which finds poor quality performance during a manic episode (Adida et al., 2008; Clark et al., 2001a; Murphy et al., 2001), and during a depressive episode (Rubinstein et al., 2000), but not during euthymia (Clark et al., 2002; Rubinsztein et al., 2006; Yechiam et al., 2008) nor during mild-moderate depression (Teves et al., 2007). Risky behaviour may be associated with specific symptoms, for instance, Adida et al. (2008) found lack of insight to be predictive of quality of decision making in mania.

The finding that mood induction did not significantly affect risk taking contrasts with previous findings in the general population. Two studies have used a “life dilemma” task to compare responses between groups following positive and negative mood induction (Yuen & Lee, 2003; Chou, Lee & Ho, 2007). Both studies found lower risk taking following negative

mood induction than positive, although Yuen & Lee (2003) showed that the positive group did not differ in risk taking from a neutral mood induction group. However, neither study measured baseline risk taking, and the hypothetical decision scenarios did not have any real consequences, therefore may have measured different processes to the BART.

This study has highlighted the importance of including a baseline condition. However, as the first known study to apply the BART to an experimental design, the research has flagged some limitations with repeating this task. It was decided to use a version of the BART which informed participants of the optimal strategy to reduce learning effects over trials. This version of the BART also presented balloons in a random order, with a randomly generated explosion point, although always with a mean of 64 across the trials. This was to prevent subjects learning the order of balloons from one set of trials to the next. Despite this, subjects did demonstrate learning, as there was a significant association between risk taking at baseline and change in risk taking following mood induction. The more conservative participants during the first set of BART trials increased their risk taking during the second trial, and the riskier participants tended to be more conservative the second time. This is a curious finding as all participants tended to play the game cautiously, i.e. well below the mean explosion point; a pattern of behaviour which has been observed in previous research (Pleskac et al., 2007).

The qualitative data collected in answer to the question “what was your strategy each time you completed the balloon task?” sheds some light on this matter, although this data has limited reliability, as it was not collected and evaluated systematically. As the optimal task strategy required extended concentration and persistence, in order to count to 64 clicks on each trial, over 50% of participants reported that they did not adopt this strategy during either set of trials. Seven of the participants said they did not believe that 64 was the mean explosion point, and seven said they found the task boring which may have influenced

performance. Seventeen participants reported that they were more / less cautious after an exploded balloon. These findings highlight the variation in motivational factors on this version of the BART. The fact almost a third of participants reported being influenced in their decisions by a previous balloon, suggests that some of the variation in task performance might have been explained by the order of presentation of balloons. In order to eliminate this, all participants would have to be shown the same set of balloons in the same order, despite potential for learning. Future research could also consider how some of the variability in motivational influences could be reduced, e.g. shortening the task, or having a lower mean explosion point to make it less boring, or demonstrating the concept of a mean explosion point more clearly during practice trials, to ensure all participants understood and believed the instructions. These adaptations could make the task performance a purer reflection of risk taking propensity, and therefore make it more suitable for repetition in an experimental design.

However in contrast with Rosier et al. (2009) and Clark et al. (2001b)'s studies, the current findings indicated a difference between clinical and control groups in baseline risk taking, with the bipolar group exploding significantly fewer balloons, and pumping almost significantly less across the unexploded balloons. This suggests a mild deficit in risk decision making even during remission in bipolar disorder. This finding is also inconsistent with previous research using the IGT and CGT as a measure of risk decision making, where performance during bipolar remission or euthymic mood states has not differed from that of controls (Clark et al., 2002; Rubinsztein et al., 2006; Yechiam et al., 2008), suggesting that the BART either involves different processes to those measured by the IGT and CGT, or is a more sensitive measure of the same processes. Although IQ and depression and mania ratings differed significantly between bipolar and control groups, these factors were not found to correlate with task performance. There was no evidence from this study that

motivational factors, i.e. trait sensitivity to reward (BAS) and punishment (BIS) were responsible for the difference in BART scores.

The differences in risk taking between the bipolar and control group could have been due to poorer cognitive functioning in the bipolar group. Previous research has found impaired executive functioning in a bipolar group compared to controls (Martinez-Aran et al., 2004), although another study has opposed this difference using 4 tests of executive functioning (Rubinsztein et al.'s, 2006). There is also evidence of deficits in visuospatial memory, and working memory (Quraishi & Frangou, 2002) in remission. Frangou et al. (2008) found that people with a diagnosis of bipolar disorder process reward-related information differently from controls, even in remission. The authors reported reduced activation in the ventral prefrontal cortex (vPFC) and increased activation in the dorsal prefrontal cortex in a bipolar group during the IGT. The vPFC is thought to be associated with maintaining affective responses to reward in working memory for use in decision making (see Frangou et al., 2008). With these findings in mind, it is possible that the lower performance of the bipolar group on the BART reflects a difficulty with maintaining an overall strategy across the task, due to poorer planning, or memory, or difficulty maintaining the emotional reaction to the overall monetary incentive (due to reduced processing in vPFC). This could lead to the immediate affective responses to the balloon popping / not popping having greater value in the decision making process than overall potential winnings, and would result in less balloons being popped.

The second research question hypothesised that trait sensitivity to reward and punishment, measured using the BIS/BAS scales could predict risk taking behaviour on the BART, but this hypothesis was not supported by the findings. The regression analysis (Table 3) demonstrates that BAS has a positive relationship with BART score, and BIS has a negative relationship, as expected, but neither of these variables significantly predict risk taking.

Furthermore, the finding that BAS sensitivity did not correlate with change in mood during the first set of BART trials supports the idea that the BAS was not activated by the task. Previous research has found reward-related activities can act as a positive mood induction procedure in individuals with bipolar disorder (e.g. Farmer et al., 2006). The BART was not designed as a BAS-activating task, although there are some rewarding components to it, i.e. participants can see money accumulating across trials. However, participants have no information on how their individual performance compares with the performance of other participants, which can be a major reward cue for many individuals. Risk taking behaviours differ from goal pursuit behaviours, in that the rewards available are often experiential, such as a high from taking drugs, rather than achievement-focussed. Therefore, perhaps other factors, such as level of cognitive functioning, are more relevant to BART scores and general risk taking behaviour than drive and motivation to pursue rewards. Indeed this is consistent with Yechiam et al.'s (2008) findings that there was no evidence of elevated attention to losses and gains on the IGT between acute and remitted bipolar groups and controls. However, the findings do not rule out the possibility that BAS sensitivity is a predictor of risk taking behaviour during a manic episode, a time of high dysregulated BAS activity.

The finding that the BAS is not activated by positive mood induction, adds to previous literature to suggest that cues must be related to rewards or goal-attainment in order to activate the BAS system, and positive affect alone is insufficient. Also, BAS activation can also be associated with anger and "complex cognitions" (Urosevic, Abramson, Harmon-Jones & Alloy, 2008) which were not targeted in the mood induction. However, Rosier et al. (2009) used a reward-related positive mood induction in their study and did not find an impact on risk decision making, suggesting that even BAS-activating events may not lead to increased risk taking during euthymic phases of bipolar illness.

Limitations of findings and directions for future research

One limitation of the study is the relatively unknown behavioural correlates of risk taking on the BART in a bipolar disorder population. The BART has been associated with a history of substance abuse in bipolar disorder (Holmes et al., 2009), however, future research could extend these findings to other risky behaviours. In order to test the usefulness of the BART as a predictor of risk taking behaviour in bipolar disorder, it needs to be administered to manic and depressed bipolar populations, in order to test whether it is sensitive to disruptions to risk decision making during mania and depression.

A limitation of using the mood induction paradigm in bipolar disorder research is that positive and negative affect only capture one aspect of mania and depression (Mansell & Lam, 2006). Indeed, mania can exist without positive affect, e.g. irritable mania. Therefore, the ability of other emotions, such as frustration, to activate manic symptoms during euthymic phases of illness should also be explored.

The majority of the bipolar participants were taking at least one form of medication for bipolar disorder, which may have been a confounding factor on task performance. This study is also limited in that it is difficult to interpret the task scores in terms of underlying processes. Further research is needed to decompose BART processes during this version of the task, possibly using a cognitive modelling approach (e.g. Wallsten, Pleskac & Lejuez, 2005). This would make it easier to judge whether task scores reflect a propensity towards risk taking or cognitive ability to make optimal decisions. In addition, participants' conscious motivators on task performance could be obtained using more rigorous qualitative methodologies than those used here.

Further research could investigate whether trait BAS sensitivity predicts risk taking behaviours during a manic episode, as BAS has been found to predict the development of

manic and depressive symptoms over time (Meyer et al., 2001; Salavert et al., 2007). Finally, risk taking tasks could aim to increase the risk involved in computerised tasks, perhaps with real monetary rewards / losses as this might lead to a more accurate reflection of the risk taking process.

Clinical implications

The lack of support for the primary hypothesis, plus previous research findings suggest that individuals with bipolar disorder may be unlikely to engage in excessive risk taking whilst out of a manic episode, regardless of current mood. In fact, risk taking was found to be greater in controls than the bipolar group at baseline. However, the impact of a mood change that is greater than the changes manipulated in this study, or increases in other emotions, such as anger, on risk taking, are unknown. This study has also found no evidence that risk taking is driven by the same underlying processes to excessive goal pursuit, therefore, these symptoms may appear independently of one another. It would be interesting for future research to replicate these findings with a larger sample size in order to develop understanding of the factors which predict the development of risk taking behaviour. This is an important field, as it contributes to the development of self-management strategies, which can enable individuals with bipolar disorder to gain a sense of control over their illness.

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Table 1. Means (and standard deviations) for demographic and clinical characteristics of bipolar and control groups

	Bipolar (n=26)	Control (n=28)
Age (years)	46.69 (9.39)	42.46 (13.22)
Males (%)	38.5	42.86
Ethnicity: White British (%)	92.3	96.43
Achieved a grade at A level / equivalent (%)	76.92	82.14
In current employment or full time education (%) ***	46.2	85.71
WTAR predicted IQ *	109.23 (5.39)	112.50 (5.80)
BDI-II *	8.04 (5.11)	5.04 (3.83)
MRS **	0.81 (1.27)	0.04 (0.19)
BAS total	37.12 (10.29)	36.75 (5.24)
BAS Drive	10.50 (3.68)	9.46 (2.46)
BAS Reward Responsiveness	15.73 (3.48)	16.32 (2.07)
BAS Fun Seeking	10.88 (3.91)	10.96 (2.57)
BIS total	20.42 (4.17)	20.21 (3.13)
History of substance abuse	10/26	
Mean age of onset of bipolar disorder (years)	26.50 (11.04)	
Mean number of manic episodes	8.81 (17.22)	
Mean number of depressive episodes	9.35 (16.94)	
Mean number of hospitalizations due to manic episode	1.50 (1.45)	
Mean number of hospitalizations due to depressive episode	1.62 (3.16)	
Currently taking psychotropic medication (% yes)	88.89	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2. Means (and standard deviations) of VAS mood and risk taking, pre and post mood induction.

		Positive Mood Induction		Negative Mood Induction	
		Bipolar n=13 (SD)	Control n=14 (SD)	Bipolar n=13 (SD)	Control n=14 (SD)
VAS (mm)	Baseline	64.00 (15.82)	63.71 (16.98)	65.42 (17.15)	72.14 (12.23)
	After BART 1	67.31 (14.49)	60.82 (23.43)	70.11 (11.93)	73.61 (13.17)
	After MI	77.46 (10.94)	77.79 (16.18)	50.27 (15.08)	48.07 (16.99)
	After BART 2	73.92 (13.18)	73.93 (18.41)	64.65 (19.20)	62.50 (18.11)
Adjusted pumps	Baseline	43.25 (13.03)	46.05 (12.50)	38.23 (11.76)	47.63 (10.90)
	After MI	39.96 (12.87)	46.10 (12.99)	41.55 (12.16)	46.46 (12.77)

Table 3. Regression analysis for BIS and BAS scales predicting risk taking at baseline.

Dependent variable	Independent variables	β	p
BART adjusted pumps (baseline)	Group	.238	.074
	Gender	-.241	.074
	BIS	-.185	.169
	BAS	.138	.300

Table 4. Regression analysis for BAS scales predicting change in risk taking following positive mood induction.

Dependent variable	Independent variables	β	p
Change in BART adjusted pumps	Risk taking at baseline	-.305	.126
	BAS	.133	.497

Table 5. Regression analysis for BAS scales predicting change in risk taking following negative mood induction.

Dependent variable	Independent variables	β	p
Change in BART adjusted pumps	Risk taking at baseline	-.329	.100
	BAS	-.086	.660

Appendices

Appendix 1 – Reflective statement

Introduction

I always had a love/hate relationship with research. I loved the ideas, the attention to detail, the critical thinking, the accumulation of knowledge and the task of presenting complex ideas in a concise and understandable way. I hated the moments when you realise a design flaw, the pressure of the looming deadline, and the uncertainty of where the next participant is going to come from. This project rewarded and challenged me in all those ways and more. In this reflective statement I aim to present my journey through the research process. I have paid attention to decision making processes throughout the course of the project, personal strengths and weaknesses, and the benefits and limitations of the wider system within which the research was conducted. Throughout the reflection, I present areas of personal learning and development, and finally come to reflect on how the “all or nothing” love/hate relationship came to be softened at the edges.

Finding a research question and study design

Keen to create new, exciting, mind-blowing research, I batted around from idea to idea for weeks and months, before finally narrowing down to a topic. The two main points of learning in finding a research question were the importance of thoroughly reading and understanding the theoretical literature, and also use of my supervisor’s knowledge. Whilst wanting to create an idea independently was very important to me, I learnt that the best ideas came from matching my ideas to my supervisor’s expertise. Contacting other researchers in the field was also invaluable in developing design ideas, for instance the creator of the Balloon Analogue Risk Task (BART) gave some very useful suggestions of which version of the task I could use. Another point for reflection was the order in which the research question and study design are developed. At times I felt as though my study design was evolving faster than my knowledge and understanding of the theoretical basis of the study, as

each design decision required a good theoretical understanding in order to be made well. I found planning the systematic literature review was a valuable process as it helped me to structure this literature search and retrieve relevant papers to ensure that my design emerged from a valid research question and not the other way round.

A potential flaw at this stage of the process was not running a pilot study. At the end of the design phase I dismissed the idea of a pilot study due to time restrictions. However, even if I had run a small pilot with a very small number of participants, this could have highlighted some flaws in my design which could have been addressed. For instance I could have seen that people might have needed a lower mean explosion point on the balloon task in order to be more likely to use the task instructions, which would have made it easier to identify those who deliberately risk taking. In a sense, the study itself can be thought of as a pilot study as it has applied the BART to a mood induction paradigm, which has never been tried before, and has made recommendations which could certainly improve future research design into this field.

Choosing journals

The Journal of Abnormal Psychology seemed an obvious choice for my empirical paper as I had designed an experimental study which was aiming to explore the development of psychopathology, which meets their inclusion criteria exactly. A study with a very similar mood induction paradigm had already been published in this journal (Wright et al., 2005), and looking through previous issues indicated that bipolar disorder was a frequently explored area of interest.

Clinical Psychology Review was felt to be appropriate for my systematic literature review as my review has both theoretical and clinical outcomes. Decision making in bipolar disorder is likely to be a topic of great interest for clinical psychologists and other health professionals

working with bipolar disorder, in order to better understand therapy processes, assess decisional capacity and help clients to learn to self-manage.

Data collection

This was both the most stressful and the most enlightening phase of the research. A major challenge to the recruitment procedure was approaching mental health teams for assistance with recruitment. While every effort was made to make the recruitment process as simple and non-time consuming for professionals as possible, in the context of the busy and time-pressured NHS, many teams simply couldn't find the time to become involved. This highlights to me the importance of existing relationships with teams, in aiding this process. With hindsight, it could have been more productive to try to integrate myself into a few teams, rather than approach a large number of teams, although the challenge of building a relationship with a team without existing links would still have remained. In an ideal world, pre-existing relationships and pathways for research recruitment agreed between research and clinical teams could make this process much smoother for both parties involved. As it was, after many months of fruitless letters and phone calls, I had to abandon recruiting in this way, and focus within the voluntary sector. This proved to be a much easier method of recruitment, which in ethical terms felt fairer because I was able to offer the groups something in return for their participation, a presentation of recent research findings in bipolar disorder, and a promise to return to the group meetings to present my own findings. However, recruiting from bipolar support groups can lead to a recruitment bias, as many of the individuals have taken part in research projects into bipolar disorder before.

Once I'd got to the stage of meeting participants, I found this was the most enjoyable part of the process. Speaking to individuals with bipolar disorder about their condition was interesting, inspiring and challenged a number of assumptions I had based upon my reading

of the literature. I discovered an extremely diverse group of individuals with very different needs and ways of living with bipolar. I found that talking to individuals in a research capacity was very different from being a clinician as firstly, I had a structured process to keep to, and secondly I was meeting individuals for a one-off meeting. I found most individuals wanted to tell their story of living with bipolar disorder and that it was important to respect this, and make sure appointments allowed enough time, as I benefitted enormously from hearing their stories, and many participants said they found it rewarding to help me to understand their condition.

Writing up

Systematic literature review: The main challenge involved in this process was the ‘sensitivity versus specificity’ question, and I spent months deliberating over this. Many times I found a search would retrieve unmanageable numbers of papers, many of which with little relevancy. In the end, narrowing the field of risk taking behaviour to the decision making process was a positive choice as it enabled me to immerse myself in a specific field which has specific clinical value, rather than broadly describe the area from many perspectives, without deep understanding. The process of quality reviewing the papers using a checklist was beneficial as it limited researcher bias, as inevitably, there are some areas of critical analysis I am more experienced in than others and would tend towards.

Empirical paper: I found the idea of asking participants about their strategy on the balloon task was very helpful in helping me to make meaning from the research findings, particularly due to the lack of significant findings. As this was not a major focus of the paper, I had not planned to systematically collect responses, therefore the data could not be formally analysed. However, I feel that careful systematic collection of qualitative data regarding participant strategies on computerised tasks, could greatly improve understanding of the conscious

motivational processes involved, particularly in pilot studies. While the findings were disappointing, I have learnt that there is still knowledge which can be gained from non-findings, which can add another tiny piece into the giant puzzle of bipolar disorder research.

Organisational issues

The time management skills I have learnt on this journey, I will take with me throughout my life. I feel over the past three years I have started to overcome my perfectionist tendencies with more realistic expectations, which has increased my enjoyment of the research process. While I clearly have more to learn in this area, it has been very encouraging to see myself learning to schedule breaks with rewards, to balance work and play, and to contain many of the anxieties involved (although there were still a number of leakages, these were cleaned up relatively quickly!). In many ways, I see this development as my biggest achievement, although it cannot be measured and graded in an academic sense.

Concluding remarks

While there have been many emotional ups and downs during the creation of this research portfolio, they have been somewhat softened by efforts to keep perspective, to stay determined and to re-immense myself in the interesting ideas. I feel that many of the skills I have developed along the way will stand me in good stead during my working life, and has provided plenty of food for thought for future projects that may come along.

Reference

Wright, K., Lam, D. & Newsom-Davis, I. (2005). Induced mood change and dysfunctional attitudes in remitted Bipolar I Affective Disorder. *Journal of Abnormal Psychology, 114* (4), 689-696.

Appendix 2 – Guidelines for submission to Journals

Appendix 2.1 - Clinical Psychology Review Author Guidelines

Appendix 2.2 – Journal of Abnormal Psychology Author Guidelines

Appendix 2.1 - Clinical Psychology Review Author Guidelines

SUBMISSION REQUIREMENTS: Authors should submit their articles electronically via the Elsevier Editorial System (EES) page of this journal (<http://ees.elsevier.com/cpr>). The system automatically converts source files to a single Adobe Acrobat PDF version of the article, which is used in the peer-review process. Please note that even though manuscript source files are converted to PDF at submission for the review process, these source files are needed for further processing after acceptance. All correspondence, including notification of the Editor's decision and requests for revision, takes place by e-mail and via the Author's homepage, removing the need for a hard-copy paper trail. Questions about the appropriateness of a manuscript should be directed (prior to submission) to the Editorial Office, details at URL above. Papers should not exceed 50 pages (including references).

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the Publisher.

FORMAT: We accept most wordprocessing formats, but Word, WordPerfect or LaTeX are preferred. Always keep a backup copy of the electronic file for reference and safety. Save your files using the default extension of the program used.

Please provide the following data on the title page (in the order given).

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Author names and affiliations. Where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name, and, if available, the e-mail address of each author.

Corresponding author. Clearly indicate who is willing to handle correspondence at all stages of refereeing and publication, also post-publication. **Ensure that telephone and fax numbers (with country and area code) are provided in addition to the e-mail address and the complete postal address.**

Present/permanent address. If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract. A concise and factual abstract is required (not exceeding 200 words). This should be typed on a separate page following the title page. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separate from the

article, so it must be able to stand alone. References should therefore be avoided, but if essential, they must be cited in full, without reference to the reference list.

STYLE AND REFERENCES: Manuscripts should be carefully prepared using the Publication Manual of the American Psychological Association, 5th ed., 1994, for style. The reference section must be double spaced, and all works cited must be listed. Please note that journal names are not to be abbreviated.

Reference Style for Journals: Cook, J. M., Orvaschel, H., Simco, E., Hersen, M., & Joiner, Jr., T. E. (2004). A test of the tripartite model of depression and anxiety in older adult psychiatric outpatients, *Psychology and Aging*, 19, 444-45.

For Books: Hersen, M. (Ed.). (2005). *Comprehensive handbook of behavioral assessment* (2 Volumes). New York: Academic Press (Elsevier Scientific).

TABLES AND FIGURES: Present these, in order, at the end of the article. High-resolution graphics files must always be provided separate from the main text file (see <http://ees.elsevier.com/cpr> for full instructions, including other supplementary files such as high-resolution images, movies, animation sequences, background datasets, sound clips and more).

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Appendix 2.2- Journal of Abnormal Psychology Author Guidelines

Journal of Abnormal Psychology®

Editor: David Watson, PhD

ISSN: 0021-843x

Published Quarterly, beginning in February

Instructions to Authors

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Keep a copy of the manuscript to guard against loss.

Masked Reviews

Masked reviews are optional and must be specifically requested in the cover letter accompanying the submission. For masked reviews, the manuscript must include a separate title page with the authors' names and affiliations, and these ought not to appear anywhere else in the manuscript.

Footnotes that identify the authors must be typed on a separate page.

Make every effort to see that the manuscript itself contains no clues to authors' identities.

Types of Articles

Most of the articles published in the *Journal of Abnormal Psychology* are reports of original research, but other types of articles are acceptable.

- Short Reports of replications or of failures to replicate previously reported results are given serious consideration.
- Comments on articles published in the journal are also considered.
- Case studies from either a clinical setting or a laboratory will be considered if they raise or illustrate important questions that go beyond the single case and have heuristic value.
- Manuscripts that present or discuss theoretical formulations of psychopathology, or that evaluate competing theoretical formulations on the basis of published data, may also be accepted.

The *Journal of Abnormal Psychology* publishes articles on basic research and theory in the broad field of abnormal behavior, its determinants, and its correlates.

The following general topics fall within its area of major focus:

- a. psychopathology - its etiology, development, symptomatology, and course
- b. normal processes in abnormal individuals
- c. pathological or atypical features of the behavior of normal persons
- d. experimental studies, with human or animal subjects, relating to disordered emotional behavior or pathology
- e. sociocultural effects on pathological processes, including the influence of gender and ethnicity
- f. tests of hypotheses from psychological theories that relate to abnormal behavior

Thus, studies of patient populations, analyses of abnormal behavior and motivation in terms of modern behavior theories, case histories, and theoretical papers of scholarly substance on deviant personality and emotional abnormality would all fall within the boundaries of the journal's interests.

Each article should represent an addition to knowledge and understanding of abnormal behavior in its etiology, description, or change.

In order to improve the use of journal resources, it has been agreed by the two Editors concerned that the *Journal of Abnormal Psychology* will not consider articles dealing with diagnosis or treatment of abnormal behavior, and the *Journal of Consulting and Clinical Psychology* will not consider articles dealing with the etiology or descriptive pathology of abnormal behavior.

Therefore, a study that focuses primarily on treatment efficacy should be submitted to the [*Journal of Consulting and Clinical Psychology*](#). However, a longitudinal study focusing on developmental

influences or origins of abnormal behavior should be submitted to the *Journal of Abnormal Psychology*.

Articles will be published in five different sections of the *Journal*: Brief Reports, Regular Articles, Extended Articles, Case Studies, and Commentaries:

- Brief Reports must not exceed 5,000 words in overall length. This limit includes all aspects of the manuscript (title page, abstract, text, references, tables, author notes and footnotes, appendices, figure captions) except figures. Brief Reports also may include a maximum of two figures. For Brief Reports, the length limits are exact and must be strictly followed.
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Components of all cover letters will contain the following:

- a. the full postal and email address of the corresponding author;
- b. the complete telephone and fax numbers of the same;
- c. the proposed category under which the manuscript was submitted;
- d. a request for masked review, if desired, along with a statement ensuring that the manuscript was prepared in accordance with the guidelines above.

Authors should also specify the overall length of the manuscript (in words) and indicate the number of tables and figures that are included in the manuscript.

*Appendix 3 - Ethical and Research Governance Approval
for empirical study*

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*Appendix 4 – Supplementary materials for
Systematic Literature Review*

Appendix 4.1 - Quality control checklist (adapted from Downs & Black, 1998)

Name of study _____

	Question	Yes	No	N/A	Comments
1	Is the hypothesis / objective of the study clearly described?				
2	Are the main outcomes to be measured clearly described in the Introduction or Methods section?				
3	Are the characteristics of the patients included in the study clearly described?				
4	Are the distributions of principal confounders in each group of subjects to be compared clearly described?				
5	Are the main findings of the study clearly described?				
6	Does the study provide estimates of the random variability in the data for the main outcomes?				
7	Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?				
8	Did the study report a power calculation?				
9	Did the study use a control group?*				
10	Was there an attempt to match the control group with the clinical group on important clinical / demographic variables?*				
11	Were the subjects asked to participate in the study representative of the entire population from which they were recruited?				
12	Were those subjects who were prepared to participate representative of the entire population from which they were recruited?				
13	Were study subjects participants randomised into intervention groups?				
14	Were the main outcome measures used accurate (reliable / valid)?				
15	Were the statistical tests used to assess the main outcomes appropriate?				
16	Were cases and controls recruited from the same population?				
17	If any of the results of the study were based on "data dredging" was this made clear?				
18	Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?				

* questions added by the author (SC)

*Appendix 5 – Supplementary materials for
Empirical Paper*

Appendix 5.1 BART Instructions

Appendix 5.2 Beck Depression Inventory

Appendix 5.3 Mania Rating Scale

Appendix 5.4 Wechsler Test of Adult Reading record form

Appendix 5.5 BIS/BAS Scales

Appendix 5.6 Participant information leaflet

Appendix 5.7 Participant consent form

Appendix 5.1 – BART instructions for participants

BART instructions

Throughout the task, you will be presented with 30 balloons, one at a time. For each balloon you can click on the button labeled “Press This Button To Pump Up the Balloon” to increase the size of each balloon. You will accumulate 5 pence in a temporary bank for each pump. You will not be shown the amount you have accumulated in your temporary bank for each pump. At any point, you can stop pumping up the balloon and click on the button labeled “Collect \$\$\$s”. Clicking this button will start you on the next balloon and will transfer the accumulated money from your temporary bank to your permanent bank labeled “Total Earned”. It is your choice to determine how much to pump up the balloon, but be aware that at some point the balloon will explode.

The explosion point varies across balloons, ranging from the first pump to the 128th pump. The ideal number of pumps is 64. What that means is that if you were to make the same number of pumps on every balloon, your best strategy would be to make 64 pumps for every balloon. This would give you the most money over a long period of time. However, the actual number of pumps for any particular balloon will vary, so the best overall strategy may not be the best strategy for any one balloon.

If the balloon explodes before you click on “Collect \$\$\$”, then you move on to the next balloon and all money in your temporary bank is lost. Exploded balloons do not affect the money accumulated in your permanent bank.

Beck Depression Inventory - Remove for hard binding

Appendix 5.3 – Mania Rating Scale

Mania Rating Scale - MRS (Bech et al. 1978)

1 Activity: Motor

- 0 Not unusual
- 1. Slight or doubtfully increased motor activity (e.g. lively facial expression).
- 2. Moderately increased motor activity (e.g. lively gestures).
- 3. Clearly excessive motor activity, on the move most of the time, rises once or several times during interview.
- 4. Constantly active, restlessly energetic. Even if urges, the patient cannot sit still.

2 Activity: Verbal

- 0. Not unusual
- 1. Somewhat talkative
- 2. Very talkative, no spontaneous intervals in the conversation.
- 3. Difficult to interrupt.
- 4. Impossible to interrupt, completely dominates the conversation.

3 Flight of Thoughts

- 0. Not present
- 1. Somewhat lively descriptions, explanations and elaborations without losing the connection with the topic of the conversation. The thoughts are thus still cohesive.
- 2. Again it is occasionally difficult for the patient to stick to the topic, he is distracted by random associations (often rhymes, clangs, puns, pieces of verse or music).
- 3. The line of thought is regularly disrupted by diversionary associations.
- 4. It is difficult or impossible to follow the patient's line of thought, as he constantly jumps from one topic to another.

4 Voice/Noise Level

- 0. Not unusual
- 1. Speaks somewhat loudly without being noisy
- 2. Voice discernible at a distance, and somewhat noisy.

3. Vociferous, voice discernible at a long distance, is noisy, singing.
4. Shouting, screaming; or using other sources of noise due to hoarseness.

5 Hostility/Destructiveness

0. No signs of impatience or hostility.
1. Somewhat impatient or irritable, but control is maintained.
2. Markedly impatient or irritable. Provocation badly tolerated.
3. Provocative, makes threats, but can be calmed down.
4. Overt physical violence; physically destructive.

6 Mood Level (Feeling of Well-Being)

0. Not unusual
1. Slightly or doubtfully elevated mood, optimistic, but still adapted to situation.
2. Moderately elevated mood, joking, laughing.
3. Markedly elevated mood, exuberant both in manner and speech.
4. Extremely elevated mood, quite irrelevant to situation.

7 Self-Esteem

0. Not unusual
1. Slightly or doubtfully increased self-esteem, for example occasionally over-estimates his own habitual capacities
2. Moderately increased self-esteem, for example, overestimates more constantly his own habitual capacities or hints at unusual abilities.
3. Markedly unrealistic ideas, for example, that he has extraordinary abilities, powers or knowledge (scientific, religious, etc.), but can briefly be corrected.
4. Grandiose ideas which cannot be corrected.

8 Contact (Intrusiveness)

0. Not unusual
1. Slightly doubtfully meddling, for example, interrupting or slightly intrusive.
2. Moderately meddling and arguing or intrusive.
3. Dominating, arranging, directing, but still in context with the setting.

4. Extremely dominating and manipulating, not in context with the setting.

9 Sleep (Average of past 3 nights)

0. Habitual duration of sleep.
1. Duration of sleep reduced by 25%
2. Duration of sleep reduced by 50%
3. Duration of sleep reduced by 75%
4. No sleep

10 Sexual Interest

0. Habitual sexual interest and activity.
1. Slight or doubtful increase in sexual interest and activity, for example, slightly flirtatious.
2. Moderate increase in sexual interest and activity, for example, clearly flirtatious.
3. Marked increase in sexual interest and activity; excessively flirtatious; dress provocative.
4. Completely and inadequately occupied by sexuality.

11 Decreased Work Ability

A At First Rating

0. Not present
1. Slightly or doubtfully increased drive, but work quality is slightly down as motivation is changing, and the patient somewhat distractible.
2. Increased drive, but motivation clearly fluctuating. The patient has difficulties in judging own work quality and the quality is indeed lowered. Frequent quarrels at work.
3. Work capacity clearly reduced; the patient occasionally loses control. He must stop work and be written off sick. If hospitalised, he can participate for some hours per day in ward activities.
4. The patient is (or ought to be) hospitalised and is unable to participate in ward activities.

B At Weekly Ratings

0. (a) The patient has resumed work at his normal activity level.

- (b) The patient would have no trouble in working, but the effort is somewhat reduced due to changeable motivation
1. (a) The patient is working, but the effort is somewhat reduced due to changeable motivation
(b) It is doubtful whether the patient can resume normal work on a full scale due to distractibility and changeable motivation.
 2. (a) The patient is working, but at a clearly reduced level, for example, due to episodes of non-attendance
(b) The patient is still hospitalised or written off sick. He is able to resume work only if special precautions are taken: close supervision and/or reduced working hours.
 3. The patient is still hospitalised or written off sick and is unable to resume work. In hospital he participates for some hours per day in ward activities.
 4. The patient is still fully hospitalised and generally unable to participate in ward activities.

Bech P., Rafaelsen, O. J., Kramp, P., & Bolwig, T. G. (1978). The mania rating scale: Scale construction and inter-observer agreement. *Neuropharmacology*, *17*, 430-431.

MRS – Summary sheet

Sub_ID _____

Date _____

	0	1	2	3	4
1. Activity: motor					
2. Activity: verbal					
3. Flight of thoughts					
4. Voice / Noise level					
5. Hostility / Destructiveness					
6. Mood Level					
7. Self-esteem					
8. Contact (intrusiveness)					
9. Sleep (average of past 3 nights)					
10. Sexual Interest					
11. Decreased Work Ability – first rating					
Decreased Work Ability – weekly rating					
Total					

MRS – Score interpretation guide

0-5	No mania
6-9	Hypomania (mild)
10-14	Probable mania
15 +	Definite mania

Wechsler Test of Adult Reading Record Form – Removed for Hard Binding

Appendix 5.5 – BIS/BAS Scales

BIS / BAS Scales (Carver & White, 1994)

Participant ID _____

Date _____

Please circle one number below each statement to show how much you agree with the statement.

1. If I think something unpleasant is going to happen I usually get pretty "worked up."

Strong agreement = 1

strong disagreement = 4

1

2

3

4

2. I worry about making mistakes.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

3. Criticism or scolding hurts me quite a bit.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

4. I feel pretty worried or upset when I think or know somebody is angry at me.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

5. Even if something bad is about to happen to me, I rarely experience fear or nervousness.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

6. I feel worried when I think I have done poorly at something.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

7. I have very few fears compared to my friends.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

8. When I get something I want, I feel excited and energized.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

9. When I'm doing well at something, I love to keep at it.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

10. When good things happen to me, it affects me strongly.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

11. It would excite me to win a contest.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

12. When I see an opportunity for something I like, I get excited right away.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

13. When I want something, I usually go all-out to get it.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

14. I go out of my way to get things I want.

Strong agreement = 1

strong disagreement = 4

1 2 3 4

15. If I see a chance to get something I want, I move on it right away.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

16. When I go after something I use a "no holds barred" approach.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

17. I will often do things for no other reason than that they might be fun.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

18. I crave excitement and new sensations.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

19. I'm always willing to try something new if I think it will be fun.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

20. I often act on the spur of the moment.

Strong agreement = 1

strong disagreement = 4

1

2

3

4

Appendix 5.6 Participant Information Sheet

Participant Information Sheet

Title of study: Risk taking in bipolar 1 disorder

I would like to invite you to take part in a research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Talk to others about the study if you wish.

Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

The purpose of this study is to improve our understanding of the development of symptoms of bipolar disorder. People with bipolar disorder can experience greater “ups and downs” in mood than the general population. This study is interested in whether small mood changes may have a different effect on risk taking behaviour of people with bipolar disorder than people who don't have bipolar disorder.

The study is being completed as part of a Clinical Psychology Doctorate training course at the University of Hull. It will also be written up for publication.

Why have I been invited to take part?

You have been invited to take part in the study because you are likely to meet the criteria. For this part of the study we are looking for people who are between 18 and 70 and have never had a mental health problem.

Do I have to take part?

It is up to you to decide. Please feel free to take time to decide and ask questions about the study before deciding. You will be asked to sign a consent form to show you have agreed to take part. You are free to withdraw at any time, without giving a reason. This would not affect the standard of care you receive in any NHS setting.

What will happen to me if I take part?

If you consent to participate in this study the following things will happen:

- You will be sent a questionnaire to complete before we meet for the task. This should take 5-10 minutes to complete
- We will arrange a time and a place to meet. We will find a private room either at the University of Hull or at an NHS hospital site.
- The study should take about 1 hour 40 minutes to complete. We will discuss whether you would like to have a break during this time on the day.
- Once the study is complete you will not be contacted by the researcher again, unless you have requested a copy of the results.

What will I have to do?

Below is a brief description of the tasks you will be asked to do. In brackets you can see how long each activity should take:

- Complete a short questionnaire about your personality at home (10 mins)
- Answer some questions about your mental health (up to 60 mins). These questions will be recorded so that the answers can be scored after the interview. All recordings will be anonymised. One other employee of Humber Mental Health and Teaching NHS Trust will also listen to the recording to check that the researcher has scored the answers correctly. Following this the recording will be destroyed.
- Complete a short questionnaire about your mood (5 mins)
- Read some words off a sheet (5 mins)
- Watch some videos (5 mins)
- Do a task on the computer (20 mins)

What are the possible disadvantages and risks of taking part?

There are no foreseen risks involved with taking part in this study. Participation in the study will have a temporary effect on your mood, either making you feel a bit happier or sadder than usual, but this effect has been found to last for just 10-15 minutes. There will be time at the end of the study to chat to the researcher and to make sure that your mood has returned to its usual state.

What are the possible benefits of taking part?

There is no intended clinical benefit to participants taking part in this study. The information we get from this study will contribute to current understanding of bipolar disorder which could help improve treatment for people with bipolar disorder.

What will happen if I don't want to carry on with the study?

If you decide to withdraw from the study at any stage in the proceedings, all data and any personal details that we have collected from you will be destroyed.

What if there is a problem?

Complaint Procedure

If you have a concern about any aspect of this study, you should contact the researcher who will try to answer your questions. If you remain unhappy and wish to make a formal complaint, you can do this through the NHS Complaints Procedure (Tel: xxxxx xxxxxx).

Harm

In the event that you are harmed during the research and this is due to someone's negligence then you may have grounds for a legal action for compensation against Humber Mental Health and Teaching NHS Trust but you may have to pay your legal costs.

Confidentiality

- The handling, storage and destruction of data will be compliant with Data Protection Act (1998).

- All information collected during the course of the research will be kept strictly confidential, and any information about you which leaves the University / NHS clinic will have your name and address removed so that you cannot be recognised.
- All questionnaires and data files will be anonymised. Data from the study will be stored on the researcher's computer in a password protected file.
- Personal details will be stored on paper in a locked filing cabinet. Only the Researcher and the Educational Supervisor will have access to this cabinet. Following participation any documents including your personal details will be disposed of securely. An exception to this is if you have requested for us to send you details about the results of the study. In this instance, your address will be kept on a piece of paper in a locked filing cabinet until we have sent you this information. It will then be destroyed.
- The data collected in this study will be kept for up to 5 years, while the researcher completes a report of the study for publication. It will then be deleted and destroyed.

What will happen to the results of the research study?

The results of the study will be written up for publication. The study will also be submitted to the University of Hull for assessment as part of the researcher's Doctorate in Clinical Psychology course.

If you would like to know the results of the study, there will be the opportunity to request a results summary sheet for participants during the consent process.

Who is organizing and funding the research?

The study is sponsored by Humber Mental Health and Teaching NHS Trust. Costs will be covered by the University of Hull.

Who has reviewed this study?

All research in the NHS is looked at by independent group of people, called a Research Ethics Committee to protect your safety, rights, wellbeing and dignity. This study has been reviewed and given favourable opinion by York Research Ethics Committee.

Further information and contact details

Please don't hesitate to contact me if you have any questions that are not answered on this sheet. You can contact me by email or post, or you can telephone my academic department and leave a message.

Email: xxxxxxxxxxxx.xxxx

Telephone: xxxxx xxxxxxx

Sarah Cole
 Department of Clinical Psychology
 Hertford Building
 University of Hull
 Hull
 HU6 7RX

Thank you for taking the time to read this information and consider taking part in this study.

Appendix 5.7 - Participant consent form

Patient Identification Number:

CONSENT FORM

Title of Project: Risk Taking in Bipolar 1 Disorder

Name of Researcher: Sarah Cole

Please initial box

1. I confirm that I have read and understand the information sheet dated 22/06/08 (version 3) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected.

3. I agree to take part in above study.

4. I agree to the researcher audio recording the interview part of the study.

Name of participant

Date

Signature

Name of person
taking consent

Date

Signature

When completed, 1 for patient; 1 for researcher site file.

Appendix 6 – Data analyses for empirical paper

Appendix 6.1 – Tables of correlational analyses

Appendix 6.2 – Tables of primary analyses

Appendix 6.1 – Tables of correlational analyses

Table 6. Correlational analysis of demographic and clinical variables with mood and BART adjusted pumps at baseline

Variable	VAS mood		Adjusted pumps	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>p</i>
Age	-.150	.278	-.035	.800
BDI – II	-.396	.003	-.067	.628
MRS	-.008	.954	.009	.946
Predicted FSIQ	.017	.904	.043	.759
VAS mood	-	-	.071	.610
Adjusted pumps	.071	.610	-	-
BAS total	.222	.107	.081	.561
BAS RR	.286	.036	.108	.436
BAS FS	.198	.150	.099	.967
BAS D	.103	.461	.006	.477
BIS total	-.063	.653	-.201	.144

Table 7. Correlational analyses of clinical variables within the bipolar sample with BART adjusted pumps at baseline

	Adjusted pumps	
	<i>R</i>	<i>p</i>
Age of onset	.147	.473
Manic episodes	.197	.335
Depressive episodes	.129	.528
Hospitalisations (mania)	.096	.642
Hospitalisations (depression)	.097	.636

Appendix 6.2 Tables of primary analyses

Table 8. ANCOVA summary table for primary analysis (dependent variable: risk taking change)

Source of variance	Sum of squares	Degrees of freedom	Mean Square	<i>F</i> -ratio
BDI	57.106	1	57.106	.746
Gender	115.175	1	115.175	1.505
BART adjusted pumps (baseline)	282.515	1	282.515	3.691
Group	25.835	1	25.835	.338
Mood Induction	54.874	1	54.874	.717
Group x Mood Induction	62.225	1	62.225	.813
Error	3597.558	47	76.544	

Table 9. ANCOVA summary table for post hoc analysis (dependent variable: risk taking change per unit mood change)

Source of variance	Sum of squares	Degrees of freedom	Mean Square	<i>F</i> -ratio
BDI	.001	1	.001	.000
Gender	3,163	1	3.163	1.081
BART adjusted pumps (baseline)	1.661	1	1.661	.568
Group	.124	1	.124	.042
Mood Induction	5.856	1	5.856	2.002
Group x Mood Induction	2.268	1	2.268	.775
Error	137.503	47	2.926	