It’s Not All About That BAS: Trait Bipolar Disorder Vulnerability Weakly Correlated with Trait BAS and Not Predictive of Risky Decision-Making

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Abstract

The behavioural activation system (BAS) theory of bipolar disorder proposes that BAS abnormality is aetiologically linked to bipolar disorder. The present project investigated this theory from a vulnerability trait perspective, utilising non-clinical participants. The novel approach was taken of examining BAS as both self-reported trait and as risky decision-making responses on behavioural tasks, a putative behavioural manifestation of BAS. Across studies, trait bipolar disorder vulnerability was measured using the 7 Up 7 Down Inventory (7U7D), whilst trait BAS was measured using the BIS/BAS Scales (BBS). Three studies were conducted. Factor analysis of the 7U7D and BBS was conducted in Study 1, and bivariate correlations between traits were examined. Risky decision-making and set-shifting, the ability to adapt to changing task demands, were examined in Study 2, using the Balloon Analogue Risk Task (BART), Iowa Gambling Task, Game of Dice Task, and Wisconsin Card-Sorting Test. Interaction between trait and mood state during repeated BART administrations was examined in Study 3. Although trait bipolar disorder vulnerability and trait BAS were correlated, no behavioural support for the BAS hypothesis of bipolar disorder was observed, and the degree to which risky decision-making tasks assessed BAS remained questionable. Discussion of findings focused on (i) the continuity of trait bipolar disorder; (ii) alternate perspectives of trait BAS; and (iii) difficulties in accounting for individual state, strategy, and motivation during risky decision-making tasks.
Acknowledgements

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All of these people made my tenure as The Fresh Prince of Swinburne enjoyable indeed.
Declaration

In submitting this thesis as a requirement for the Doctor of Philosophy (Clinical Psychology) program at Swinburne University of Technology, I declare that the following work:

1. Contains no material which has been accepted for the award to myself of any other degree or diploma, except where due reference is made in the text of the examinable outcome;
2. To the best of my knowledge contains no material previously published or written by another person, except where due reference is made in the text of the examinable outcome;
and
3. Where the work is based on joint research or publications, discloses the relative contributions of the respective workers or authors.

Signed:

James Collett
29/04/2016
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Overview of Thesis

The overarching aim of the present project was to better understand the proposed association between trait vulnerability to bipolar disorder and the behavioural activation system (BAS). Bipolar disorder is a severe and often chronic mental disorder (Goodwin & Jamison, 2007) that is associated with diminished quality of life (Dean, Gerner, & Gerner, 2004), decreased life expectancy (Kessing, Vradi, McIntyre, & Andersen, 2015), and elevated risk of suicide (Costa et al., 2015). BAS is a neurobehavioural motivational system underlying reward sensitivity and approach motivation (Corr, 2008). Theory and evidence suggest a link between bipolar disorder, trait BAS, and trait behavioural inhibition system (BIS) sensitivity (Alloy & Abramson, 2010; Carver, Johnson, & Joorman, 2009; Depue et al., 1981). Improved understanding of the link between trait bipolar disorder vulnerability, trait BAS, and risky decision-making could enhance early intervention strategies and psychological therapies for bipolar disorder (Nusslock, Young, & Damme, 2014).

The project’s primary innovation over existing literature was the use of common risky decision-making tasks as behavioural measures of BAS (Corr, 2008; Davis, Patte, Tweed, & Curtis, 2007; Rao, Dunn, Zhou, & Li, 2015), in addition to the use of self-report questionnaires as measures of trait BAS.

The present project adopted a dimensional perspective of bipolar disorder as an underlying vulnerability trait measurable in the non-clinical population (Depue et al., 1981). Vulnerability to bipolar disorder was measured as two separable traits: mania-proneness and depression-proneness. Three studies were conducted. Study 1 aimed to evaluate the relationship between trait bipolar disorder vulnerability and trait BAS using cross-sectional self-report methodology, with the secondary aim of investigating the factor structure of trait measures of bipolar disorder and BAS. Study 2 aimed to evaluate the relationship between trait bipolar disorder vulnerability and risky decision-making in the form of behavioural task responses. Four behavioural tasks were administered to assess whether risky decision-making was correlated with bipolar disorder vulnerability, trait BAS, trait BIS, or multiple traits. Study 2 also explored the degree to which risky decision-making was a specific indicator of trait bipolar disorder vulnerability. This was accomplished by
examining set-shifting, defined as the ability to adjust responses to adapt to changing task demands (Schultz & Searleman, 2002), during a risky decision-making task and during a decision-making task that did not involve risk and reward cues. Finally, Study 3 aimed to experimentally monitor the potential effect of state mood on risky decision-making responses, and to test whether this effect was modulated by trait bipolar disorder vulnerability. This was accomplished by utilising a false feedback mood induction prior to administration of a risky decision-making task. Across the three studies, trait BAS was only moderately correlated with trait bipolar disorder vulnerability, and trait bipolar disorder vulnerability had little impact on risky decision-making. Potential reasons for these findings are discussed following the reporting of the three studies.

Chapter 1 defines bipolar disorder, introduces the dimensional approach that underpins the present project, and reviews the 7 Up 7 Down Inventory (7U7D; Youngstrom, Murray, Johnson, & Findling, 2013) and its precursor, the General Behavior Inventory (GBI; Depue, et al., 1981; see Appendix 1). Chapter 2 summarises reinforcement sensitivity theory (RST; Corr, 2008; Gray & McNaughton, 2000), the theoretical paradigm from which BAS and BIS originate, and reviews the BIS/BAS Scales (BBS; Carver & White, 1994; see Appendix 2) used here to assess trait BAS and trait BIS. Risky decision-making is introduced in Chapter 3, along with a series of tasks designed to assess risky decision-making and set-shifting. Research linking bipolar disorder to RST is reviewed in Chapter 4, whilst Chapter 5 introduces state mood and mood induction techniques. Finally, the aims and hypotheses of the project as a whole and the three individual studies are introduced in Chapter 6. Chapter 7 reports the method and results of Study 1, Chapter 8 reports the method and results of Study 2, and Chapter 9 reports the method and results of Study 3. Finally, Chapter 10 interprets the findings of each study and discusses useful directions for future research.

### 1. Trait Vulnerability to Bipolar Disorder

#### 1.1. Structure of Chapter 1

Section 1.2 of Chapter 1 defines bipolar disorder and introduces the vulnerability trait perspective of bipolar disorder. Section 1.4 reviews the GBI
(Depue et al., 1981) and its short-form, the 7-Up 7-Down Inventory (Youngstrom et al., 2013), as the 7U7D was used in this project to assess mania-proneness and depression-proneness.

1.2. Definition of Bipolar Disorder

1.2.1. Diagnostic definition of bipolar disorder. Bipolar disorder is a mental disorder characterised primarily by the experience of two extreme mood states, mania and depression (American Psychiatric Association [APA], 2013). Mania is a state of euphoric or irritable mood and heightened activity, whilst depression is a state of depressed mood or loss of interest and pleasure, usually associated with diminished activity (APA, 2013). The 12-month prevalence of bipolar disorder is estimated at 0.6% (APA, 2013), and the disorder is associated with a range of negative health outcomes (Rosa et al., 2009), including suicidality (Tondo, Isaacson, & Baldessarini, 2003). Bipolar disorder is regarded as aetiologically multifactorial and complex, with researchers focusing on a range of plausible psychobiological explanations (Berk et al., 2011; Etain, Henry, Bellivier, Mathieu, & Leboyer, 2008; Goodwin & Jamison, 2007; Power, 2005).

Although previous iterations of the Diagnostic and Statistical Manual of Mental Disorders (DSM; APA, 2000) categorised bipolar disorder as a mood disorder alongside major depressive disorder, the recent fifth edition of the DSM (DSM-5; APA, 2013) separates these disorders into two chapters – Bipolar and Related Disorders and Depressive Disorders. In contrast to the majority of mental disorders described in the DSM, diagnosis of bipolar disorder is based on the episodic mood syndromes that characterise the disorder, in addition to overarching criteria. These mood syndromes are primarily divided into manic episodes or major depressive episodes (hereafter referred to simply as depressive episodes). The DSM-5 characterisation of manic and depressive episodes are supplied in Table 1.1 and Table 1.2.

The episodic states outlined in Tables 1.1 and 1.2 are the major components of a diagnosis of bipolar disorder. Two other mood phenomena important to bipolar disorder also warrant definition. Firstly, a hypomanic episode is an attenuated state of mania, where similar manic symptoms are present, but to a lesser extent and duration. Within the DSM-5 classification system, the criteria for a hypomanic
episode are identical to those for mania, save that (i) the symptoms need only be present for four days; and (ii) the episode is not severe enough to cause social or occupational impairment or hospitalisation, although the mood disturbance must be observable by others. Secondly, mixed features, where manic symptoms present simultaneously with depressive symptoms (and vice-versa) also commonly occur.

Table 1.1

DSM-5 Diagnostic Criteria for a Manic Episode (APA, 2013, p.124)

<table>
<thead>
<tr>
<th>Manic Episode</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. A distinct period of abnormally and persistently elevated, expansive, or irritable mood and abnormally and persistently increased goal-directed activity or energy, lasting at least 1 week and present most of the day, nearly every day (or any duration if hospitalization is necessary).</td>
</tr>
<tr>
<td>B. During the period of mood disturbance and increased energy or activity, three (or more) of the following symptoms (four if the mood is only irritable) are present to a significant degree and represent a noticeable change from usual behavior:</td>
</tr>
<tr>
<td>1. Inflated self-esteem or grandiosity.</td>
</tr>
<tr>
<td>2. Decreased need for sleep (e.g., feels rested after only 3 hours of sleep).</td>
</tr>
<tr>
<td>3. More talkative than usual or pressure to keep talking.</td>
</tr>
<tr>
<td>4. Flight of ideas or subjective experience that thoughts are racing.</td>
</tr>
<tr>
<td>5. Distractibility (i.e., attention to easily drawn to unimportant or irrelevant external stimuli), as reported or observed</td>
</tr>
<tr>
<td>6. Increase in goal-directed activity (either socially, at work or school, or sexually) or psychomotor agitation (i.e., purposeless non-goal-directed activity).</td>
</tr>
<tr>
<td>7. Excessive involvement in activities that have a high potential for painful consequences (e.g., engaging in unrestrained buying sprees, sexual indiscretions, or foolish business investments).</td>
</tr>
</tbody>
</table>
Table 1.2
*DSM-5 Diagnostic Criteria for a Major Depressive Episode (APA, 2013, p.125)*

<table>
<thead>
<tr>
<th>Major Depressive Episode</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.</td>
</tr>
</tbody>
</table>

**Note:** Do not include symptoms that are clearly attributable to another medical condition.

1. Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad, empty, or hopeless) or observation made by others (e.g., appears tearful). *(Note: In children and adolescents, can be irritable mood.)*

2. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation).

3. Significant weight loss when dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day. *(Note: In children, consider failure to make expected weight gain.)*

4. Insomnia or hypersomnia nearly every day.

5. Psychomotor agitation or retardation nearly every day (observable by others; not merely subjective feelings of restlessness or being slowed down).

6. Fatigue or loss of energy nearly every day.

7. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick).

8. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others).

9. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.

Several variant diagnoses are encompassed by the *Bipolar and Related Disorders* chapter of the DSM-5. The archetypal bipolar disorder, *Bipolar Disorder I* (BD-I), is diagnosed with the occurrence of a single manic episode, irrespective of whether the manic episode has been preceded or followed by depressive or hypomanic episodes. Typically, both manic and depressive episodes are experienced over the course of the disorder, with the first episode being depressive *(APA, 2013).* *Bipolar Disorder II* (BD-II) is diagnosed when at least one depressive episode and one hypomanic episode are experienced (any occurrence of manic episodes escalates the diagnosis to BD-I). *Cyclothymic Disorder,* or cyclothymia, consists of numerous
periods of hypomanic symptoms (that do not meet criteria for a hypomanic episode) and depressive symptoms (that do not meet criteria for a major depressive episode) continuing for at least two years (one year in children and adolescents). These symptoms must be present more than 50% of the time and with no more than two months at a time without symptoms. Criteria for full mood episodes must not be met. This constitutes a change in diagnostic criteria from the previous DSM (APA, 2000), where hypomanic episodes were permitted in cyclothymia, and manic and depressive episodes were allowed provided the cyclothymia had commenced at least two years prior (APA, 2013).

Despite now being classified in a separate DSM-5 chapter, knowledge of two of the depressive disorders is necessary to properly understand bipolar disorder. **Major Depressive Disorder** (MDD) is diagnosed if depressive episodes are experienced without the presence of any manic or hypomanic episodes (as these would alter the diagnosis to BD-I or BD-II respectively). **Persistent Depressive Disorder** (Dysthymia) is a long-term temperamental variant of MDD, consisting of depressive symptoms present for more than a two-year period (one year for children or adolescents). These symptoms can be subsyndromal; however, in a departure from the previous DSM, the label dysthymia can now also be applied when full criteria for a depressive episode are met for the two-year period. DSM-5 dysthymia now accommodates major depressive episodes, with specifiers used to differentiate dysthymia consisting of subsyndromal depressive symptoms with intermittent depressive episodes from a persistent depressive episode (APA, 2013). The DSM-5 depressive disorders are often termed “unipolar disorders” or “unipolar depression” as they involve only one “polarity” of mood episode (Goodwin & Jamison, 2007).

**1.2.2. Continuous spectrum conceptualisation of bipolar disorder.** There has been concern that the categorical diagnoses in the DSM group psychiatric symptoms in a manner that may not accurately or usefully represent reality (Hyman, 2010). These categorical groupings can obscure theoretically meaningful research data (e.g., Wright, Lam, & Brown, 2008). The DSM is also deliberately atheoretical, and largely avoids consideration of aetiology (Angst & Cassano, 2005). Hence, while it is generally considered to be a useful taxonomy of mental disorders, the structure and assumptions of the DSM do not necessarily suit all research applications.
An alternative perspective is to view psychopathology as fundamentally continuous (Depue et al., 1981; Krueger & Piasecki, 2002). Under this perspective, bipolar disorder is a phenomenon that can be quantitatively present to varying degrees in different individuals. This bipolar disorder continuum can be termed *trait bipolar disorder vulnerability* (Clark, 2005; Depue et al., 1981). On this continuum, those warranting diagnosis would likely represent a clinically extreme level of bipolar disorder vulnerability, with the lower extremes representative of normal mood fluctuation. Trait bipolar disorder vulnerability can be viewed as describing a genetic diathesis that results in clinical bipolar disorder through interaction with environmental stressors (Depue et al., 1981; Monroe & Simons, 1991).

Consequently, trait bipolar disorder can also be viewed as an endophenotype of bipolar disorder, an intermediate manifestation of psychopathology occurring between aetiology and clinical disorder (Kendler & Neale, 2010). A trait vulnerability approach is useful as it circumvents some of the limitations of clinical research, such as the effects of clinical state (Goodwin, Martinez-Aran, Glahn, & Vieta, 2008), prodromal and residual symptoms (Keitner et al., 1996), medication (Phillips, Travis, Fagiolini, & Kupfer, 2008), and “scarring” consequences associated with long-term psychopathology (e.g., Kessing & Andersen, 2004).

Viewing bipolar disorder vulnerability as falling on a continuum is concordant with a number of lines of evidence. Biologically, a continuous spectrum approach fits the theory that bipolar disorder vulnerability is caused by a multitude of genes of individually small effect (Kelsoe, 2003; Kendler, 2005). Between individuals, researchers generally find a continuous distribution of symptomatology, where there is no clear demarcation between normality and abnormality (Meyer & Keller, 2003; Prisciandaro & Roberts, 2011; Watson, 2005), and within individuals with bipolar disorder, varying intensities of symptoms are seen, suggesting a spectrum of severity (Akiskal, 1996). The ordinarily ranked bipolar disorder categorical diagnoses described in the DSM-5 also imply this continuity (APA, 2013). BD-I, BD-II, and cyclothymia can be ordered by gradations in severity from full mood episode symptoms to subsyndromal experiences, which are in turn said to abut normal affective temperament (Akiskal, 2003; Angst & Cassano, 2005).

A conceptual problem arises when trying to include major depressive disorder and dysthymia in the ordinal ranking of mood disorders. Although these are
both unipolar depressive disorders, their close link to bipolar disorder and similar focus on mood suggest that a continuous model of bipolar disorder should encompass them (Cassano et al., 2004). MDD involves more severe symptoms than cyclothymia, but does not feature a manic component (APA, 2013), and hence is difficult to fit into an ordinal ranking of bipolar disorders. The solution is to conceptualise bipolar disorder vulnerability as not a single continuum but as two separable continua, one relevant to mania and one relevant to depression (Murray et al., 2007). This two-dimensional model of trait bipolar disorder vulnerability is portrayed in Figure 1.2.

Figure 1.1. The heuristic benefits of a two-dimensional model of bipolar disorder vulnerability.

The two-dimensional model portrayed above shows the term “bipolar” to be something of a misnomer at a trait level, as bipolar disorder vulnerability is best modelled as two separable yet highly correlated continua (Joffe, Young, & MacQueen, 1999; Johnson et al., 2011; Murray, Goldstone, & Cunningham, 2007). The separation of two dimensions relevant to mania and depression respectively has been supported by observations of client phenomenology (e.g., Johnson et al., 2011);
factor analysis and modelling using trait measures of bipolar disorder (e.g., Bullock & Murray, 2014; Depue et al., 1981; Murray et al., 2007); and by genetic data (McGuffin, Rijsdijk, Sham, Katz, & Cardno, 2003; Merikangas et al., 2014). Separating manic and depressive phenomena also accounts for episodes of mixed features (APA, 2013), as the co-occurrence of symptoms is much more difficult to conceptualise when mania and depression are viewed as opposing poles of a unitary continuum. The two-dimensional continuum model is therefore a useful way to conceptualise bipolar disorder vulnerability, and for this reason was adopted as the core approach of the present project. The 7U7D (Youngstrom et al., 2013) was used to assess bipolar disorder vulnerability throughout the present project. The recently published 7U7D is a short form of the earlier GBI, both of which are described next.

1.3. Measurement of Trait Bipolar Disorder Vulnerability

1.3.1. The General Behavior Inventory and 7 Up 7 Down Inventory. The GBI was designed to assess trait bipolar disorder vulnerability via self-report questionnaire (Depue et al., 1981). The GBI represents bipolar disorder vulnerability as a personality or temperamental predisposition towards the development of bipolar disorder (Depue et al., 1981), that is to say, a trait indicator of risk. A central assumption of the GBI is that the affective dysfunction characterising bipolar disorder is at least partially continuous with normal affective functioning, and that people possessing higher trait levels of this affective dysfunction are more vulnerable to the development of bipolar disorder (Depue et al., 1981). The GBI measures bipolar disorder vulnerability as two separable yet related traits: (i) mania-proneness, a trait indicative of susceptibility to the manic component of bipolar disorder; and (ii) depression-proneness, a trait indicative of susceptibility to the depressive component of bipolar disorder, or to unipolar depression (Depue, Krauss, Spoont, & Arbisi, 1989; Depue et al., 1981). Although these GBI traits were previously referred to as hypomania/biphasic symptoms and depression respectively (e.g., Depue et al., 1989), mania-proneness and depression proneness are used throughout this thesis as these terms more accurately reflect the notion of a subsyndromal vulnerability trait (Clark, 2005).

The GBI assesses bipolar disorder using items based on affective, cognitive, and behavioural symptoms of mania, depression, and mood lability. These symptom
indicators may be distinguished from normal levels of affective functioning with respect to intensity, duration, rapidity of shifting, and frequency (Depue et al., 1989; Depue et al., 1981). Items used include questions such as “Have there been times of a couple days or more where you felt that you were a very important person or that your abilities or talents were better than most other people’s?” (mania-proneness), and “Have you had periods when it seemed that the future was hopeless and things could not improve?” (depression-proneness). Items are worded to appear non-psychiatric in nature to avoid inadvertently provoking defensiveness or malingering (Depue et al., 1981). The full administration of the GBI consists of 73 items (Depue & Klein, 1988).

The GBI utilises a four-point response scale ranging from 0 (Never or hardly) to 3 (Very often or almost constantly). This was selected to reduce the agreement and neutrality biases associated with bimodal response options (e.g., True or False) and response scales with a mid-point (e.g., Neither agree nor disagree) respectively (Depue et al., 1981; Goldberg, 1972; Guilford, 1954). Due to the focus on categorically separating at-risk individuals from those not at risk, the GBI response scale was designed to suit a case-scoring method, wherein respondents are only scored when they endorse the third or fourth response. Because of this consideration, the response scale cannot be technically regarded as a linear series of options, as conceptually there is a larger divide between the second (Sometimes) and third (Often) responses than between the other points on the response scale (Depue et al., 1981). Nonetheless, an alternative scoring technique is to simply sum responses to produce a continuous range of trait scores, and the discrepancy of interval between the second and third indicators is not believed to bias scoring (Depue et al., 1989).

Continuous scoring of the GBI has become the standard scoring protocol in contemporary literature (e.g., Youngstrom, Findling, Danielson, & Calabrese, 2001; Youngstrom et al., 2013). Both case-scoring and continuous scoring were endorsed by the authors of the GBI and validity evidence is regarded as applicable to both forms of scoring (Depue et al., 1989; Depue et al., 1981). Youngstrom, Findling, Danielson, and Calabrese (2001) were the first research group focusing on bipolar disorder to adopt continuous scoring rather than the case-scoring method common in earlier GBI literature. Youngstrom et al. cited three reasons for this decision: (i) the preservation of information about symptom frequencies; (ii) an extending of the
potential variability of summed GBI scores; and (iii) the guaranteed increase in reliability (as a point of statistical fact) of the obtained scales. Additionally, Findling et al. (2002) noted that the cut-off demarcations used in case-scoring are likely to elicit a higher degree of variability across samples.

The 7U7D is a short-form scale, comprising 14 items drawn from the 73-item GBI (Youngstrom et al., 2013). The 7U7D has two subscales, one assessing mania-proneness and one assessing depression-proneness. Items are scored on an identical response scale to the GBI. The continuous form of scoring was presented as standard for the 7U7D as continuous scoring is more desirable from both a research perspective and for the purposes of clinical decision-making (Youngstrom et al., 2001; Youngstrom et al., 2013). For this reason, the continuous scoring paradigm was used in the present project. As with the GBI, the 7U7D was designed to be valid across non-clinical, subsyndromal, and clinical samples. Although relatively little validity evidence has been reported for the 7U7D, validity evidence for the GBI is also supportive of the validity of the 7U7D, due to the close association between the two scales (Youngstrom et al., 2013). The 7U7D was selected to measure trait bipolar disorder vulnerability in the present thesis due to its brevity, versatility, parsimony of factor structure, and established psychometric quality (Youngstrom et al., 2013).

1.3.2. Reliability and validity of the GBI. Strong support has been found for the reliability and validity of the GBI, and this data is also relevant to the 7U7D. In a large-scale sample stratified by GBI score and psychiatric status, Depue et al. (1981) demonstrated convergent and concurrent criterion-related validity across a range of modalities, including (i) ability to differentiate psychiatric outpatients from non-psychiatric controls at a level of accuracy greater than measures of neuroticism and state depression; (ii) concordance with observer ratings in addition to self-report; (iii) the matching of subsyndromal symptoms as an attenuated expression of clinical symptoms; (iv) identification of individuals with a family history of affective disorder; and (v) identification of individuals possessing a cyclothymic temperament. The internal consistency of the GBI was high (Cronbach’s $\alpha = .94$) and test-retest reliability of the GBI across a 15-week interval was adequate (Pearson’s $r = .73$) and comparable to that of other scales (Depue et al., 1981). The GBI was also validated biologically, predicting higher cortisol secretion over a three-hour mathematics test,
an indicator of increased stress reactivity in those higher in bipolar disorder vulnerability (Depue, Kleiman, Davis, Hutchinson, & Krauss, 1985).

Subsequent research has further supported the validity of the GBI. Depue and Klein (1988) tested the specificity of the GBI in a large sample of psychiatric outpatients ($N = 176$), finding that it was able to correctly identify individuals with a mood disorder diagnosis 99% of the time. This ability to discriminate mood disorders from other diagnoses was replicated by Mallon, Klein, Bornstein, and Slater (1986) in a smaller sample ($N = 81$). Depue, Krauss, Spoont, and Arbisi (1989) validated the GBI in a non-clinical context using a sample of North American university students ($N = 201$) who had been allocated to sub-samples stratified by the GBI case scoring method and using percentile-based cut-off scores. The researchers found that the GBI was concordant with interviewer-derived mood disorder diagnosis at a high rate of accuracy and specificity. Klein and Depue (1984) found that individuals who had been rated as high-risk during the original GBI validation project continued to experience higher levels of psychological impairment and suicidal ideation at 19-month follow-up. Klein, Dickstein, Taylor, and Harding (1989) demonstrated high accuracy in terms of matching clinical participants ($N = 167$) to mood disorder diagnoses. Higher scores on the mania-proneness and depression-proneness subscales were predictive of the occurrence of hypomanic episodes and greater impairment in functioning respectively. The former finding was supported even for patients who had been classified under unipolar depression based on their past history (Klein, Dickstein, Taylor, & Harding, 1989).

A subset of GBI literature has focused more specifically on childhood and adolescent manifestations of bipolar disorder (Youngstrom et al., 2001). As the focus of the current thesis is on bipolar disorder vulnerability in adults, the specific findings of this literature are tangential to the present project. However, it is worth noting that the adolescent-sample literature has continued to support the reliability and validity of the GBI. A parent-rated GBI replicated the same two-factor structure (depression and hypomania/biphasic symptoms), strong reliability, and discriminant validity in being able to separate affective disorder diagnoses from both attention deficit/hyperactivity disorder (ADHD) diagnoses and non-psychiatric controls (Youngstrom et al., 2001). Findling et al. (2002) endorsed the ability of the GBI to screen for affective disorder in a youth sample ($N = 196$). Danielson, Youngstrom,
Findling, and Calabrese (2003) established that the GBI was capable of differentiating affective disorder diagnoses from non-affective disorder diagnoses in a youth outpatient sample \((N = 197)\). Danielson et al. replicated the expected two-factor GBI solution, and found the GBI to be capable of differentiating unipolar from bipolar affective disorders. Finally, in a large adolescent sample \((N = 642)\), Youngstrom et al. (2004) concluded that the mania-proneness subscale of the GBI, rated by parents, was amongst the most specific indicators of manic/hypomanic vulnerability available when compared to similar measures, a finding replicated by Youngstrom et al. (2005) using a short-form GBI.

There is little data on the cross-cultural validity of the GBI. Reichart et al. (2004) replicated the two-factor structure in a sample of Dutch adolescents \((N = 117)\). Both GBI subscales were correlated with self-reported internalising symptoms (withdrawn behaviour, somatic complaints, and anxiety and depression). However, the authors found that although the depression-proneness subscale could discriminate between adolescents with an affective disorder, those with other psychiatric disorders, and non-psychiatric controls, the hypomania/biphasic symptom subscale was only able to differentiate psychiatric patients from controls. This result is contrary to the findings of Danielson et al. (2003) and Youngstrom et al. (2004). However, Reichart et al.’s (2004) psychiatric disorder sample was reasonably heterogeneous and included individuals with affective comorbidities, possibly artificially inflating the false positive rate. Reichart et al. (2005) later supported the predictive validity of the GBI following a five-year longitudinal study examining a sample of adolescent offspring of affective disorder patients. Depression-proneness was found to not only predict the emergence of a unipolar depressive disorder, but higher depression-proneness scores were predictive of subsequent bipolar disorder diagnosis. Although mania-proneness was not predictive of a later bipolar disorder diagnosis, this may have been due to the use of a relatively small, at-risk sample (Reichart et al., 2005).

1.3.3. The 7 Up 7 Down Inventory. The 7U7D was designed as a brief form of the GBI, with the primary aim of decreasing administration time, a consideration noted as problematic in previous research (Youngstrom, Frazier, Demeter, Calabrese, & Findling, 2008). The revision also aimed to enhance the separability of subscales, with previous research yielding high correlations between depression-
proneness and mania-proneness (e.g., \( r = .80; \) Murray, Goldstone, & Cunningham, 2007), hindering specificity. A core consideration in the 7U7D redesign process was also to remove items assessing biphasic symptoms (lability of mood), as this construct and its theoretical link to depression and mania has not been clearly defined (Youngstrom et al., 2013). Studies have revealed discrepant patterns of correlation when mania-proneness and biphasic symptoms were separated, and hence continuing to aggregate these constructs was regarded as undesirable (Youngstrom et al., 2013). The 7U7D was also designed to be applicable to both adults and adolescents across both clinical and non-clinical populations, acknowledging a continuity of symptoms between these demographics (Youngstrom, Birmaher, & Findling, 2008). A clinical youth sample \( (N = 738) \) and an adult sample \( (N = 1,756) \) were used for factor analysis and validity testing.

To select items from the GBI to form the 7U7D, maximum likelihood factor analysis was conducted to identify depression-proneness and mania-proneness factors, with the 7U7D comprising the seven highest-loading items across youth and adult samples for each factor (Youngstrom et al., 2013). Important for reasons of parsimony, the decreased number of items in the 7U7D allows factorial validity to be assessed without resorting to the item-parcelling methodology that has characterised previous GBI factor analyses (e.g., Danielson et al., 2003; Reichart et al., 2004; Youngstrom et al., 2001). Across both youth and adult samples, the internal consistency for the short-form scales was excellent (average depression Cronbach’s \( \alpha = .93 \), average mania Cronbach’s \( \alpha = .82 \)), with the depression-proneness scale exhibiting a high correlation with the previous 46-item subscale of the GBI (average Pearson’s \( r = .94 \)) and the mania-proneness scale exhibiting a high correlation with the previous 28-item subscale (average Pearson’s \( r = .87 \)). Convergent and discriminant validity were found to be adequate across a range of alternate affective disorder measures and measures of temperament, life satisfaction, creativity, chronotype, and seasonality of affect. The authors concluded that the 7U7D provides a suitable and brief measure for the assessment of bipolar disorder vulnerability as a pair of continuous traits (Youngstrom et al., 2013).

1.3.4. Rationale for use of the 7U7D in the present project. The reliability, validity, and parsimony of the 7U7D made it the most appropriate measure of bipolar disorder vulnerability to use throughout the present project. In addition to the strong
psychometric properties of the 7U7D and its precursor, the GBI, the 7U7D (a) assesses both mania-proneness and depression-proneness within the one measurement tool; and (b) explicitly adopt a dimensional vulnerability trait focus (Clark, 2005; Depue et al., 1981). The GBI has also been used in a prominent series of large-scale studies examining trait BAS and vulnerability to bipolar disorder (Alloy et al., 2006; Alloy et al., 2008). Whilst the Hypomanic Personality Questionnaire (Eckblad & Chapman, 1986) and the Temperament Evaluation of the Memphis, Pisa, Paris, and San Diego Autoquestionnaire (Akiskal & Akiskal, 2005) were considered as alternative measures of trait bipolar disorder vulnerability, these scales are less parsimonious and also invest in more specific models than the 7U7D. Due to the present project already investing in a highly specific theoretical model of reward and punishment sensitivity, RST, it was judged as desirable to use a more theoretically general measure of bipolar disorder vulnerability. For these reasons the 7U7D was selected to measure bipolar disorder vulnerability in the present project.

2. Reinforcement Sensitivity: Theory and Measurement

2.1. Structure of Chapter 2

Chapter 2 introduces RST, a theory that proposes the existence of BAS and BIS as neurobehavioural systems that, at a personality level, generate sensitivity to reward and sensitivity to punishment respectively (Corr, 2008). A theoretical introduction to RST is presented first, followed by a review of the BIS/BAS Scales (BBS; Carver & White, 1994), the measurement tool that was used here to assess trait BAS and trait BIS. RST forms the theoretical context used to investigate bipolar disorder and generate predictions in the present project. Together, the 7U7D introduced in Chapter 1 and the BBS introduced in Chapter 2 measure the trait variables of interest. Risky decision-making, a behavioural manifestation of BAS, is then described in Chapter 3.

2.2. The Complex History of Reward Sensitivity

It is important to note that there are a number of iterations of RST. This is because RST has developed over a period of 45 years (Gray & Smith, 1969; Gray, 1970; Gray, 1982), undergoing a significant revision in this time (Gray &
Since the publication of revised RST by Gray and McNaughton (2000), revised RST has also undergone continued development (e.g., Corr & Perkins, 2009; McNaughton & Corr, 2004; Smillie, Pickering, et al., 2006). This revision means that RST can be organised in two separate ways: original RST and revised RST (Corr, 2008). Gray and McNaughton (2000) intended for revised RST to supersede original RST. However, revision of RST has had different implications for different levels of research (e.g., physiological, cognitive, personality-based), and some literature still maintains a focus on original RST, especially as measurement tools capable of examining revised RST at the level of self-reported traits have only been published relatively recently (e.g., Jackson, 2009). Due to this historical complexity, the following sections provide a broad definition of BAS, BIS, and a third neurobehavioural system proposed by RST, the fight-flight system (FFS; original RST) or fight-flight-freezing system (FFFS; revised RST) before explaining how their historical nuances affect the present project.

A second complexity in thinking about RST is the level of examination at which the theory is applied. RST was originally developed to explain the findings of learning studies. These studies were primarily conducted on animals using classical and operant conditioning principles (Gray, 1975). BAS, BIS, and FFS/FFFS were proposed as conceptual neurobehavioural systems underlying the sensitivity to reinforcement and sensitivity to punishment observable behaviourally in learning research (Gray, 1975): The qualifier *conceptual* is used to acknowledge that the model proposed by RST is a theoretical model of neurophysiology, based on learning functionality, and that the organisation of BAS, BIS, and FFS/FFFS at a neurophysiological level may be more complex than is represented at the theoretical level (Gray, 1975, 1980). Expression of BAS, BIS, and FFS/FFFS at the level of human dispositional traits, the level of analysis most relevant to the present investigation, has received less coverage in the RST literature. Additionally, less attention has been focused on describing BAS than BIS/FFFS, as major human-level application of RST has been directed at explaining anxiety disorders (Fowles, 1980; Gray, 1987; Gray & McNaughton, 2000). The most definitive coverage of BAS, BIS, and FFS in a manner applicable at a trait level has been provided by Corr (2008), and Corr’s article is the primary source informing the following sections.
2.3. Reward Sensitivity: Defining Properties of the Behavioural Activation System

In RST, BAS is a neurobehavioural system controlling appetitive motivation, approach behaviour, and responsiveness to positive feedback or to the termination or omission of punishment (Corr, 2008). Appetitive motivation refers to the tendency to move towards (approach) potential sources of reward, noting that in this sense “move towards” includes temporal elements (e.g., undertaking a series of actions to achieve a desired reward stimulus) as well as spatial elements (e.g., direct physical movement towards a reward stimulus within one’s line of sight). Positive feedback refers to the attainment or achievement of any consequence that has a pleasing or desirable effect. This includes the fulfilment of basic physiological needs, such as consuming food to relieve hunger, but also includes more complex and abstract rewarding consequences, such as feelings of self-efficacy when a task is mastered, or feelings of importance and increased social status when a high-paying promotion is achieved in the workplace. Due to its responsiveness to reinforcing stimuli, BAS is aligned with positive affect and emotions such as excitement, happiness, and enthusiasm (Corr, 2008). However, Corr (2002) noted that BAS may also be responsive to experiences involving failure to obtain an expected reward (known as frustrative non-reward), and accordingly BAS can be associated with negative emotions such as anger in situations where progress towards an anticipated reward is obstructed (Carver & Harmon-Jones, 2009; Carver & Scheier, 1990).

BAS is theorised to underlie sensitivity to virtually all forms of rewarding stimuli. BAS is reward-oriented in focus, but can equally be said to be goal-oriented in its applicability to longer term sources of reward (Corr & Cooper, n. d.). Reward stimuli can be extrinsic, that is, externally and physically manifested, or intrinsic, that is, internally and psychologically manifested (Ryan & Deci, 2000). An organism may be conscious of their motivation toward a reward stimulus, or they might pursue a reward at an unconscious level. Original RST differentiated reward stimuli in terms of whether they were (a) unconditioned (innate biological drives or necessities such as hunger, thirst, respiration, etc.); or (b) conditioned (the result of prior experience, association, and learning), stating that BAS was only responsive to conditioned reward (Corr, 2008). However, revised RST has negated this distinction and presents BAS as responsive unconditioned and conditioned rewards (Gray & McNaughton,
Within RST, BAS is relevant to the process of reward selection and pursuit (the incentive, or “wanting”, response) rather than pleasure or satisfaction following attainment of the reward (the consummatory, or “liking” response; Berridge, Robinson, & Aldridge, 2009; Corr, 2008). However, consummatory responses tend to be included in more general discussions of reward sensitivity (e.g., Berridge et al., 2009; Carver & White, 1994), and can also be thought of as conditioning BAS responsiveness to future reward stimuli.

The neurophysiology of BAS has been investigated in a number of studies. Responsiveness to rewarding stimuli has consistently been linked to mesolimbic and mesocortical dopaminergic pathways (Pickering & Gray, 1999). For example, simian research has implicated dopaminergic neurons of the substantia nigra and ventral tegmental area as being responsive to reward learning (Cohen, Haesler, Vong, Lowell, & Uchida, 2012; Schultz, Apicella, Scarnati, & Ljungberg, 1992). This neuronal pathway is also characterised by synapses to the prefrontal cortex, dorsomedial thalamic nucleus, and the nucleus accumbens, all regions implicated in modulation, inhibition, or conscious control of BAS responses (Houk, Adams, & Barto, 1995). The ventral striatum has been particularly implicated in BAS functionality, as activation in this area of the brain is associated with the evaluation of potentially rewarding stimuli (Cohen et al., 2012; Schultz et al., 1992). At a cortical level, approach motivation is associated with increased activity in the left frontal lobe relative to right frontal activity (Coan & Allen, 2003; Davidson, 1992; Harmon-Jones & Allen, 2003). The pathways outlined above have achieved widespread support from convergent neurophysiological, neuroanatomical, and neurotransmission-linked genetic evidence, usually tested in the context of a behavioural paradigm or via association with trait impulsivity or sensation-seeking (see Corr, 2008, and Pickering & Gray, 1999, for a review).

Expression of BAS at a personality level can be labelled trait BAS. Trait BAS is characterised by a predisposition towards pursuing, engaging in, and persevering at rewarding (or potentially rewarding) experiences (Carver & White, 1994; Corr, 2008). A number of trait BAS models have been proposed, primarily evident in self-report measures (Carver & White, 1994; Torrubia, Ávila, Moltó, & Caseras, 2001). These measures differ with regards to how closely they are aligned with RST, and also with regards to whether their factor structure has been planned...
with attention to theory (rationally derived) or been allowed to emerge during statistical exploration (statistically derived). A central tension in the trait BAS literature is whether trait BAS should be considered unidimensional or whether it should encompass multiple related dimensions (Corr & McNaughton, n. d.; Jackson, 2009; Leone, Perugini, Bagozzi, Pierro, & Mannetti, 2001). Although BAS was postulated as a functionally unitary physiological system by Gray (1972, 1975), there is no a priori reason that BAS should not manifest multidimensionally at a personality trait level (Corr & Cooper, n. d.; Leone et al., 2001; Smillie, Jackson, & Dalgleish, 2006). Indeed, description of BAS as a functional system implies a circuit of multiple components, and the neural substrate of BAS is known to constitute separately identifiable areas of the brain (Corr, 2008). The stance adopted in the present thesis is that the trait outcomes of BAS can be usefully thought of as multiple separable dimensions, and that doing so does not conflict with RST.

One multidimensional model of BAS is provided by Carver and White’s (1994) BBS, the most commonly used self-report measure of trait BAS and trait BIS. The BBS measures three aspects of trait BAS, labelled Drive (BAS-D), Fun-Seeking (BAS-FS), and Reward Responsiveness (BAS-RR). Drive is characterised by the expenditure of effort and directed action in pursuit of a goal, with implicit connotations of strategy and perseverance. Fun-Seeking is characterised by both a craving for novel and exciting sensations and stimuli, and by impetuous decision-making. Finally, Reward Responsiveness is characterised by the experience of positive emotion (e.g., desire, enthusiasm, satisfaction) at the prospect of, or whilst attaining, a reward (incentive response) and following achievement of the award (consummatory response).

Before completing the introduction of BAS, it is important to distinguish trait BAS from the concept of impulsivity (Carver & White, 1994; Quilty & Oakman, 2004; Smillie, Pickering, & Jackson, 2006; Zelenski & Larsen, 1999). The precise definition of impulsivity differs across studies, but normally includes an overriding sensitivity towards positive reinforcement (Stanford et al., 2009). Typically, impulsivity refers to unplanned behavioural responses that are short-term in scope, difficult to control, and enacted with a disregard for long-term consequences (Stanford et al., 2009). In addition, impulsivity is often paired with (and is positively correlated with) the related construct of sensation-seeking, involving an appetite for
novel experiences (often with an element of risk) and a susceptibility to boredom (Zuckerman & Link, 1968). Whilst earlier published measures of impulsivity simply distinguished between psychological impulsivity and motor impulsivity (Barratt, 1959), more complex multidimensional trait models have been published distinguishing between different forms of impulsivity occurring in different contexts (Whiteside and Lynam, 2001).

Despite the shared emphasis on positive reinforcement, it is useful to distinguish trait BAS from impulsivity (Smillie, Pickering, & Jackson, 2006). Firstly, trait BAS is situated within the RST framework, whereas impulsivity is a more general and non-theory-specific construct. Secondly, impulsivity is primarily focused on situations of immediate reward (Stanford et al., 2009), whereas trait BAS is applicable to all forms of reward, including longer-term processes of goal attainment. Thirdly, impulsivity appears to be less integrated with affective processes than is BAS (Zelenski & Larsen, 1999), and BAS appears to interact with affect in a more complex manner (Carver, 2004; Carver & Harmon-Jones, 2009). However, despite these differences, there is some degree of overlap between trait BAS and impulsivity, with BAS-FS closely linked to impulsivity both conceptually and statistically (Quilty & Oakman, 2004; Smillie, Jackson, & Dalgleish, 2006; Zelenski & Larsen, 1999). Both trait BAS and impulsivity are fuzzy constructs, and the precise nature of their relationship at a theoretical level remains unclear. At present, however, it is most useful to view trait BAS and impulsivity as separate constructs (see Smillie, Pickering, & Jackson, 2006, for a comprehensive discussion of this issue).

2.4. Punishment Sensitivity: Defining Qualities of the Behavioural Inhibition System and Fight-Flight-Freezing System

RST proposes BIS as a neurobehavioural system controlling aversive motivation, avoidance behaviour, and responsiveness to punishment and threat (Corr, 2008). Aversive motivation refers to the tendency to move away from (avoid) potential sources of punishment. As with approach motivation, in this sense “move away” includes temporal elements (e.g., undertaking a series of actions to minimise the likelihood of an anticipated undesirable stimulus occurring) as well as spatial elements (e.g., direct physical movement away from a directly threatening stimulus
within one’s proximity). Punishment refers to the occurrence or infliction of any consequence that has a harmful or undesirable effect, whilst threat refers to anticipation of the subsequent occurrence of punishment. Due to its responsiveness to threatening stimuli, BIS is aligned with negative affect and emotions such as anxiety and sadness (Corr, 2008).

The concept of BIS underwent substantial changes between original (Gray, 1982; Gray, 1987) and revised RST (Gray & McNaughton, 2000). An understanding of these changes is required to provide a context for considering both the physiological underpinnings of BIS and trait-level measurement of BIS. Under original RST, BIS was distinguished as being exclusively sensitive to conditioned threat, as well as stimuli signalling the termination or omission of a reward stimulus. Hence, responsiveness to frustrative non-reward was initially identified as a property of BIS, although it is now seen as being equally influenced by BAS (Carver, 2004; Corr, 2002). However, BIS was also seen as being sensitive to extreme novelty (presumably where conditioning had not had an opportunity to take place), highly intense stimuli, and also to stimuli that individuals appear innately predisposed to fearing, such as snakes, heights, and blood (APA, 2013; Gray, 1971). BIS was not proposed to govern responsiveness to unconditioned aversive stimuli. Instead, these stimuli were theorised to be the concern of another system, the FFS (Corr, 2008; Gray, 1987).

The FFS was originally viewed as sensitive to unconditioned aversive stimuli, those which are innately painful (Corr, 2001). The FFS was characterised by the emotion of fear, leading to behavioural responses of defensive attack (“fight”) or fleeing (“flight”; Cannon, 1932; Gray, 1987). Under revised RST, the FFS was broadened to include cessation of action (freezing), and relabelled the FFFS (Gray & McNaughton, 2000). The FFFS encompasses not only responsiveness to unconditioned aversive stimuli, but to all aversive or threatening stimuli, including innate and conditioned stimuli. Hence, the revised FFFS is now viewed as fulfilling many of the functions originally attributed to BIS, with the distinction between conditioned and unconditioned stimuli becoming less important between original and revised RST (Corr, 2008; Gray & McNaughton, 2000). For this reason, the FFFS can be viewed as an important contributor to individual sensitivity to punishment, aversive motivation, and avoidance behaviour.
The concept of BIS was substantially altered under revised RST, corresponding with much of its previous functionality being subsumed by the FFFS (Gray & McNaughton, 2000). Under revised RST, BIS is a system of inhibitory control and caution, rather than sensitivity to punishment itself. BIS is now viewed as sensitive to conflict between approach (BAS) and avoidance (FFFS) systems during the process of progressing towards an expected reward (Gray & McNaughton, 2000). The function of BIS is to attempt to reduce this systemic conflict, and it is biased towards doing so via inhibition of approach behaviour, accompanied by the cognitive-emotional phenomena that characterise anxiety (Corr, 2008). It is because of this bias that BIS can be viewed as contributing to sensitivity to punishment, rather than functioning as a motivationally neutral regulatory mechanism (Gray & McNaughton, 2000). In this manner, the revised concept of BIS is similar to the original concept of BIS, in that its function is still to suppress behavioural responses that are proving maladaptive, and that execution of this function is accompanied by increased arousal and attentional vigilance (Gray, 1978). However, the revised BIS is different from its original conceptualisation in that it serves as a regulator between motivational drives promoted by BAS and FFFS (Gray & McNaughton, 2000).

A number of studies have characterised BIS and FFFS at a neurological level (for a comprehensive review, see Gray & McNaughton, 2000). Activity in the amygdala, septo-hippocampal system, posterior cingulate cortex, and dorsal prefrontal cortex has been implicated in different aspects of the BIS-mediated anxiety response (Corr, 2008). Activity in the periaqueductal grey matter, medial hypothalamus, amygdala, anterior cingulate cortex, and ventral prefrontal cortex has been implicated in different aspects of the FFFS-mediated fear response (Corr, 2008). It is noteworthy that as distributed functional systems, rather than localised neural regions per se, there is some overlap between BIS and FFFS, most prominently in terms of amygdala activation. Anxiety and fear, the primary emotional components of BIS and FFFS respectively, both form elements of negative affect (Watson & Tellegen, 1985). At a cortical level, avoidance motivation and negative affect have been associated with increased right frontal activation relative to left frontal activation (Davidson, 1992). However, this association between BIS/FFFS and increased right frontal activation has not been observed as
consistently as the more robust association between BAS and increased left frontal activation (Coan & Allen, 2003; Harmon-Jones & Allen, 1997).

An important consideration in understanding BIS and FFFS is the differentiation between anxiety and fear. RST conceives of anxiety and fear as alternate responses to threatening or punishing stimuli (Perkins, Kemp, & Corr, 2007): Anxiety is an emotion of worried distress, whereas fear is an emotion of outright panic (Gray, 1971). Anxiety occurs in response to punishing stimuli that nonetheless need to be approached in some fashion, whilst fear occurs in response to punishing stimuli that simply require avoidance (Perkins, Kemp, & Corr, 2007). This distinction is supported neurophysiologically via demonstration that certain pharmaceutical agents are capable of diminishing anxiety without diminishing fear, and vice versa (Gray & McNaughton, 2000). The distinction has also been demonstrated at a personality level using self-report trait correlations and behaviourally through self-report-based prediction of military testing performance (Perkins, Kemp, & Corr, 2007). Hence, the separability of BIS and FFFS holds consistently at multiple level of analysis.

Expression of BIS at a personality level can be labelled trait BIS. Researchers have typically viewed trait BIS as unidimensional (Carver & White, 1994; Jackson, 2009). Carver and White (1994) describe trait BIS as reflective of anxiety-proneness, encompassing both anticipatory anxiety for potentially threatening future events and heightened reactivity to negative evaluation from others. Because of these features, trait BIS is seen as similar to the concept of neuroticism (Perkins, Corr, & Kemp, 2007). Less work has been conducted in translating outcomes of the FFFS to a trait level, partly because (a) there is less theoretical material regarding how responsiveness to fear stimuli would be expressed as a general and enduring personality trait (Carver & White, 1994; Wilson, Barret, & Gray, 1989); and partly because (b) the comparative recency of revised RST publications that place greater emphasis on FFFS (Gray & McNaughton, 2000; Perkins, Kemp, & Corr, 2007). Although recent RST-based measures include scales assessing trait FFFS (e.g., Jackson, 2009), in older measures trait FFFS is either not assessed, or is implicitly incorporated into trait BIS due to their similar relevance to sensitivity to punishment under original RST (Carver & White, 1994).
2.5. Reinforcement Sensitivity Theory as a Theory of Personality

RST is grounded in several related assumptions in its explanation of human emotion, cognition, and behaviour (Corr, 2008). Firstly, RST is an evolutionary account of motivation, as it assumes that findings from studies of animal learning and behaviour generalise to explaining human learning and behaviour (Corr, 2008). Secondly, RST is a functional account of motivation, as it categorises learning and behavioural propensities as adaptive functional systems (Corr, 2008; Jagacinski, 1977; McFarland & McFarland, 1968). Thirdly, RST is a neurological account of motivation, as it assumes that BAS, BIS, and FFFS are represented as distributed neuronal regions and connections within the brain (Corr, 2008; Gray & McNaughton, 2000). Finally, RST is a motivational account of personality, as it assumes that activation, inhibition, and sensitivity of BAS, BIS, and FFS/FFFS underlie trait characteristics of personality (Corr, 2008).

The trait model proposed by RST is a causative theory of personality. Within RST, surface personality traits are generated by underlying neurobehavioural systems. This can be viewed as a “bottom-up” approach to creating a taxonomy of personality (Corr, 2008). In this respect, RST differs fundamentally from personality trait perspectives that have approached the classification of personality from a more abstract and conceptual, or “top-down” perspective. One example of the top-down approach is the five-factor model of personality (Goldberg, 1992; McCrae & Costa Jr, 1987; Tupes & Christal, 1961). Research leading to this commonly-used model was typified by the collection of lexical descriptors of personality and the use of factor-analytic techniques (e.g., Allport & Odbert, 1936; Cattell, 1945). Top-down trait models typically attempt to determine overarching traits and then use these as a starting point from which to investigate biological and behavioural correlates. This is the reverse of the approach taken by RST (Smillie, Pickering, & Jackson, 2006).

A tension within the RST literature is the degree to which BAS, BIS, and FFS/FFFS are independent systems. Originally, these systems were viewed as neurologically and functionally independent, a separable subsystems perspective (Gray, 1970; Gray, 1987). At a personality level, such a perspective suggests that trait BAS, trait BIS, and (potentially) trait FFS/FFFS are orthogonal, and hence uncorrelated (Jackson, 2009). However, more recent RST research considers that BAS, BIS, and FFS/FFFS modulate one another’s effects (Corr & Cooper, n. d.).
This is known as the joint subsystems perspective (Corr, 2002). The joint subsystems approach has been supported theoretically (Smillie, Pickering, & Jackson, 2006) and experimentally (Corr, 2002), and suggests that trait BAS, trait BIS, and trait FFS/FFFS interact to inform personality.

As noted above, the contribution of trait FFS/FFFS to personality has been under-researched, and hence many self-report questionnaires have focused on a BAS-related trait of reward sensitivity and a BIS-related trait of punishment sensitivity (which may include elements of trait FFS/FFFS). Although trait BAS and trait BIS were originally labelled “impulsivity” and “anxiety” (Gray, 1972), these labels risk conflation with more general concepts and measures of impulsivity and anxiety not situated within the RST framework. It is for this reason that the present project used the labels trait BAS and trait BIS. The three-system model proposed by revised RST is summarised in Figure 2.1.

![Figure 2.1. Multi-level conceptualisation of BAS, BIS, and FFFS, the primary systems of reinforcement sensitivity theory.](image-url)
2.6. Self-Report Measurement of RST Personality Traits

A number of self-report questionnaire measures of RST traits have been developed. Initial research viewed Eysenck’s (1967) three-factor personality questionnaire, incorporating extraversion, neuroticism, and psychoticism, as capturing trait-level expression of BAS, BIS, and FFS respectively (Corr, 2001; Gray, 1975). However, applying Eysenck’s model to RST is no longer considered useful (see Pickering, Corr, & Gray, 1998; Rusting & Larsen, 1998). Instead, self-report questionnaires generated directly from RST have been employed (Carver & White, 1994; Gray, 1981). The first of these, the Gray-Wilson Personality Questionnaire (GWPQ; Wilson, Barrett, & Gray, 1989), sought to measure trait BAS as approach and active avoidance, trait BIS as passive avoidance and extinction, and FFS as fight and flight subscales. However, the poor factorial and construct validity of the GWPQ limited its widespread use (see Carver & White, 1994; Wilson, Barrett, & Gray, 1989; Wilson, Gray, & Barrett, 1990).

Later RST-based self-report measures include (i) the Generalised Reward And Punishment Expectancies Questionnaire (GRAPES; Ball & Zuckerman, 1990); (ii) the BIS/BAS Scales (BBS; Carver & White, 1994); (iii) the Sensitivity to Punishment/Sensitivity to Reward Questionnaire (SPSRQ; Muntaner & Torrubia, 1985; Torrubia, Ávila, Moltó, & Caseras, 2001; Torrubia & Tobeña, 1984); the as-yet unpublished Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ; Corr & Cooper, n. d.); (v) the Jackson-5 Revised Reinforcement Sensitivity Questionnaire (Jackson, 2009); (vi) the Reinforcement Sensitivity Questionnaire (RSQ; Smederevac, Čolović, & Mitrović, 2010; Smederevac, Mitrović, Čolović, & Nikolašević, 2014); and (vii) the Revised Reinforcement Sensitivity Questionnaire (rRST-Q; Reuter, Cooper, Smillie, Markett, & Montag, 2015). MacAndrews and Steele (1991) developed a one-sided scale assessing trait BIS, whilst a one-sided trait BAS measure was developed by Jackson and Smillie (2004). Finally, the Achievement Goals Questionnaire (AGQ; Elliot & Church, 1997) is similar to the aforementioned measures due to its approach/avoidance dichotomy, although the AGQ is more specifically focused towards academic, occupational, and athletic achievement.

The BBS was chosen to measure trait BAS and trait BIS in the present project. Of the available RST-oriented self-report measures, the BBS has been the
most widely used (2,395 citations in Scopus as of 26/01/2016). The BBS divides BAS into three statistically-derived sub-factors: BAS-D, BAS-FS, and BAS-RR, an important consideration as the focus of the present project was trait BAS rather than trait BIS. No other RST measure has incorporated a subordinate breakdown of BAS save for the GWPQ, which possesses an inconsistent factor structure (Wilson, Gray, & Barrett, 1990), and the RST-PQ, which to date has not appeared in a peer-reviewed publication (Corr & Cooper, n. d.). Although the Jackson-5, RSQ, and rRST-Q match revised RST more closely (Jackson, 2009; Reuter et al., 2015; Smederevac et al., 2014), these questionnaires were judged as unsuitable as they only present a unidimensional concept of trait BAS. Similarly, other alternative measures were not selected due to their unidimensional approach to trait BAS and trait BIS (e.g., Torrubia, Ávila, Moltó, & Caseras, 2001), or for focusing on only one RST trait (e.g., Jackson & Smillie, 2004). Measurement of trait FFFS was not prioritised due to the lack of consensus on how FFFS is best represented as a general trait and the lack of representation of trait FFFS in scales assessing BAS multidimensionally (Carver & White, 1994; Corr, 2008; Jackson, 2009). Instead, the project was conducted with the understanding that because the BBS predates publication of revised RST, measurement of trait BIS would constitute a more general measurement of sensitivity to punishment that includes attributes now categorised as trait FFFS and does not discriminate between anxiety and fear. Hence, the BBS was the most suitable RST trait measure for the present project. A comprehensive review of BBS factor analysis and validation studies is presented next.

2.7. The BIS/BAS Scales

2.7.1. Construction and validation of the BIS/BAS Scales. Carver and White (1994) developed the BBS to assess trait BAS and trait BIS. Commencing from a conceptual understanding of BAS and BIS, item generation began by considering the cognitive, affective, and behavioural reactions predicted by the RST (Carver & White, 1994). Trait BAS was regarded as a more complex construct than trait BIS, and items were generated to target (a) strong pursuit of rewarding goals; (b) a strong response or reaction to wanting or obtaining rewards; (c) the tendency to seek out rewarding stimuli; and (d) the tendency to act quickly when pursuing a
desired reward (Carver & White, 1994). Trait BIS items were developed by focusing on concern over the possibility of a negative occurrence, or sensitivity to such events once they have occurred (Carver & White, 1994). Two of the trait BIS items were negatively worded and therefore required reverse-coding. The BBS item-generation content was not chosen to match a predicted factor structure, and instead the BBS factor structure was left to emerge statistically (Carver & White, 1994).

The details of Carver and White’s (1994) principal components analysis (PCA) are described in Table 2.1. Basing extraction on Kaiser’s (1960) criterion of extracting factors with eigenvalues greater than one, Carver and White arrived at a four-factor BBS structure consisting of three trait BAS factors and one trait BIS factor. The factor solution encompassed 20 items rated from 1 (Very true for me) to 4 (Very false for me). Four filler items were included that did not load on any factor. The three trait BAS factors identified by Carver and White (1994) were Drive (BAS-D, four items), Fun-Seeking (BAS-FS, four items), and Reward Responsiveness (BAS-RR, five items). These factors were moderately intercorrelated (r coefficients ranging from .34 to .41) and were found to load together on an overarching second-order trait BAS factor. Trait BAS was separable from the seven-item BIS factor, although overlap between BAS-RR and trait BIS was noted (r = .28).

Carver and White (1994) found that the BBS factors possessed adequate reliability (Cronbach’s α ranging from .66 to .76), and validity. Extraversion was moderately associated with the trait BAS scales but only weakly related to BIS. Socialisation was related to BAS-FS, whilst hypomania (measured using the Minnesota Multiphasic Personality Inventory; Hathaway & McKinley, 1940) was related to both BAS-FS and BAS-D, with neither significantly associated with BAS-RR. Optimism was correlated with trait BIS and BAS-D, whilst anxiety was strongly correlated with BIS and uncorrelated with all three trait BAS factors. The trait BAS factors were associated with increased positive affect (BAS-D r = .31, BAS-FS r = .19, BAS-RR r = .28), whilst the trait BIS factors were associated with increased negative affect (r = .42), with the authors suggesting that these correlations were weaker than expected due to the much broader scope of the affect constructs. Experiments utilising false feedback on a computerised task and the awarding of bonus research credits found that all three BAS factors were related to self-reported happiness, although the strength of these correlations changed over the course of the
task. Similarly, trait BIS predicted experimentally assessed severity of nervousness and changes in nervousness over time. It was concluded that initial validation of the BBS provided strong evidence of convergent and discriminant construct validity, in addition to experimental criterion-related validity (Carver & White, 1994).

2.7.2. Factor Analysis of the BIS/BAS Scales. The BBS has subsequently been examined in a large number of factor-analytic studies. These broadly support the factor structure identified by Carver and White (1994), whilst also raising a number of specific issues with the measure. A review of these issues is warranted in order to inform factor analysis of the BBS during Study 1 of the present project and to understand the limitations of the BBS when interpreting the findings of Study 2 and Study 3. Details of the 29 studies that have performed factor analysis on the BBS items are summarised in Tables 2.1, 2.2, and 2.3.

The majority of factor-analytic studies have found a four-factor solution to be the optimal BBS factor structure, consistent with Carver and White (1994). However, there are inconsistencies within this factor structure across studies, typically presenting in the form of (i) items that either load across multiple factors or that do not load sufficiently on any factor; or (ii) lower than expected internal consistency of factor scores (e.g., Cogswell, Alloy, van Dulmen, & Fresco, 2006). In part, these inconsistencies can be attributed to variability across samples, analysis techniques, culture, and language of administration (e.g., Dissabandara, Loxton, Dias, Daglish, & Stadlin, 2012). Variability in BBS factor structure between culture-based samples has been demonstrated empirically (Demianczyk, Jenkins, Henson, & Connor, 2014), although the factor structure appears to hold constant across adolescent and adult age groups (Cooper, Gomez, & Aucote, 2007; Muris, Meesters, de Kanter, & Timmerman, 2005).
### Table 2.1
**Research conducting Factor Analysis on BIS/BAS Scales, 1994 – 2004**

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Analysis</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carver &amp; White, 1994</td>
<td>732 US students</td>
<td>PCA</td>
<td>4-factor solution: BAS-D, BAS-FS, BAS-RR, BIS</td>
</tr>
<tr>
<td>Cologon, 1996</td>
<td>(unpublished)</td>
<td>(unpublished)</td>
<td>3-factor solution; BAS-D and BAS-RR collapsed</td>
</tr>
<tr>
<td>Heubeck, Wilkinson, &amp; Cologon, 1998</td>
<td>336 Australian students</td>
<td>PCA &amp; CFA</td>
<td>4-factor optimal but still inadequate fit</td>
</tr>
<tr>
<td>Jorm et al., 1999</td>
<td>2,684 Australian participants</td>
<td>PCA</td>
<td>4-factor replicated; 2-factor also fit</td>
</tr>
<tr>
<td>Leone, Perugini, Bagozzi, Pierro, &amp; Mannetti, 2001</td>
<td>216 US, 263 UK (13.3% non-student), and 200 Italian students</td>
<td>CFA</td>
<td>4-factor adequate fit; 2-factor inadequate; altered response scale to five points rather than standard four; items parcelled for CFA</td>
</tr>
<tr>
<td>Strobel, Beauducel, Debener, &amp; Brocke, 2001</td>
<td>389 German participants</td>
<td>(unavailable)</td>
<td>2-factor superior to 4-factor</td>
</tr>
<tr>
<td>Ross, Millis, Bonebright, &amp; Bailley, 2002</td>
<td>460 Canadian students</td>
<td>PCA &amp; ML CFA</td>
<td>4-factor better fit when BAS factors viewed as independent</td>
</tr>
<tr>
<td>Johnson, Turner, &amp; Iwata, 2003</td>
<td>1,803 US participants</td>
<td>PCA</td>
<td>4-factor optimal; reverse-coded items loaded on spurious factor</td>
</tr>
<tr>
<td>Campbell-Sills, Liverant, &amp; Brown, 2004</td>
<td>1,825 US mood/anxiety clients</td>
<td>ML EFA &amp; CFA</td>
<td>4-factor model optimal across analysis methods</td>
</tr>
<tr>
<td>Knyazev, Slobodskaya, &amp; Wilson, 2004</td>
<td>345 Russian participants</td>
<td>PCA &amp; CFA</td>
<td>4-factor optimal but BAS factors load on second-order overall BAS</td>
</tr>
</tbody>
</table>

### Table 2.2

*Research conducting Factor Analysis on BIS/BAS Scales, 2005 – 2007*

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Analysis</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franken, Muris, &amp; Rassin, 2005</td>
<td>246 Dutch students</td>
<td>PCA &amp; CFA</td>
<td>4-factor model good fit</td>
</tr>
<tr>
<td>Gomez, Cooper, &amp; Gomez, 2005</td>
<td>520 Australian students</td>
<td>PCA, CFA, &amp; IRT</td>
<td>4-factor constitutes four unidimensional factors when analysed separately; may lose reliability at higher extreme of scoring range</td>
</tr>
<tr>
<td>Müller &amp; Wytykowska, 2005</td>
<td>303 Polish students</td>
<td>CFA</td>
<td>4-factor superior to 2-factor; some inconsistencies with Polish BAS-RR items</td>
</tr>
<tr>
<td>Muris, Meesters, Kanter, &amp; Timmerman, 2005</td>
<td>284 Dutch schoolchildren</td>
<td>PCA</td>
<td>2-factor BAS versus BIS more appropriate for children; oblique rotation optimal</td>
</tr>
<tr>
<td>Cogswell, Alloy, van Dulmen, &amp; Fresco, 2006</td>
<td>1,140 US students</td>
<td>PCA &amp; CFA</td>
<td>4-factor superior to 2-factor, however both inadequate fit</td>
</tr>
<tr>
<td>Smillie, Jackson, &amp; Dalgleish, 2006</td>
<td>543 Australian participants</td>
<td>CFA</td>
<td>Only examined BAS items; single factor inadequate fit; separating BAS-FS from merged BAS-D/BAS-RR superior</td>
</tr>
<tr>
<td>Caci, Deschaux, &amp; Baylé, 2007</td>
<td>144 French students</td>
<td>PCA &amp; CFA</td>
<td>4-factor PCA inadequate by CFA; potential second-order BAS-D/BAS-FS versus BAS-RR/BIS factors; some inconsistencies with French items</td>
</tr>
<tr>
<td>Cooper, Gomez, &amp; Aucote, 2007</td>
<td>631 Australian adult and 300 adolescent participants</td>
<td>ML CFA</td>
<td>4-factor superior to 2-factor across ages; adult and adolescent scores comparable</td>
</tr>
<tr>
<td>Sava &amp; Sperneac, 2006</td>
<td>345 Romanian students</td>
<td>PAF EFA &amp; CFA</td>
<td>4-factor superior to 2-factor, optimally with correlations permitted between BAS factors</td>
</tr>
</tbody>
</table>

*Note.* PCA = principal components analysis, EFA = exploratory factor analysis, CFA = confirmatory factor analysis, ML = maximum likelihood estimation, PAF = principal axis factoring, IRT = item response theory. Estimation format seldom provided for CFA, but ML typically used as standard. "Students' refers to university students, "participants" refers to adult samples with a notable proportion of non-students. Oblique rotation (direct oblimin or Promax) used for all PCA/EFA, orthogonal tested by Muris et al. (2005) but found to be sub-optimal. Inter-factor correlation typically permitted and optimal for CFA.
Table 2.3

Research conducting Factor Analysis on BIS/BAS Scales, 2008 – 2014

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Analysis</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heym et al., 2008</td>
<td>212 UK students</td>
<td>CFA</td>
<td>5-factor optimal; three BIS items identified as &quot;fear&quot; factor</td>
</tr>
<tr>
<td>Poythress et al., 2008</td>
<td>1,515 US criminal offenders</td>
<td>PCA &amp; CFA</td>
<td>5-factor optimal; reverse-coded BIS items identified as &quot;fear&quot; factor; fit improved when correlations permitted</td>
</tr>
<tr>
<td>Beck, Smits, Claes, Vandereycken, &amp; Bijttebier, 2009</td>
<td>103 Belgian eating disorder clients</td>
<td>CFA</td>
<td>5-factor superior to 4, 2, and 1-factor; reverse-coded BIS items identified as &quot;fear&quot; factor</td>
</tr>
<tr>
<td>Bjørnebekk, 2009</td>
<td>661 Norwegian schoolchildren</td>
<td>CFA</td>
<td>2-factor fit but support for 3-factor where BAS separated into pleasurable affect versus goal pursuit; some items removed</td>
</tr>
<tr>
<td>Vervoort et al., 2010</td>
<td>115 anxious Dutch child/adolescent clients and 60 non-psychiatric controls</td>
<td>CFA</td>
<td>5-factor adequate but not compared to alternative models; three BIS items identified as &quot;fear&quot; factor</td>
</tr>
<tr>
<td>Levinson, Rodebaugh, &amp; Frye, 2011</td>
<td>723 US students</td>
<td>WLS CFA</td>
<td>4-factor good fit after removing seven problematic items (35% of scale); analysis did not assume normality</td>
</tr>
<tr>
<td>Yu, Branje, Keijsers, &amp; Meeus, 2011</td>
<td>497 Dutch early adolescents, 697 middle adolescents, and 734 mothers of adolescents</td>
<td>CFA</td>
<td>2-factor optimal across groups</td>
</tr>
<tr>
<td>Dissabandara, Loxton, Dias, Daglish, &amp; Stadlin, 2012</td>
<td>968 Sri Lankan participants and 302 heroin users</td>
<td>PCA &amp; CFA</td>
<td>5-factor optimal but poor fit; four BIS items identified as &quot;fear&quot; factor but cross-loading present</td>
</tr>
<tr>
<td>Müller, Smits, Claes, &amp; de Zwaan, 2013</td>
<td>1,881 German participants</td>
<td>CFA</td>
<td>5-factor optimal but poor reliability; selection of BIS items identified as &quot;fear&quot; factor</td>
</tr>
<tr>
<td>Demianczyk, Jenkins, Henson, &amp; Connor, 2014</td>
<td>636 African-American, 408 Asian-American, and 1,686 Caucasian-American participants</td>
<td>CFA</td>
<td>4-factor solution that applies across demographics unobtainable; independent factors adequate fit; item deletions required</td>
</tr>
</tbody>
</table>

Note. PCA = principal components analysis, EFA = exploratory factor analysis, CFA = confirmatory factor analysis, ML = maximum likelihood estimation, WLS = weighted least square estimation (does not impose assumption of normality). Estimation format seldom provided for CFA, but ML typically used as default. "Students" refers to university students, whilst "participants" refers to adult samples with a notable proportion of non-students. Oblique rotation (direct oblimin or Promax) used for all PCA/EFA, except for Poythress et al. (2008) who used an orthogonal rotation. Inter-factor correlation typically permitted and optimal for CFA.
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The previous BBS factor analysis sample most resembling that collected for the present project is that of Jorm et al. (1999). Jorm et al. used a large-scale sample randomly selected from the Australian electoral roll, and replicated Carver and White’s (1994) four-factor BBS structure with only two minor incidences of cross-loading present. The authors also tested a two-factor model and found that the items could also be categorised under an overarching trait BAS factor and a trait BIS factor, albeit with several BAS-RR items loading on this iteration of trait BIS. The two-factor dimensions were largely orthogonal (Pearson’s $r = .07$), with the three trait BAS factors moderately intercorrelated. Trait BIS exhibited a weak to moderate positive correlation with BAS-RR, a consistent finding across BBS studies (e.g., Carver & White, 1994; Heubeck, Wilkinson, & Cologon, 1998). Validity tests demonstrated correlations between the trait BAS factors and extraversion and positive affect, and trait BIS with neuroticism, negative affect, anxiety, and depression. A further PCA resulted in the creation of positive (BAS, extraversion, positive affect) and negative (BIS, neuroticism, negative affect) super-factors.

Campbell-Sills, Liverant, and Brown (2004) used a novel factor analytic procedure to examine the BBS. The authors utilised a large sample of clients diagnosed with mood and anxiety disorders, in order to assess whether the findings of previous BBS factor analyses generalised to a clinical population. Campell-Sills et al. were the first researchers to apply exploratory factor analysis (EFA) rather than PCA, which operates under different assumptions and is less accommodating of error variance (see Tabachnick & Fidell, 2012). Adopting the novel approach of applying CFA diagnostics (such as multiple indices of model fit) to EFA, the authors identified the expected four-factor model, although three items (including the reverse-coded BIS items) were deleted as ill-fitting across two sub-samples. Progressing to a mixed exploratory/confirmatory factor analysis, the authors once again found the four-factor model to be an adequate fit. Finally, CFA also demonstrated the adequate fit of a four-factor model, although two pairs of items exhibited heavy overlap and one item cross-loaded on both BAS-D and BAS-RR. Campbell-Sills et al. (2004) also established the presence of a latent overarching BAS factor, although the ability of the three BAS factors to explain unique variance beyond this second-order factor supported previous contentions that the three BAS factors are ideally examined separately (e.g., Carver & White, 1994).
A study adopting an item-response theory approach has also supported the four-factor structure of the BBS (Gomez, Cooper, & Gomez, 2005). An item-response theory approach provides more detailed item-level information, especially with regards to the ability of an item to maintain reliability at different levels of the underlying trait (Reise, Widaman, & Pugh, 1993). This approach is an alternative to the classical test theory approach adopted by all other factor-analytic BBS research to date. Using item-response theory to inform their analyses, Gomez, Cooper, and Gomez (2005) found that the majority of BBS items provided an adequate representation of their relevant underlying trait. However, these associations became less reliable at higher extremes of the scoring range. A CFA also confirmed each individual BBS factor to be unidimensional in nature, although testing each factor in a separate model meant that potential cross-loading was not assessed.

In sum, a four-factor structure has consistently emerged as more appropriate than a two-factor structure across the BBS factor-analytic literature. This finding has emerged in large-scale nonclinical research (Jorm et al., 1999), large-scale clinical research (Campbell-Sils et al., 2004), and across different forms of statistical analysis (Campbell-Sils et al., 2004; Gomez et al., 2005). Despite this multidimensional trait BAS structure being different from the unidimensional or bidimensional structures proposed by RST (Gray, 1972; Wilson, Barrett, & Gray, 1989), BAS can be usefully viewed as manifesting multidimensionally at a trait level (Corr & Cooper, n. d.; Leone et al., 2001; Smillie et al., 2006). For this reason, it was predicted that three correlated yet separable trait BAS factors would emerge in the present project.

2.7.3. Controversy regarding separable anxiety and fear factors within BIS. A tension regarding whether trait BIS can be meaningfully and usefully separated into anxiety and fear factors has emerged in the BBS literature (Poythress et al., 2008). Originally, Carver and White’s (1994) trait BIS factor was reported as unidimensional. However, noting the emphasis on FFFS in revised RST (Gray & McNaughton, 2000), a small number of studies have proposed that trait BIS as measured by the BBS can in fact be separated into two factors (Poythress et al., 2008). Under this five-factor solution (see Table 2.3), the more traditional trait BIS factor, labelled BIS-Anxiety, corresponds to anxious worry and cautious behaviours. The newly extracted factor corresponds to fear, and has hence been labelled BIS-
Fear or FFFS-Fear (Heym et al., 2008; Poythress et al., 2008), the latter label being more appropriate as fear is an outcome of FFFS and not BIS within RST (Gray & McNaughton, 2000).

Problematically, the two items said to constitute FFFS-Fear are also the only two BBS items that require reverse-coding during scoring: Item 2 (“Even if something bad is about to happen to me, I rarely experience fear or nervousness”), and Item 22 (“I have very few fears compared to my friends”). Accordingly, it is possible that FFFS-Fear is actually a methodologically-generated factor that does not constitute a meaningful trait. The literature proposing extraction of an “FFFS-Fear” factor is reviewed in the following paragraphs.

Carver and White (1994) reported in a footnote that Item 2 and Item 22 had formed a separate factor in their original BBS validation study. However, this occurred only within the female participant data and not within the sample data as a whole. The first authors to report BBS Item 2 and Item 22 as problematic across a whole-sample data-set were Johnson, Turner, and Iwata (2003). Johnson et al. noted that this subset of trait BIS items was reverse-coded, and opted to retain the conventional scoring algorithm of the BBS rather than attempting to modify the scale. Subsequent studies also identified Item 2 and Item 22 as problematic. For example, Campbell-Sills et al. (2004), Cogswell et al. (2006), and Levinson, Rodebaugh, and Frye (2011) excluded the reverse-coded BBS items, viewing their BBS findings as indicative of poor psychometric properties and a methodological discrepancy rather than a separable factor. This view is consistent with (a) Carver and White’s (1994) single category of item-generation content when designing the trait BIS scale of the BBS, with the authors focusing on anxiety experienced in the context of punishment cues; and (b) the statistical consideration that a minimum of three items should be present to constitute a meaningful factor (Tabachnick & Fidell, 2012).

In contrast, several more recent studies have viewed the reverse-coded items as measuring an FFFS-Fear factor. The first study identifying Item 2 and Item 22 as a separable factor was conducted by Poythress et al. (2008). Their reasoning was based on (i) the word “fear” being present in both items; (ii) FFFS-Fear being associated with harm avoidance where BIS-Anxiety was not; and (iii) BIS-Anxiety being associated to a greater degree with trait anxiety and exclusively correlated with
BAS-RR. Poythress et al. viewed this as evidence that an interpretable and meaningful FFFS-Fear factor had been embedded in the BBS since its inception. However, although a reviewer noted that both of the contentious items were reverse-coded (reported in Poythress et al., 2008), Poythress et al. (2008) did not address previous conclusions concerning the reverse-coded trait BIS items (Campbell-Sills et al., 2004; Cogswell et al., 2006). Several assertions made by Poythress et al. (2008) regarding BIS were rebutted by Newman and Malterer (2009), including subjective evaluation of item content. Subsequent studies identifying an FFFS-Fear factor include publications by Heym et al. (2008), Beck, Smits, Claes, Vandereycken, and Bijttebier (2009), Vervoort et al. (2010), Dissabandara, Loxton, Dias, Daglish, and Stadlin (2012), and Müller, Smits, Claes, and de Zwaan (2013), with some of these publications expanding FFFS-Fear beyond the two reverse-coded items (Dissabandara et al., 2012; Heym et al., 2008).

Viewing a subset of trait BIS items as a separable FFFS-Fear factor is problematic in a number of ways. Firstly, two items arguably do not provide sufficient breadth of content or variance to assess a reasonably complex theoretical construct that at its most basic level consists of three phenomena: fight, flight, and freezing (Gray & McNaughton, 2000; Jackson, 2009). Secondly, the argument that the reverse-coded items assess trait FFFS based on explicit use of the word “fear” is limited. Many scales include items that do not explicitly mention the name of the construct that they are assessing; for example, BAS-D items do not feature the words “drive” or “driven”, and BAS-RR items do not feature the word “reward” (Carver & White, 1994). Thirdly, at face value, Item 2 and Item 22 appear to be assessing self-confidence or the absence of anticipatory fear, due to their reverse-coding. This leads to a fundamental validity issue in measuring a trait based solely on its absence. Finally, Carver and White (1994) explicitly stated that the FFS had been excluded when designing the BBS, due to lack of theory defining trait FFS.

A statistical limitation in proposing an FFFS-Fear factor within the BBS is whether or not discriminant validity can be meaningfully assessed with only two items. Studies have found discrepant patterns of correlation for FFFS-Fear versus BIS-Anxiety (Beck et al., 2009; Heym et al., 2008), or identified additional FFFS-Fear items on the basis of shared correlation between items (Dissabandara et al., 2012; Heym et al., 2008). However, selecting subsets of items from any scale is
likely to yield different patterns of correlation than using a total set of items. This probability has not been sufficiently addressed by studies measuring FFFS-Fear, especially given that item-level variability differs across samples and has been shown to be a limitation in previous BBS research (e.g., Cogswell et al., 2006; Gomez et al., 2005).

Based on the above arguments and the lack of empirical demonstration that “FFFS-Fear” items do not simply covary based on reverse-coding and/or sample variability, it is not valid to propose that trait FFFS is measurable using the BBS as published. There is sufficient evidence to predict that Item 2 and Item 22 load on a separate factor rather than being grouped with the other five trait BIS items. However, it was assumed here, should this occur, that Item 2 and Item 22 would be forming a spurious factor with insufficient content validity to comprise a useful measure, and hence these items would warrant exclusion from subsequent analyses.

2.7.4. Similarities and differences between the BBS trait BAS variables. BAS-D, BAS-FS, and BAS-RR as measured by the BBS share a common focus on trait BAS. These trait variables all emerged from items designed to reflect the concept of BAS (Carver & White, 1994). All three trait BAS factors consistently exhibit moderate intercorrelation, and these correlations tend to be higher than their correlations with trait BIS (e.g., Campbell-Sils et al., 2004; Carver & White, 1994; Cogswell et al., 2006; Huebeck et al., 1998; Jorm et al., 1999). Evidence for intercorrelation between the three trait BAS variables can also be observed in the EFA techniques that best suit BBS data. All but one study summarised in the above tables (Ross, Millis, Bonebright, & Bailey, 2002) implemented oblique rotation during exploratory factor analysis (EFA) or permitted inter-factor correlation during confirmatory factor analysis (CFA), both appropriate techniques when correlations are present in the data (Tabachnick & Fidell, 2012).

BAS-D, BAS-FS, and BAS-RR are better viewed as separate variables rather than grouped as an overarching trait BAS factor, despite their shared conceptual origins and intercorrelation (Carver & White, 1994; Ross et al., 2002). The majority of studies found a four-factor BBS solution containing BAS-D, BAS-FS, BAS-RR, and trait BIS to be statistically superior to a two-factor solution containing an overarching trait BAS factor and trait BIS (e.g., Carver & White, 1994; Cogswell et al., 2006; Cooper, Gomez, & Aucote, 2007; Huebeck, Wilkinson, & Cologon, 1998).
Studies that have found a two-factor BBS solution to be a superior fit tend to use data drawn from cross-cultural samples (e.g., Muris, Meesters, Kanter, & Timmerman, 2005). Both Carver and White (1994) and Ross, Millis, Bonebright, and Bailey (2002) noted that although BAS-D, BAS-FS, and BAS-RR might be viewed as a conceptual grouping reflective of an overarching BAS trait, in statistical terms the three constitute individual variables that should be examined separately when conducting trait research. By making this distinction, research has uncovered important divergence in the external correlates of the three BBS BAS variables. One of these differences is the extent to which the traits share variance with the non-BAS traits of impulsivity and trait BIS respectively (Carver & White, 1994; Smillie et al., 2006).

BAS-FS differs from BAS-D and BAS-RR in that it appears to represent an overlap between the RST-framed construct of trait BAS and the more general construct of impulsivity (Smillie, Jackson, & Dalgleish, 2006). This difference between BAS-FS and the other trait BAS variables was first suggested by Cologon’s (1996) data, which supported a factor solution grouping BAS-D and BAS-RR but maintaining BAS-FS as a separate trait. A later CFA conducted by Smillie, Jackson, and Dalgleish (2006) determined that BAS-D and BAS-RR were more strongly linked to an overarching BAS trait, with a follow-up multi-level linear regression model indicating that BAS-FS could be differentiated by its overlap with impulsivity. Smillie et al. suggested that the discrepancies between trait BAS subscales were not sufficient to suggest that they arose from separate causal factors or that a total trait BAS score was rendered meaningless. Nonetheless, they did note that a subscale level of analysis was likely to be more useful due to the differences between the BAS traits (Smillie et al., 2006).

The overlap between BAS-FS and impulsivity has been shown in studies aggregating BBS data with those of other questionnaires in order to investigate the presence of higher-order factors. These studies have tended to support the overlap between BAS-FS and impulsivity (Caseras, Àvila, & Torrubia, 2003; Miller, Joseph, & Tudway, 2004; Zelenski & Larsen, 1999). Zelenski and Larsen (1999) conducted principal axis factoring (using an orthogonal rotation) on measures derived from a number of biologically-based personality taxonomies. BAS-D and BAS-RR loaded on a reward expectancy super-factor and BIS loaded on a punishment expectancy
super-factor. In contrast, BAS-FS loaded on an *impulsivity/thrill-seeking* super-factor. This finding was replicated in a similar study using a Catalan translation of the BBS (Caseras et al., 2003), wherein BAS-FS grouped separately from BAS-D and BAS-RR. A multi-questionnaire PCA by Miller, Joseph, and Tudway (2004) grouped BAS-D and BAS-RR together as an aptly labelled *reward responsiveness and drive factor*, whereas BAS-FS loaded approximately equally across this factor as well as *non-planning and dysfunctional impulsive behaviour* and *functional venturesomeness*. Although not every study to aggregate BBS data with that of other questionnaires has found BAS-FS to more strongly align with general impulsivity than with the other trait BAS variables (Meda et al., 2009), the overlap between BAS-FS and impulsivity is relatively consistent in the literature. One view of this relationship is that BAS-FS can be viewed just as much a measure of general impulsivity as of trait BAS (Miller, Joseph, & Tudway, 2004; Zelenski & Larsen, 1999).

BAS-RR can be differentiated from BAS-D and BAS-FS by its consistent moderate positive correlation with trait BIS (e.g., Caci, Deschaux, & Baylé, 2007; Carver & White, 1994; Heubeck, Wilkinson, & Cologon, 1998). The correlation between BAS-RR and BIS is inconsistent with theory (Corr, 2008; Gray, 1981) and is noteworthy because neither BAS-D nor BAS-FS are significantly correlated with BIS (e.g., Carver & White, 1994; Ross, Millis, Bonebright, & Bailley, 2002). The correlation between BAS-RR and trait BIS has not been explained in the literature, although due to their shared emphasis on emotional responses, a potential explanation is that both variables are capturing the intensity of emotional engagement with a reward stimulus. Although this hypothesis has not been tested empirically and falls outside of the aims of the present project, it is apparent from the literature that BAS-RR shares almost as much variance with trait BIS as it does with the other BAS variables. Additionally, BAS-RR differs from BAS-D and BAS-FS because it includes item content assessing elements of consummatory reward, such as satisfaction (Berridge et al., 2009), and also possesses poorer internal consistency (Cogswell et al., 2006). Because of these issues, BAS-RR was considered separately from BAS-D and BAS-FS in a prominent large-scale project examining the role of BAS in bipolar disorder (Alloy et al., 2006).
Factor-analytic and correlational findings consistently suggest that BAS-D, BAS-FS, and BAS-RR are most usefully treated as separate variables, even though they share conceptual and correlational overlap and have at times been combined into an overarching trait BAS variable (Carver & White, 1994; Ross et al., 2002; Smillie et al., 2006). When attempting to operationalise trait BAS in research using the BBS, this creates the question of which of BAS-D, BAS-FS, and BAS-RR is most appropriate for framing hypothesis-testing around. In the present project, BAS-D was viewed as the variable most strongly representative of trait BAS as conceptualised within RST. This was because the content of the BAS-D items most clearly assess approach motivation and pursuit of goals (Carver & White, 1994), and no literature has developed consistently grouping BAS-D with variables falling outside of the trait BAS concept. Although BAS-FS and BAS-RR still assess meaningful aspects of trait BAS (Corr, 2008; Ross et al., 2002; Smillie et al., 2006), the strong overlap of these variables with impulsivity (e.g., Smillie et al., 2006) and trait BIS (e.g., Carver & White, 1994) respectively suggests that they are measuring elements of these variables in addition to trait BAS. For this reason, although all three trait BAS variables were analysed in the present project, BAS-D was selected as the most appropriate operationalisation of trait BAS for hypothesis-testing.

2.7.5. Rationale for use of the BIS/BAS Scales. The BBS is a self-report measure of trait BAS and trait BIS that shows adequate reliability and validity (e.g., Carver & White, 1994). The BBS is one of only three RST-based scales to incorporate a multidimensional measure of trait BAS, and is the most commonly used of these scales, with one alternative possessing poor factor structure (Wilson, Barrett, & Gray, 1989; Wilson, Gray, & Barrett, 1990) and the other yet to see publication (Corr & Cooper, n. d.). However, inconsistencies in the factor structure of the BBS across studies have led authors to advocate caution in continued use of the scale as scored (Cogswell et al., 2006; Demianczyk et al., 2014; Heubeck, Wilkinson, & Cologon, 1998). While important questions remain about the optimal factor structure of trait BAS and trait BIS, the BBS was deemed to be the optimal measure for use in the present project. To explore some of these questions about factor structure, the BBS was assessed via EFA and CFA in Study 1. Of the three trait BAS variables, BAS-D was viewed as the variable providing the best operationalisation of trait BAS for the present project. The following chapter
describes risky decision-making, a phenomenon assessed using behavioural tasks that can be viewed as a behavioural manifestation of BAS (Corr, 2008; Davis et al., 2012; Rao et al., 2015).

3. Risky Decision-Making as a Behavioural Manifestation of BAS

3.1. Structure of Chapter 3

Chapter 3 argues that risky decision-making, as measured by behavioural tasks, is a putative behavioural manifestation of BAS that is useful to test in the context of trait bipolar disorder vulnerability. In so doing, Chapter 3 draws a distinction, as per Simon, Stenstrom, and Read (2015), between (i) cognitive processes that rely on the integration of affective processing (“hot cognition”); and (ii) cognitive processes that operate with little affective involvement (“cold cognition”). The concept of set-shifting is introduced as a means of exploring whether any increased risky decision-making associated with trait bipolar disorder vulnerability might be occurring due to deficits in non-affective cognition more generally. In introducing these topics, Chapter 3 also draws on research that has investigated neuropsychological deficits that are associated with clinical bipolar disorder (Malhi, Ivanovski, Szekeres, & Olley, 2004; Quraishi & Frangou, 2002).

Four behavioural tasks used in the present project are then introduced and reviewed: (i) the Balloon Analogue Risk Task (BART; Lejuez et al., 2002); (ii) the Game of Dice Task (GDT; Brand, Fujiwara, et al., 2005; Brand et al., 2004); (iii) the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994); and (iv) the Wisconsin Card-Sorting Test (WCST; Berg, 1948; Grant & Berg, 1948). Following the introduction and review of each of these tasks, a comparison of the tasks is provided, prior to presenting a rationale for their inclusion in the present project.

3.2. Risky Decision-Making

3.2.1. Definition and measurement of risky decision-making. Risky decision-making refers to probabilistic decision-making in a context where a potential gain or reward is sought, but must be balanced against a threat of loss or harm (Lejuez et al., 2002; Rao et al., 2015). Situations that involve risk and hence
elicited risky decision-making occur frequently in everyday life, from constrained contexts such as gambling and games of chance to more abstract life decisions with potentially long-term consequences, such as prioritising the freedom to travel or study over steadiness of income (Rao et al., 2015; Trimpop, Kerr, & Kirkcaldy, 1999).

In conceptualising risky decision-making, it is important to distinguish between two broad categories of neuropsychological processes: affective (“hot”) cognition and non-affective (“cold”) cognition. Affective cognitive processes are those that rely on the integration of affective processing, and typically involve appraisal, evaluation, motivation, empathy, or awareness, recognition, and regulation of emotions (Dolcos & McCarthy, 2006; Gross, 1998; Seidel et al., 2012; Simon et al., 2015; Smith et al., 1993). In contrast, non-affective, or “pure” cognitive processes are those that operate with little integration of affective information or processing, including decision-making, planning, problem-solving, and working memory in contexts that are not emotionally or motivationally salient (Kolb & Whishaw, 2008). The distinction between affective and non-affective cognitive processes is important as it can help to differentiate elevated risky decision-making from more general cognitive impairment. Risky decision-making is viewed as a form of affective cognition because it by definition involves value judgements and potential consequences (Rao et al., 2015; Simon et al., 2015; Smith et al., 1993).

Risky decision-making is commonly measured using computerised behavioural tasks (e.g., Bechara et al., 1994; Brand, Fujiwara, et al., 2005; Brand et al., 2004; Lejuez et al., 2002; Rao et al., 2015). These tasks typically involve gambling situations, in which participants evaluate the probability of positive versus negative outcomes occurring and respond accordingly (Rao et al., 2015). Cues emphasising reward are commonly present in risky decision-making tasks. These include provision of a total score, feedback on responses, use of financial gain as a metaphor, and visual and auditory indicators of winning versus losing (Bechara et al., 1994; Brand, Fujiwara, et al., 2005; Brand et al., 2004; Lejuez et al., 2002). For this reason, most tasks assessing risky decision-making can be described as reward-laden.

Behavioural tasks can assess risky decision-making from categorical or continuous perspectives (Bechara et al., 1994; Brand, Fujiwara, et al., 2005; Brand et
al., 2004; Lejuez et al., 2002). Categorical approaches to risky decision-making assessment categorise one set of options as advantageous and another as disadvantageous based on their probabilistic effect on the final outcome of the task (Bechara et al., 1994; Brand, Fujiwara, et al., 2005; Brand et al., 2004). In contrast, continuous approaches place risk and reward on a dynamic spectrum whereby higher potential rewards are associated with correspondingly higher risks, and hence follow a law of diminishing returns (Lejuez et al., 2002). Different task contexts and different operationalisations of risky decision-making mean that behavioural task responses are not always strongly correlated, emphasising the importance of a multi-task approach to the assessment of risky decision-making (Buelow & Blaine, 2015; Lejuez et al., 2002).

It is important to differentiate risky decision-making from the term “risk-taking”. Risk-taking refers to actual situations and behaviours that involve risk, such as substance abuse, extreme sports, or unsafe sexual practices (Lejuez et al., 2002; Trimpop et al., 1999). In contrast, risky decision-making is the decision-making process that leads to these situations and behaviours (Rao et al., 2015). This distinction is important because behavioural tasks assessing risky decision-making technically do not always provide opportunity for risk-taking, as due to ethical considerations these tasks can only involve minimal threat of loss and no threat of harm to the participant. Instead, it is more accurate to view behavioural tasks assessing risky decision-making as providing a context analogous to how risky decision-making and risk-taking might operate in a real world setting (Bechara et al., 1994; Brand, Fujiwara, et al., 2005; Brand et al., 2004; Lejuez et al., 2002). This association is borne out by correlations between risky decision-making on behavioural tasks and self-reported real-world risk-taking behaviour (Fernie, Cole, Goudie, & Field, 2010; Lejuez, Aklin, Zvolensky, & Pedulla, 2003; Skeel, Neudecker, Pilarski, & Pytlak, 2007).

3.2.2. Risky decision-making as a putative behavioural measure of BAS.

RST suggests that risky decision-making may serve in part as a behavioural outcome of BAS (Corr, 2008; Gray, 1975). This is because risky decision-making by definition involves balancing the probability of reinforcement, in the form of gain, achievement, or an otherwise pleasing consequence, against the probability of punishment, in the form of loss, failure, or an otherwise displeasing consequence.
The RST framework, and more specifically the BBS trait measure, have only rarely been applied in studies examining risky decision-making task performance, and contrary to theory, the majority of these studies have found no significant relationships. Demaree, DeDonno, Burns, and Everhart (2008) examined risk decision-making in terms of amount wagered in a slot machine simulation, and found BAS-D and BAS-FS to be moderately positively correlated with amount wagered, with trait BIS being moderately negatively correlated with amount wagered. However, a PCA by Meda et al. (2009) did not group any BBS variables with risky decision-making as measured by the BART, and studies have found no significant correlations between the BBS variables and risky decision-making as measured by the IGT (Buelow & Suhr, 2013; Danner, Ouwehand, van Haastert, Hornsveld, & de Ridder, 2012; Penolazzi, Leone, & Russo, 2013) and GDT (Brand & Altstötter-Gleich, 2009). Finally, two electrophysiological studies have used the BBS to create categorical trait BAS groups. Black et al. (2014) found that BAS-related frontal EEG symmetry was related to BAS group and BART risky decision-making, whilst Balconi, Finocchiaro, and Canavesio (2015) found similar results comparing BAS groups in terms of event-related potential and IGT risky decision-making. However, these findings appear to be relatively complex interactions rather than a connection observable at the level of bivariate correlations. Overall, although trait BAS should theoretically predict risky decision-making, only Demaree et al. (2008) have found support for this, using a task that is less commonly used than the BART, GDT, or IGT.

There are several plausible explanations why trait BAS is only infrequently correlated with the outcomes of risky decision-making tasks. One possibility is that trait BAS and risky decision-making tasks assess differing aspects of an underlying BAS construct that are not clearly associated at a bivariate level (Skeel, Neudecker, Pilarski, & Pitlak, 2007). In the context of RST, it is also likely that risky decision-making tasks involve a complex interplay of BAS and BIS/FFFS, with these systems promoting reward pursuit and risk minimisation respectively (Corr, 2008; Demaree, DeDonno, Burns, & Everhart, 2008; Gray, 1975). Hence, it is possible that an effect
of trait BAS in risky decision-making tasks could be obscured by the presence of effects arising from BIS and FFFS, or by a complex and dynamic interaction between all three systems (Corr, 2008; Demaree et al., 2008; Gray, 1975), with no standard approach to statistical differentiation of the influence of BAS, BIS, and FFFS on risky decision-making currently published (e.g., Balconi, Finocchiaro, & Canavesio, 2015; Corr, 2002; Demaree et al., 2008). The lack of correlation might also arise from multi-method variance due to the use of differing forms of measurement (i.e., self-report and behavioural task responses; Campbell & Fiske, 1959; Ferketich, Figueredo, & Knapp, 1991), or from the difficulty of predicting specific behaviours in specific contexts based on a general trait construct (Mischel & Shoda, 1995).

A meta-analysis by Lauriola, Panno, Levin, and Lejuez (2014) addressed a similar issue with regards to impulsivity and sensation-seeking correlations with BART risky decision-making. The authors could only conclude that the lack of correlations was due to random effect size fluctuation across studies, rather than a flaw in theory or measurement. Hence, it remains unclear why trait BAS is seldom significantly correlated with risky decision-making task outcomes, with the sparse number of relevant studies being prohibitive of meta-analytic inquiries.

In summary, despite a plausible theoretical link, trait BAS and risky decision-making task responses tend to be uncorrelated in the relatively few studies that have examined them together, and this is a finding replicated in other studies attempting to correlate trait measures with behavioural task responses (Demaree et al., 2008; Lauriola et al., 2014; Skeel et al., 2007). Based on this finding, multiple authors (e.g., Demaree et al., 2008; Lauriola et al., 2014; Skeel et al., 2007) have concluded that it is advisable to administer both trait measures and behavioural tasks when examining risky decision-making. Hence, as trait BAS has been linked to risky decision-making conceptually (Corr, 2008; Gray & McNaughton, 2000) and in some empirical research (Balconi et al., 2015; Demaree et al., 2008; Voigt et al., 2009), risky decision-making was used within the present project as a putative behavioural measure of BAS functioning, as it was judged useful to examine the potential relationship between BAS and trait vulnerability to bipolar disorder at both a trait and behavioural level. This decision was made with the understanding that direct correlation between the BBS variables and risky decision-making may not be
observable (Lauriola et al., 2014; Skeel et al., 2007), and that risky decision-making is likely to reflect a more complex and dynamic interplay of BAS, BIS, and FFFS than is separable at the level of general trait measures (Corr, 2008; Gray, 1975). Because of this uncertain relationship between risky decision-making and the BBS variables, the link between the two was explored during the present project at the same time as the link between risky decision-making and trait bipolar disorder vulnerability was investigated as the primary focus of the project.

3.2.3. The importance of risky decision-making to bipolar disorder.

Increased risk-taking is characteristic of manic and hypomanic episodes in bipolar disorder, and may also be characteristic of individuals during euthymia (APA, 2013; Fletcher, Parker, Paterson, & Synnott, 2013; Glahn & Burdick, 2011; Reddy et al., 2014). Risky decision-making research that has used the behavioural tasks administered in the present project, the BART, GDT, and IGT, to examine bipolar disorder is reviewed later in Section 4.4. Less research has been conducted on risk-taking and risky decision-making in terms of trait vulnerability to bipolar disorder, however given the increased frequency of risky decisions in clinical bipolar disorder, an increase in risky decision-making corresponding to trait vulnerability to bipolar disorder appears plausible.

Elevated risky decision-making can be seen as especially relevant to trait bipolar disorder vulnerability because it may constitute an impairment specific to bipolar disorder (Alloy & Abramson, 2010; Depue & Iacono, 1999; Roiser et al., 2009). Cognitive deficits are characteristic of bipolar disorder, with several deficits remaining stable during euthymia (see Malhi, Ivanovski, Szekeres, & Olley, 2004, and Quraishi & Frangou, 2002, for reviews), and data suggesting that cognitive deficits are to some extent a heritable sign of bipolar disorder and hence may occur as an indicator of vulnerability (Balanzá-Martínez et al., 2008, Bora, Yucel, & Pantelis, 2009). Deficits in affective cognition have also been consistently identified in bipolar disorder (Chamberlain & Sahakian, 2004; Elliott, Zahn, Deakin, & Anderson, 2011; Wessa & Linke, 2009). However, the cognitive and affective-cognitive deficits observed in bipolar disorder are also characteristic of schizophrenia, often at a more severe level of intensity (Rossell, 2006; Rowland, Hamilton, Lino, et al., 2013; Rowland, Hamilton, Vella, et al., 2013; Stefanopoulou et al., 2009). In contrast, risky decision-making represents a reward-laden subset of
affective-cognitive processes, a subset that may be more specifically relevant to bipolar disorder (Alloy & Abramson, 2010; Chamberlain & Sakakian, 2006; Roiser et al., 2009).

The present project focused on trait vulnerability to bipolar disorder, rather than bipolar disorder as a clinical diagnosis. However, it is plausible that if reward-laden affective cognition constitutes a specific impairment in clinical bipolar disorder, then poorer reward-laden affective cognition might also serve as a specific indicator of trait vulnerability to bipolar disorder. One method of exploring this research question is to examine a cognitive process that can be tested in a risky decision-making context (reward-laden affective cognition), and also tested in a decision-making context with minimal reward cues present (non-affective cognition). In the present project, set-shifting was chosen as a testable cognitive process that could be contrasted within a risky decision-making task and in a non-affective decision-making task.

3.3. Set-shifting as a Means of Differentiating Reward-Laden and Non-Reward-Laden Processes

The term set-shifting refers to the ability to adjust strategy and behavioural responses (i.e., to “shift” one’s perceptual/cognitive “set”) in the face of changing task demands (Schultz & Searleman, 2002). Set-shifting is seen as an indicator of cognitive flexibility, the ability to change and adapt cognition (Schultz & Searleman, 2002). The opposite or absence of set-shifting is termed *perseveration*, the continuation of a strategy or response that is no longer adaptive or relevant, which is viewed as a sign of cognitive rigidity and inflexibility of thought (Schultz & Searleman, 2002). *Reversal learning* refers to when rules shift from reinforcing one type of response to reinforcing the opposite response, a particular form of set-shifting (Smillie et al., 2009).

An important feature of set-shifting for the present project is that it can be measured during any behavioural task that involves changing task demands, and these tasks can be constructed to elicit either affective or non-affective cognitive processes (Buelow & Blaine, 2015; Turnbull et al., 2006). For example, set-shifting occurring within a task environment that emphasises sources of reinforcement and pursuit of goals can be viewed as an affective cognitive set-shifting task that is also
reward-laden. In contrast, set-shifting occurring within a task environment with minimal reward cues or other emotional stimuli can be viewed as non-affective and non-reward-laden set-shifting. This differentiates set-shifting from risky decision-making, as by definition the choices in a risky decision-making task require emotional valence and potential reward to properly constitute risk (Rao et al., 2015; Reimann & Bechara, 2010; Smith et al., 1993). In the present project, set-shifting during a risky decision-making task was compared to set-shifting during a non-affective task, as a means for exploring the specific relevance of risky decision-making to trait bipolar disorder vulnerability.

3.4. Investigation of Trait Bipolar Disorder Vulnerability using Behavioural Tasks

In summary, risky decision-making can be viewed as a putative behavioural manifestation of BAS, and behavioural tasks measuring risky decision-making constitute an under-utilised but potentially fruitful means of investigating trait bipolar disorder vulnerability. Elevation in risky decision-making might be a specific correlate of trait bipolar disorder vulnerability. Administration of tasks assessing set-shifting in a reward-laden or non-reward-laden context provide a means for exploring this specificity. The present project utilised three behavioural tasks assessing risky decision-making, one also incorporating set-shifting. A non-reward-laden set-shifting task was also included for comparison.

The following four sections introduce the behavioural tasks used in the present project: (i) the BART, assessing risky decision-making from a continuous approach (Lejuez et al., 2002); (ii) the GDT, assessing risky decision-making from a categorical approach (Brand, Fujiwara, et al., 2005; Brand et al., 2004; Lejuez et al., 2002); (iii) the IGT, assessing risky decision-making and reward-laden set-shifting (Bechara et al., 1994; Turnbull et al., 2006); and (iv) the WCST, assessing set-shifting with minimal reward cues present. Following the introduction of each task, a more thorough comparison of the properties of each task is presented to explain the multi-task approach adopted by the present project and to underscore important differences across tasks that will influence interpretation of findings.
3.5. The Balloon Analogue Risk Task

The BART (Lejuez et al., 2002) was designed to be an ecologically valid task that could be used to study risk-taking behaviour in a laboratory setting (Bornovalova et al., 2009). The BART examines risky decision-making under explicit conditions, with the explicit rule set reinforced by the metaphor of a balloon that may burst at any time (Lejuez et al., 2002). The BART also conceptualises risky decision-making as falling on a quantitative spectrum, where choices differ in terms of degree of risk, but cannot easily be categorised as “advantageous” or “disadvantageous” (Lejuez et al., 2002).

The BART is a computer simulation of a balloon being inflated with a pump that the participant controls (Lejuez et al., 2002). Standard BART administration consists of 30 “balloons”, or trials. Each time that the participant inflates the balloon, a set monetary reward is deposited into a temporary financial reserve, or hypothetical bank balance. The goal of BART participation is to accrue as high a hypothetical bank balance as possible (Lejuez et al., 2002). The balloon is capable of bursting due to overinflation, creating an element of risk (Lejuez et al., 2002). The BART probability algorithm dictates that the likelihood of the balloon bursting increases with each with each press of the pump. Initially, each balloon has a 1 in 128 chance of popping. This chance increases to 1/127, 1/126, and so forth, until on the 128th pump there is a 1/1 probability of the balloon exploding (Lejuez et al., 2002). This algorithm sets the average breaking point for the balloon at 64 pumps. The participant can choose to abandon the trial at any time, retaining their bank balance and proceeding to the next trial. Hence, as the number of BART pumps progresses within each trial, the amount that it is possible for the participant to lose increases, whilst the value of the remaining potential reward relative to what they have already accumulated decreases. This dynamic escalation of risk within the BART is viewed as more accurately reflecting risky decision-making in a real-world context (Lejuez et al., 2002; Lauriola et al., 2014). The BART interface screen is presented below in Figure 3.1.
The standard method of assessing risky decision-making using the BART is to calculate the average number of pumps for trials where the balloon did not explode (Lejuez et al., 2002). This metric can be labelled *adjusted mean pumps* (AMP). Higher AMP indicates greater risky decision-making (Lejuez et al., 2002). The mean pumps are adjusted to exclude trials where the balloon burst, because this artificially limits the number of button presses the participant was capable of making during that trial (Lejuez et al., 2002). Although AMP is the primary BART metric (Lejuez et al., 2002), Lejuez et al. (2002) reported that analysing absolute mean pumps, highest number of pumps on one balloon, or number of explosions produced similar results. The number of explosions constitutes a more probabilistic metric than AMP because the bursting of the balloons is influenced by chance more than decision-making (Lejuez et al., 2002). The hypothetical bank balance amount is not used for BART scoring. However, it should be noted that because trials where the balloon bursts automatically contribute zero score to the hypothetical bank balance, the amount of money earned on the BART is a function of AMP (Lejuez et al., 2002).

The BART has shown adequate reliability, but BART responses may be affected by variation in task parameters. White, Lejuez, and de Wit (2008) administered 60 trials of the BART, increasing the amount earned with each pump every 20 trials to create low (0.5 cents per pump), medium (1 cent per pump), and
high (5 cents per pump) reward conditions. The results demonstrated that (i) test-retest reliability across BART sessions was moderate to high; (ii) cumulative exposure to the BART did not alter BART performance; and (iii) BART AMP did not change significantly over time. In addition, the amount of hypothetical money used to reward each button press on the BART did not affect BART performance (White, Lejuez, & de Wit, 2008). However, although White et al. assessed BART test-retest reliability over consecutive days, some data suggest that AMP increases over the course of administration, possibly indicating that individuals can become desensitised to risky decision-making within the BART context over time (Holmes et al., 2009; Lejuez, Aklin, Jones, et al., 2003). Additionally, at higher reward values (25 cents per pump) participants respond more cautiously on the BART, exhibiting decreased AMP (Bornovalova et al., 2009). Although experiments have differed in whether the BART hypothetical bank balance was equated with a real monetary reward, different reward schemes do not appear to markedly influence BART performance (e.g., Lejuez, Aklin, Jones, et al., 2003).

The BART has exhibited validity in predicting a wide range of real-world risk-taking behaviours. These include alcohol use, number of illicit substances used, gambling, infrequent stealing or “shoplifting”, unsafe sexual practices, neglecting to wear a seatbelt in a motor vehicle, smoking, carrying a weapon, physical violence, and not wearing a helmet when riding a bike (Fernie, Cole, Goudie, & Field, 2010; Lejuez, Aklin, Zvolensky, & Pedulla, 2003; Lejuez et al., 2002). BART AMP data have also been shown to differentiate daily cigarette smokers versus non-smokers (Lejuez, Aklin, Jones, et al., 2003), and adolescents who have smoked once or more versus those who have never smoked (Lejuez, Aklin, Bornovalova, & Moolchan, 2005). BART AMP have also been correlated with decreased sleep (Killgore, Kamimori, & Balkin, 2011). No significant difference in BART AMP presents between genders (Lejuez, Aklin, Zvolensky, et al., 2003).

3.6. The Game of Dice Task

The GDT was designed to assess risky decision-making within a task framework that provides explicit rules informing strategic thinking (Brand, Fujiwara, et al., 2005; Brand et al., 2004). In neurocognitive terms, the GDT was developed to measure risky decision-making in terms of impaired executive functioning and
disturbances in emotional feedback processing of gains versus losses (Brand, Fujiwara, et al., 2005; Brand et al., 2004). Logical thinking and probability handling ability also contribute to advantageous decision-making on the GDT (Schiebener, Zamarian, Delazer, & Brand, 2011). The GDT has been most commonly applied to investigations targeting neurocognitive disorders (e.g., Delazer, Sinz, Zamarian, & Benke, 2007) and pathological gambling (e.g., Labudda, Wolf, Markowitsch, & Brand, 2007), with a small selection of studies focusing exclusively on decision-making processes in healthy controls (e.g., Brand, 2008).

GDT administration is computerised, and involves the participant being presented with a series of randomised dice-roll trials, 18 trials constituting standard administration (Brand, Fujiwara, et al., 2005; Brand et al., 2004). Administration takes approximately 15 minutes. Immediately prior to each dice-roll, participants choose which number or numbers on a six-sided die that they gamble will result from the dice-roll. Participants can place a bet on one number, or a spread of two, three, or four numbers. Only one number in the spread needs to result for the bet to be paid; betting in each trial is independent of other trials and by choosing a spread the participant is not betting on a sequence of numbers emerging across multiple trials. Dice-roll results are chance-based, although the probability of winning or losing is mitigated by the number or spread of numbers chosen by the participant (Brand, Fujiwara, et al., 2005; Brand et al., 2004).

The goal of the GDT is for participants to maximise points represented in terms of a hypothetical bank balance (Brand, Fujiwara, et al., 2005; Brand et al., 2004). Participants begin the GDT with a balance of $1,000, with gains and losses adjusting this balance in either a positive or negative direction (the balance can fall below zero). The amount paid on bets increases with escalating risk. Betting on one number (1:6 chance of success) yields $1,000 if correct, whilst the most conservative bet, on a spread of four numbers (4:6 chance of success), yields only $100. Betting on a spread of two numbers (2:6 chance of success) provides $500 if correct, whilst betting on a spread of three numbers (3:6 chance of success) provides $200. Choosing a spread of four or three numbers is categorised as advantageous decision-making (as the winning probability is 50% or greater) whilst choosing a spread of two numbers or choosing one number are categorised as disadvantageous (as the winning probability is less than 34%). Gains and losses are accompanied by a
differing acoustic tone, providing an auditory component to response feedback. In addition, a green bar fills up to provide ongoing visual feedback on earnings. The interface screen of the GDT is presented below in Figure 3.2.

![Figure 3.2](Image.png)

Figure 3.2. The on-screen interface of the GDT.

Scoring of the GDT is focused on decision-making rather than the amount of hypothetical bank balance accumulated (Brand, Fujiwara, et al., 2005; Brand et al., 2004). The maximum amount the participant can accumulate in 18 trials of the GDT is $19,000, whilst the minimum amount that the participant can accumulate is -$17,000. As task performance is weighted towards probability, rather than skill, achieving either of these extremes would be highly improbable. This makes analysis of balance accumulated a poor metric of risky decision-making (Brand, Fujiwara, et al., 2005; Brand et al., 2004). Instead, analysis of results is performed by focusing on the number of advantageous versus disadvantageous choices made (Brand, Fujiwara, et al., 2005; Brand et al., 2004). Risky decision-making on the GDT is computed as number of advantageous decisions minus number of disadvantageous decisions, where positive values indicate more cautious decision-making, whilst negative values indicate more reckless decision-making, irrespective of final monetary score (Brand, Fujiwara, et al., 2005; Brand et al., 2004).

The GDT has been validated via application to a number of clinical samples in whom heightened risky decision-making was expected. These include
pathological gamblers (Brand, Kalbe, et al., 2005; Labudda et al., 2007), patients with Parkinson’s disease (Brand, Fujiwara, et al., 2005; Brand et al., 2004; Euteneuer et al., 2009; Labudda et al., 2010), Korsakoff syndrome (Brand, Fujiwara, et al., 2005), bulimia nervosa (Brand, Franke-Sievert, Jacoby, Markowitsch, & Tuschen-Caffier, 2007), opiate dependence (Brand, Roth-Bauer, Driessen, & Markowitsch, 2008), binge-eating disorder (Svaldi, Brand, & Tuschen-Caffier, 2010), paediatric ADHD (Matthies, Philipsen, & Svaldi, 2012), borderline personality disorder (Svaldi, Philipsen, & Matthies, 2012), and excessive internet use (Pawlikowski & Brand, 2011).

3.7. The Iowa Gambling Task

3.7.1. The design of the IGT. The IGT was developed to assess risky decision-making in a sample of patients with frontal lobe impairment (Bechara et al., 1994). The IGT assesses implicit, emotion-based learning and the impact that this has on risky decision-making (Buelow & Suhr, 2009). The National Institute of Mental Health (NIMH) has recommended the IGT as a suitable task-based measure of approach motivation (NIMH, 2011), a construct falling under the definition of BAS (Corr, 2008). Neurologically, IGT performance has been related to the functioning of the ventromedial prefrontal cortex, theorised to be critical to the formation of associations between decisions and emotional feedback (Damasio, Tranel, & Damasio, 1990; Walton, Chau, & Kennerly, 2015). The IGT is described as an implicit measure of risky decision-making, because the rules and probability algorithms governing the task are not made explicit to the participant (Bechara et al., 1994). Because of this, the IGT has been described as capturing decision-making under ambiguity (Brand, Fujiwara, et al., 2005).

The goal of IGT participation is to earn as much hypothetical money as possible over the course of the task (Bechara et al., 1994), starting at a balance of $2,000. Participants choose from four decks of cards (labelled Deck 1, 2, 3, and 4) represented in a row on-screen. Each card choice results in an amount of hypothetical money gained, but occasionally will also result in the loss (or penalty) of an amount of money (Bechara et al., 1994). Gains always have a 100% probability of occurrence, whilst losses are variable. Deck 1 provides a high gain ($100) and a high frequency of low-magnitude penalties. Deck 2 provides a high gain and a low
frequency of high-magnitude penalties. Deck 3 provides a low gain ($50) and a high frequency of lower magnitude penalties, whilst Deck 4 provides a low gain and a low frequency of higher magnitude penalties. The interface screen for the IGT is presented below in Figure 3.3, whilst the monetary gains and losses and their probability of occurrence for each deck is provided in Table 3.1.

![Figure 3.3. The on-screen interface of the IGT.](image)

<table>
<thead>
<tr>
<th>Pattern of Deck Outcomes in the standard Iowa Gambling Task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Magnitude of Reward</strong></td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td><strong>Frequent Loss</strong></td>
</tr>
<tr>
<td>Large Reward</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Small Reward</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*Note.* Despite providing higher rewards, the magnitude of loss in Deck A and Deck B is such that consistent selection of those decks is more likely to yield a net loss, and hence these decks are termed *disadvantageous selections.* In the above table, disadvantageous selections have been shaded in grey, whilst advantageous selections have been left unshaded.
Table 3.1 represents the standard administration of the IGT. The IGT probability algorithm is such that if a participant consistently chooses from Decks 3 and 4 then their modest yet consistent gains are likely to outweigh the amount of money that they are penalised. In contrast, whilst Decks 1 and 2 provide higher gains, over time these are likely to be neutralised by the higher magnitude of losses. Hence, Decks 3 and 4 represent low risk options, termed advantageous selections, whereas Decks 1 and 2 represent high risk options, termed disadvantageous selections (Bechara et al., 1994). The IGT is scored using number of advantageous choices minus number of disadvantageous choices. Lower values indicate riskier decision-making, with values lower than zero indicating that disadvantageous selections have occurred more commonly than advantageous selections (Bechara et al., 1994; Upton et al., 2011).

A number of researchers have considered how the implicit decision-making process occurring on the IGT can best be explained (Bechara & Damasio, 2005; Bechara et al., 1997; Busemeyer & Stout, 2002; Buelow & Suhr, 2009; Reimann & Bechara, 2010; Stocco & Fum, 2008; Upton et al., 2011). The somatic marker framework is the dominant theory as to how participants make decisions during the IGT, especially during earlier trials (see Reimann & Bechara, 2010, for a review). The somatic marker framework posits that primary emotions are generated from an organism’s subjective interpretation of a set of innate bodily sensations (Bechara & Damasio, 2005). These sensations then become stimuli and responses in conditioned learning, creating a network of secondary sensations and emotions. The bodily sensations that signify emotional responses have been termed somatic markers (Bechara & Damasio, 2005). Somatic markers are said to bias decision-making as an individual proceeds through the IGT, leading to a conditioned aversion to decks associated with long-term loss and a preference for decks associated with long-term gain (Bechara, Damasio, Tranel, & Damasio, 1997). In this way, participants develop a pattern of deck selections based on implicit emotional conditioning, without full awareness of the IGT rule set (Bechara & Damasio, 2005; Bechara et al., 1997; Reimann & Bechara, 2010).

Explicit decision-making also has a role in IGT decision-making, especially on later trials (Busemeyer & Stout, 2002; Buelow & Suhr, 2009; Stocco & Fum, 2008; Upton et al., 2011). Stocco and Fum (2008) noted that risky decision-making
on the IGT possesses both implicit and explicit components, with the degree of each differing across individuals and also across task duration. Task duration is of particular importance, as several authors have noted that due to its implicit nature the IGT places a greater weighting on learning during earlier trials of the task (Busemeyer & Stout, 2002; Buelow & Suhr, 2009; Stocco & Fum, 2008; Upton et al., 2011). Earlier trials of the IGT are required to set up enough associations for implicit emotional responses, or somatic markers to form (Bechara & Damasio, 2005; Bechara et al., 1997; Reimann & Bechara, 2010). Intermediate trials are then weighted towards demonstration of implicit learning, in accordance with the somatic marker framework (Bechara & Damasio, 2005; Bechara et al., 1997; Reimann & Bechara, 2010). Finally, on later trials, deck selection may be based on explicit knowledge as the participant has now experienced sufficient trials to achieve an understanding of the underlying rules of the task (Busemeyer & Stout, 2002; Buelow & Suhr, 2009; Stocco & Fum, 2008; Upton et al., 2011). Hence, earlier IGT trials place greater weighting on implicit and emotion-based decision-making, whereas later trials place greater weighting on explicit and cognitive-based decision-making (Buelow & Suhr, 2009).

In summary, the IGT acts as an implicit measure of risky decision-making, albeit one that also begins to engage explicit risky decision-making more heavily later in the task (Reimann & Bechara, 2010; Stocco & Fum, 2008). Hence, although the IGT functions as a behavioural measure of risky decision-making, findings from the task must be interpreted with the understanding that task performance is influenced by learning effects (Busemeyer & Stout, 2002; Smillie et al., 2009).

Of particular interest to the present project, researchers have taken advantage of IGT learning effects by modifying the task so that it also functions as a measure of set-shifting in a risky decision-making context (e.g., Kovalchik & Allman, 2006; Turnbull et al., 2006). The following section reviews studies that have used the IGT to examine set-shifting in order to select the IGT protocol most appropriate for the present project.

### 3.7.2. Set-shifting modifications to the IGT

The importance of learning effects in IGT decision-making means that the IGT can be easily modified to create a task that assesses set-shifting in the context of risky decision-making (Kovalchik & Allman, 2006; Turnbull et al., 2006). The incorporation of a set-shifting element
within the standard IGT protocol requires the inclusion of additional blocks of trials where the underlying reward/loss contingencies of each deck have been surreptitiously altered (Turnbull et al., 2006). Four different set-shifting modifications of the IGT have been published. These modifications are summarised below in Table 3.2. Following this, each modified IGT is reviewed in turn in order to establish the most suitable IGT protocol for the present project.

Table 3.2

<table>
<thead>
<tr>
<th>Original Study</th>
<th>IGT Name</th>
<th>IGT Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnbull, Evans, Kemish, Park, &amp; Bowman, 2006</td>
<td>Contingency-shifting variant IGT</td>
<td>Uses four decks with underlying rule shifting one deck to the right each 40 trials following the first 100 trials, which are identical to the standard IGT</td>
</tr>
<tr>
<td>Hassin, Bargh, &amp; Zimmerman, 2009</td>
<td>Environment change IGT</td>
<td>Uses four decks over 500 trials, with the two disadvantageous decks swapping position with the two advantageous decks after 250 trials</td>
</tr>
<tr>
<td>Smillie, Cooper, Tharp, &amp; Pelling, 2009</td>
<td>Modified set-shifting IGT</td>
<td>As per Turnbull et al. (2006), but position of frequent versus infrequent loss rules also shifted</td>
</tr>
<tr>
<td>Kovalchik &amp; Allman, 2006</td>
<td>Variable IGT</td>
<td>Features two decks that not only reverse in rule but also alter based on frequency of loss</td>
</tr>
</tbody>
</table>

Note. IGT names were extrapolated from the language used to introduce the IGT variant for articles that have not applied a consistent label to their IGT variant.

The most commonly used set-shifting modification to the IGT was developed by Turnbull, Evans, Kemish, Park, and Bowman (2006), who sought to examine the impact of emotion and cognitive flexibility on risky decision-making in schizophrenia. The protocol used by Turnbull et al. maintained compatibility with the standard 100-trial IGT, but included 120 additional trials, with the pattern of decks changing every 40 trials. Amongst both patients with schizophrenia ($n = 21$) and a matched non-clinical comparison group ($n = 21$), the data showed a learning curve wherein IGT performance steadily became better (i.e., biased towards advantageous selections) over the course of the task until a rule change was reached, whereupon performance then fell and started to improve again until subsequent rule
changes. Negative symptoms of schizophrenia were associated with marked difficulty adjusting to changes in deck rule. These findings demonstrate that the modified IGT used by Turnbull et al. (2006) is sensitive to difficulties with set-shifting.

Three additional studies have used the IGT protocol developed by Turnbull et al. (2006), making it the most commonly-used IGT set-shifting modification. In the first of these studies, Dymond, Cella, Cooper, and Turnbull (2010) administered a set-shifting IGT to undergraduate students (N = 208), identifying an expected decrement to decision-making following each shift, followed by gradual improvement. By splitting their sample into high (n = 39) and low (n = 26) performers based on the standard IGT trials, Dymond et al. also found that poor performance on the contingency-shifted IGT blocks resulted from impaired reversal learning. This means that riskier decision-making occurred due to perseveration of previously reinforced choices that were now associated with increased loss (Dymond, Cella, Cooper, & Turnbull, 2010). The remaining two studies are of only limited relevance to the present project, having investigated risky decision-making and set-shifting in university students reporting psychotic symptoms (Cella, Dymond, & Cooper, 2009) and in patients diagnosed with unipolar depression (Cella, Dymond, & Cooper, 2010), with both studies supporting a decrement in decision-making following contingency shifts.

Hassin, Bargh, and Zimmerman (2009) and Smillie et al. (2009) both conducted studies using similar set-shifting IGT protocols to that used by Turnbull et al. (2006). Hassin, Bargh, and Zimmerman (2009) to examine whether unconsciously-primed approach motivation could be characterised by cognitive flexibility in the same manner as conscious approach motivation (N = 64). However, the 500-trial set-shifting IGT used by Hassin et al. was limited in that it only incorporated one rule change, taking place after the first 250 trials. Smillie et al. (2009) examined the impact of working memory, extraversion, neuroticism, psychoticism on WCST set-shifting and modified IGT reversal learning in a nonclinical sample (N = 78). The authors based their IGT protocol on that of Turnbull et al. (2006), featuring an identical shifting pattern in terms of advantageous versus disadvantageous decks, but differing in the positioning of the frequent versus infrequent decks.
Finally, Kovalchik and Allman’s set-shifting IGT protocol represents the furthest departure from the standard IGT protocol (Bechara et al., 1994). Kovalchik and Allman (2006) created a set-shifting in order to test whether frontal lobe deficits in IGT performance occur due to impaired reversal learning. Kovalchik and Allman’s set-shifting IGT only included two decks, and in addition to controlling the potential for overall gain or loss in each deck (with one being advantageous and one being disadvantageous), the authors also varied whether or not the more rewarding deck was always higher risk. This is a key difference from the standard IGT, where the relationship between reward and risk is held constant. Kovalchik and Allman’s paradigm allowed for good experimental control within their project. However, the modifications made to their IGT constitute a sufficient departure from conventional IGT administration that Kovalchik and Allman’s results are arguably not comparable to those arising from the wider body of conventional IGT research.

Accordingly, after reviewing the seven studies that have implemented an IGT modified to assess set-shifting, the specific paradigm used by Turnbull et al. (2006) was judged to be the most suitable for the present study. This modified protocol has been labelled the *contingency-shifting variant IGT* (CS-IGT; Smillie et al., 2009; Turnbull et al., 2006) to differentiate it from the standard IGT originally designed by Bechara et al. (1994). The CS-IGT was chosen as the most appropriate modified IGT protocol for the present study due to its seamless integration with the standard IGT protocol (Bechara et al., 1994) and it being the most commonly used set-shifting IGT protocol (Cella et al., 2009; Cella et al., 2010; Dymond et al., 2010; Turnbull et al., 2006). The pattern of changes in decks during the CS-IGT is summarised in Table 3.3.
Table 3.3

Pattern of Deck Outcomes in the Set-Shifting Iowa Gambling Task used in the Present Study (adapted from Turnbull et al., 2006, Figure 1)

<table>
<thead>
<tr>
<th>Rule</th>
<th>Deck Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First</td>
</tr>
<tr>
<td>Rule 1 (Trials 1-100)</td>
<td>Deck 1</td>
</tr>
<tr>
<td></td>
<td>Large/Frequent</td>
</tr>
<tr>
<td>Rule 2 (Trials 101-140)</td>
<td>Deck 4</td>
</tr>
<tr>
<td></td>
<td>Small/Infrequent</td>
</tr>
<tr>
<td>Rule 3 (Trials 141-180)</td>
<td>Deck 3</td>
</tr>
<tr>
<td></td>
<td>Small/Frequent</td>
</tr>
<tr>
<td>Rule 4 (Trials 181-220)</td>
<td>Deck 2</td>
</tr>
<tr>
<td></td>
<td>Large/Infrequent</td>
</tr>
</tbody>
</table>

Note. In the above table, disadvantageous selections have been shaded in grey, whilst advantageous selections have been left unshaded. The Deck Position columns refer to the position in which the decks are presented from left to right on screen during CS-IGT administration. The magnitude and frequency of each deck has been summarised below the deck number for convenience.

For the initial 100 trials the CS-IGT is identical to the standard IGT, and thus decision-making on these trials is comparable to decision-making during the standard IGT protocol, and can be viewed as a measure of risky decision-making (Dymond et al., 2010; Turnbull et al., 2006). Trials 101 through 220 contain contingency shifts, where the rules underlying each deck change (Turnbull et al., 2006). Performance over these trials can be seen as reflective of set-shifting, as the participants must observe that the deck rules have changed, and adjust their responses accordingly by inhibiting a prepotent response that is no longer being reinforced (Dymond et al., 2010; Turnbull et al., 2006). This means that increased disadvantageous decision-making in CS-IGT trials following a shift in rule is viewed as indicating poorer set-shifting ability (Dymond et al., 2010; Smillie et al., 2009; Turnbull et al., 2006).
3.8. The Wisconsin Card-Sorting Test

The WCST is a measure of extradimensional set-shifting ability (Berg, 1948; Grant & Berg, 1948). In doing this, the WCST is viewed as broadly assessing executive function localised to the frontal lobe of the brain (Berg, 1948; Grant & Berg, 1948). The WCST is a classic neuropsychological testing protocol that has been used in over 600 studies (Bowden et al., 1998), with support for test-retest reliability found in both clinical and non-clinical samples (e.g., Tate, Perdices, & Maggiotto, 1998).

During each trial of the WCST, participants are presented with a target card and a selection of four other cards. The participant must then select the appropriate card that matches the target based on a given sorting rule (Berg, 1948; Grant & Berg, 1948). Cards vary in terms of three categories: (i) the colour of the symbols on the card (blue, yellow, green, or red); (ii) the number of symbols depicted on the card (one through four); and (iii) the shape of the symbols on the card (crosses, circles, triangles, or stars). Matching is accomplished with reference to these categories, with the sorting rule determining which matching category is relevant for a given trial (Berg, 1948; Grant & Berg, 1948). Sorting rules are provided implicitly, with simple correct versus incorrect feedback allowing participants to shape their responses (Berg, 1948; Grant & Berg, 1948). The sorting rule is changed once the participant correctly matches an option to the target card five trials in a row. Failure to correctly match the cards is seen as indicating difficulty with set-shifting, with perseverative errors that would have been correct responses for the previous sorting rule seen as especially indicative of set-shifting impairment (Berg, 1948; Grant & Berg, 1948). The WCST involves a variable number of trials, as administration is discontinued once participants have cycled through each sorting category twice, up to a maximum of 128 card-sorting trials. The interface screen of the WCST is presented below in Figure 3.4.
The most commonly examined WCST scoring metrics are percentage of total errors and percentage of perseverative errors. Both percentage of total errors and percentage of perseverative errors are viewed as measuring set-shifting ability (Berg, 1948; Grant & Berg, 1948). Percentage of perseverative errors is seen as a more specific measure of reversal learning and conscious inhibition, as avoiding perseveration requires that a participant learns the new card-sorting rule whilst inhibiting the previously learned rule. Lower percentages of either form of error indicate better set-shifting ability (Berg, 1948; Grant & Berg, 1948). Evidence suggests that different metrics derived from the WCST are largely assessing the same underlying construct (Bowden et al., 1998; Greve, Stickle, Love, Bianchini, & Stanford, 2005). However, because of the ability to identify reversal learning difficulties more specifically when examining perseverative errors, both total error percentage and perseverative error percentage metrics were used in the present project.

3.9. Comparison of the BART, GDT, CS-IGT, and WCST

3.9.1. Rationale for comparison of tasks. Specific task context and demands mean that a multi-task approach is desirable in the assessment of risky decision-making (Buelow & Blaine, 2015). This is because although tasks may
purport to measure the same underlying construct, such as risky decision-making or set-shifting, the manner in which this construct is measured differs. These differences mean that tasks that are superficially similar may not produce correlated output, because they are measuring different aspects of an underlying construct (Lejuez et al., 2002). Accordingly, this section reviews important similarities and differences between the BART, GDT, CS-IGT, and WCST in order to clarify the reasons for including each task within the one study. Table 3.4 summarises these similarities and differences.

Table 3.4
Comparison of Features of the BART, GDT, CS-IGT, and WCST

<table>
<thead>
<tr>
<th>Feature</th>
<th>BART</th>
<th>GDT</th>
<th>CS-IGT</th>
<th>WCST</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Assesses risky decision-making</td>
<td>- Assess risky decision-making</td>
<td>- Assess risky decision-making and set-shifting</td>
<td>- Assess risky decision-making and set-shifting</td>
<td>- Assesses set-shifting</td>
</tr>
<tr>
<td>- Recognisable task metaphor</td>
<td>- Recognisable task metaphor</td>
<td>- Less recognisable task metaphor</td>
<td>- Recognisable task metaphor</td>
<td></td>
</tr>
<tr>
<td>- Explicit rule-set</td>
<td>- Explicit rule-set</td>
<td>- Implicit rule-set</td>
<td>- Implicit rule-set</td>
<td></td>
</tr>
<tr>
<td>- Rules constant</td>
<td>- Rules constant</td>
<td>- Rule shifts</td>
<td>- Rule shifts</td>
<td></td>
</tr>
<tr>
<td>- Dynamic algorithm</td>
<td>- Static algorithm</td>
<td>- Static algorithm</td>
<td>- Adaptive algorithm</td>
<td></td>
</tr>
<tr>
<td>- Ongoing feedback</td>
<td>- Ongoing feedback</td>
<td>- Ongoing feedback</td>
<td>- Immediate feedback</td>
<td></td>
</tr>
<tr>
<td>- Simple interface</td>
<td>- Complex interface</td>
<td>- Simple interface</td>
<td>- Simple interface</td>
<td></td>
</tr>
<tr>
<td>- Monetary scoring</td>
<td>- Monetary scoring</td>
<td>- Monetary scoring</td>
<td>- No score provided</td>
<td></td>
</tr>
<tr>
<td>- Score positive</td>
<td>- Score bidirectional</td>
<td>- Score bidirectional</td>
<td>- Score bidirectional</td>
<td>- No score provided</td>
</tr>
</tbody>
</table>

*Note.* BART = Balloon Analogue Risk Task, GDT = Game of Dice Task, CS-IGT = Contingency-Shifting Iowa Gambling Task, and WCST = Wisconsin Card-Sorting Test.

**3.9.2. Comparison of the BART to other tasks.** The BART assesses risky decision-making through the recognisable metaphor of a balloon bursting (Lejuez et al., 2002). Along with the explicit instructions provided to participants upon administration, this ensures that participants are aware of the goals and consequences of task responses (Upton et al., 2011). The BART uses a very simple interface, with only two responses available to participants: *pump* and *collect* (Lejuez et al., 2002). Participants are aware that each pump increases their monetary score but attracts a greater risk of the balloon bursting, and that choosing to collect their earning on that trial saves their monetary score to their hypothetical bank balance but moves them
on to the subsequent trial (Lejuez et al., 2002). An important feature of the BART that differentiates it from the GDT and CS-IGT is that it uses a dynamic probability algorithm (Lejuez et al., 2002). This means that the rather than risk remaining static, risk escalates the more that the participant pumps for each trial. This design captures the conceptualisation of risky decision-making as falling on a continuum, where a moderate amount of risk in decision-making can actually be adaptive, whilst excessive risk is likely to lead to undesirable outcomes (Lejuez et al., 2002; Bornovalova et al., 2009). Although the probability of loss escalates within each trial, the rules of the BART can be said to remain constant, because the participant is aware of the escalating risk and this escalation of risk is applied in an identical manner across trials.

3.9.3. Comparison of the GDT to other tasks. The GDT is similar to the BART in a number of respects. Both tasks assess risky decision-making and both tasks feature an explicit rule-set with monetary scoring (Brand, Fujiwara, et al., 2005; Brand et al., 2004; Lejuez et al., 2002). Like the BART, the GDT also relies on an immediately recognisable metaphor to cement the explicit nature of the task: the metaphor of rolling a six-sided dice. In addition to the analogy between monetary scoring and financial gain, the GDT also differentiates gains and losses using green and red text as well as differing auditory cues, and uses a green bar to provide a visual gauge of earnings (Brand, Fujiwara, et al., 2005; Brand et al., 2004). Hence, the GDT emphasises its reward-laden context more explicitly than any other task mentioned here.

The primary difference between the GDT and the BART are that the GDT uses a static probability algorithm: each number on the dice has a 1 in 6 chance of occurrence on each trial, with this probability remaining stable across trials. Additionally, the GDT presents the participant with a more complex array of response options. The GDT provides 14 options, although these fall within four probability categories (Brand, Fujiwara, et al., 2005; Brand et al., 2004). In contrast, the BART interface presents the participant with only two options (Lejuez et al., 2002). Hence, participant decision-making on the GDT may be a more effortful process than decision-making on the BART (Bettman, Johnson, & Payne, 1990). Finally, the GDT has the potential to be a much more punishing task than the BART due to the frequency and magnitude of scoring penalties (Brand, Fujiwara, et al.,
Participants can only accumulate hypothetical bank balance on the BART, with losses only occurring within-trial when a balloon bursts (Lejuez et al., 2002). In contrast, the GDT balance can decrease to negative values when losses are experienced. Experimentation is not rewarded, as a losing selection on the riskiest option requires a minimum of ten successful trials on the safest option in order to recoup the loss (Brand, Fujiwara, et al., 2005; Brand et al., 2004). Few studies have administered both the BART and the GDT, although they have been shown to provide differing results in a drug challenge protocol examining risk-taking and testosterone (Goudriaan et al., 2010).

3.9.4. Comparison of the CS-IGT to other tasks. The CS-IGT acts as a very different measure of risky decision-making than the BART or the GDT. The primary difference is that CS-IGT risky decision-making is made under an implicit rule-set (Bechara et al., 1994; Brand, Fujiwara, et al., 2005; Brand et al., 2004). The participant is not provided with explicit information regarding which decks represent low-risk options (probabilistically advantageous in the long-term) and which represent high-risk options (probabilistically disadvantageous in the long-term). Consequently, the CS-IGT places a heavier weighting on learning the underlying probability algorithm of the task than do the BART and GDT. The somatic marker framework proposes that participants rely on subtle emotional responses to monitor the probability of gain versus loss as the task progresses, a form of implicit learning (Bechara & Damasio, 2005; Reimann & Bechara, 2010). Because participants are provided with explicit feedback (gain and loss values for each selection made), explicit learning also plays a role in CS-IGT responding (Buelow & Suhr, 2009; Upton et al., 2011). However, the implicit nature of the task means that intuitive emotional responding is arguably more important to the CS-IGT than it is to the BART or GDT. The weighting towards learning means that CS-IGT involves decision-making under conditions of ambiguity as much as it does decision-making under conditions of risk (Brand, Fujiwara, et al., 2005; Brand et al., 2004).

A number of studies have compared the BART to the standard IGT protocol. Skeel et al. (2007) found BART number of explosions to be weakly positively correlated with disadvantageous IGT selections. However, Lejuez, Aklin, Jones, et al. (2003) found no correlation between BART AMP and IGT selections. BART AMP was predictive of smoking status, whereas IGT selections were not, suggesting
that BART performance may be more relevant to at least certain types of real-world risk-taking behaviour. Although data from Lejuez, Aklin, Jones, et al. suggested that individuals are prone to riskier decision-making on the BART over time, the opposite trend was demonstrated for IGT selections, with advantageous choices increasing over repeated administrations. Despite a lack of bivariate correlation, statistical modelling shows that the BART and IGT appear to assess some common elements of risky decision-making at an underlying construct level, specifically in terms of sensitivity to losses and consistency of decision-making (Bishara et al., 2009). The higher weighting towards learning on the IGT means that later IGT trials are most likely to correlate with BART AMP (Upton, Bishara, Ahn, & Stout, 2011), although overall the BART and IGT appear to be best viewed as measuring different forms of risky decision-making (Buelow & Blaine, 2015). As with the BART, the IGT has demonstrated equivocal associations with trait measures (Bishara et al., 2009; Upton et al., 2011).

The GDT was designed to provide an explicit counterpoint to the implicit measurement of risky decision-making provided by the IGT (Bechara et al., 1994; Brand, Fujiwara, et al., 2005; Brand et al., 2004). Brand, Labudda, and Markowitsch (2006) argued that whereas the IGT requires greater input from frontal-striatal neurotransmission loops and somatic markers to guide implicit learning, GDT performance is more dependent on executive functions localised to the dorsolateral prefrontal cortex (see Schiebener et al., 2011). The ratio of risk of loss versus potential gain is always reciprocal for the GDT, as the amount gambled by the participant (based on the range of numbers they have chosen) is the amount gained if successful or lost if unsuccessful (Brand, Fujiwara, et al., 2005; Brand et al., 2004). In contrast, IGT gains and losses operate independently (Bechara et al., 1994). Hence, not only does the GDT place less weighting on learning the rule set (Brand, Fujiwara, et al., 2005; Brand et al., 2004), it could also be argued that the GDT simplifies the role of learning and probability monitoring, as participants only need to monitor one stream of feedback.

As with the BART, risky decision-making measured by the GDT is most likely to correlate with risky decision-making measured by later blocks of the IGT, as performance on these blocks is the least dependent on learning (Upton et al., 2011). Brand, Recknor, Grabenhorst, and Bechara (2007) administered both the
GDT and the IGT to a sample of healthy participants ($N = 32$), finding that GDT decision-making was moderately positively correlated with decisions made on the latter blocks of the IGT, but not on the initial two blocks. Brand, Heinze, Labudda, and Markowitsch (2008) found that participants used alternative strategies in responding to the GDT and IGT. Risky decision-making on the GDT drew more heavily upon a calculative, cognition-based decision-making pathway, whilst risky decision-making on the IGT drew more heavily upon an intuitive, emotion-based decision-making pathway (Brand, Heinze, Labudda, & Markowitsch, 2008).

3.9.5. Comparison of the WCST to other tasks. The WCST assesses set-shifting (Berg, 1948; Grant & Berg, 1948). The assessment of set-shifting provided by the WCST does not occur in the context of risky decision-making, as the WCST utilises as few reward cues as possible. Unlike the BART, GDT, and CS-IGT, the WCST does not incorporate monetary scoring, an instructional emphasis on task success, auditory feedback on success versus failure, a visual gauge of progress, or ongoing feedback into its design. Therefore, the WCST assesses set-shifting in a context that is not reward-laden. For this reason, the WCST was included in the present project in order to serve as a contrast with set-shifting occurring on the CS-IGT.

The WCST and CS-IGT assess different forms of set-shifting (Berg, 1948; Dymond et al., 2010; Grant & Berg, 1948; Smillie et al., 2009). The WCST utilises extradimensional set-shifting across response categories, whilst the CS-IGT utilises intradimensional set-shifting within the one response framework (Linke et al., 2012; Schultz & Searleman, 2002; Smillie et al., 2009). However, both forms of set-shifting provide an indicator of overarching cognitive flexibility (Linke et al., 2012; Schultz & Searleman, 2002; Smillie et al., 2009).

An important difference between the WCST and CS-IGT is the reward-laden context used by the CS-IGT. In this sense, the CS-IGT can be seen as a methodological counterpoint to the WCST. Whilst the WCST assesses set-shifting, it does this in a way that is not reward-laden, where the participant is not aware of their numerical score, and the goal of the task is more diffuse (with participants aiming to get as many trials correct as possible) than the monetary score accumulation and probability evaluation that drives the CS-IGT (Turnbull et al., 2006). Accordingly,
the WCST assesses set-shifting in a non-reward-laden context, whilst the CS-IGT assesses set-shifting in a reward-laden context.

Although some studies have found an association between WCST performance and risky decision-making on the standard IGT protocol (e.g., Brand, Labudda, & Markowitsch, 2006; Brand et al., 2007), the two studies comparing WCST performance to CS-IGT performance have not found a significant association (Smillie et al., 2009; Turnbull et al., 2006). Previous findings have indicated a moderate positive correlation between WCST performance and risky decision-making on later trials of the IGT, with WCST performance assessed as percentage of perseverative and non-perseverative errors (Brand, Labudda, & Markowitsch, 2006; Brand et al., 2007). However, no association was present between WCST and IGT performance in studies conducted by Turnbull et al. (2006) and Smillie et al. (2009). Smillie et al. explained this dissociation between tasks as arising from differing set-shifting mechanisms, with WCST performance possessing a great emphasis on attentional control and executive functioning, and modified IGT performance also being influenced by affective processing and impulse control.

3.10. Summary of Chapter 3

Risky decision-making as assessed using behavioural tasks provides a putative BAS measure that may capture elements of BAS not assessed by trait questionnaires. Measurement of set-shifting is useful for exploring the degree to which elevated risky decision-making is a specific characteristic, rather than being associated with difficulties in cognitive processing more generally. Due to the importance of adopting a multi-task approach to measuring risky decision-making, the present project utilised the BART, GDT, and CS-IGT as measures of risky decision-making. The WCST was also included for comparison with the CS-IGT, as comparing set-shifting across non-reward-laden and reward-laden contexts can provide evidence for the specificity of risky decision-making impairment. The following chapter describes research linking BAS and risky decision-making with bipolar disorder and trait bipolar disorder vulnerability.
4. The Role of BAS Abnormality in Bipolar Disorder

4.1. Structure of Chapter 4

The purpose of Chapter 4 is to review research linking abnormal functioning of BAS to bipolar disorder. This review will lead to hypotheses relating to the central aim of the present project, which was the investigation of a link between trait BAS and trait vulnerability to bipolar disorder using self-report and behavioural task methodologies.

Chapter 4 clarifies the manner in which BAS, BIS, and bipolar disorder might be linked, and then reviews selected sets of literature. Two caveats must be made regarding the formulation of this review. Firstly, due to the limited research focusing specifically on linking BAS to trait bipolar disorder vulnerability, both clinical bipolar disorder and bipolar disorder vulnerability research is used to draw inferences. Secondly, few studies are presented that have examined BAS and bipolar disorder using a correlational, questionnaire-based approach, meaning that there is little evidence to inform predictions regarding relationships between the 7U7D and BBS variables. This gap in the review reflects a dearth of literature that has administered both the 7U7D (or GBI) and the BBS. The decision was made not to purposefully broaden the review to encompass all questionnaire measures relevant to bipolar disorder or reward sensitivity. This was viewed as creating a risk of extrapolating too far beyond the measurement tools adopted by the present project, and also risked conflating (a) trait vulnerability measures and quantitative symptom checklists; and (b) single-factor and multiple factor reward sensitivity measures.

The selection of studies for review was based on how central the examination of mood disorder phenomenology and RST motivational systems were to the aims of the study in question. Studies were prioritised for inclusion if they used RST as an explanatory framework, made use of the GBI or BBS as measurement tools, or administered the BART, GDT, IGT, or WCST. The first part of the review focuses on research examining (i) diagnostic or vulnerability groups; (ii) positive and negative life events; and (iii) cognitive styles. The second part of the review focuses on research into bipolar disorder and risky decision-making that has utilised the same behavioural tasks used in the present project.
4.2. A Link between BAS and Bipolar Disorder

The BAS theory of bipolar disorder proposes that abnormalities in BAS are aetiollogically related to bipolar disorder (Depue & Iacono, 1989). The nature of the proposed abnormalities has been varyingly described as hypersensitivity (e.g., Alloy, Nusslock, & Boland, 2015; Johnson, Edge, et al., 2014) and dysregulation (e.g., Johnson, 2005; Urošević, Abramson, Harmon-Jones, & Alloy, 2008). However, the mechanism by which BAS may contribute to bipolar disorder aetiology remains unknown, and hence the more general term abnormality is used in the present project.

The idea that BAS abnormalities function as a causal factor in bipolar disorder vulnerability, onset, and course was first proposed by Depue and Iacono (1989). This proposal followed previous work linking neurological systems of behavioural impulsivity and constraint to mood disorders (e.g., Depue & Spoont, 1986). Depue and Iacono proposed a behavioural facilitation system, and discussed how alteration of this system could explain the physiological, behavioural, emotional, and pharmacological effects that research has associated with bipolar disorder (see Goodwin & Jamison, 2007). Further work in clarifying the role of the behavioural facilitation system in mood disorders has focused on (a) a system of relevant midbrain structures and their limbic and cortical projections; (b) neurotransmission via the biogenic monoamines (dopamine, serotonin, and noradrenaline); and (c) personality traits similar to trait BAS due to their associations with approach motivation, including positive emotionality, extraversion, and impulsivity (Depue, Luciana, Arbisi, Collins, & Leon, 1994; Depue & Collins, 1999).

Depue and Iacono’s (1989) concept of a behavioural facilitation system was derived from earlier work on dual motivational processes (e.g., Schneirla, 1959), and was not framed within the context of RST. However, Depue and Iacono noted the similarity between the behavioural facilitation system and BAS (Gray, 1982). Differences between the behavioural facilitation system and BAS (Fowles, 1980; Gray, 1982) are minimal, and the present project adheres to the term BAS, concordant with the approach taken by the wider literature (e.g., Johnson, 2005).

In terms of clinical phenomenology, the BAS theory of bipolar disorder proposes that the extreme mood lability that characterises bipolar disorder occurs
due to abnormalities in BAS functioning that likely consist of hypersensitivity or dysregulation (Depue & Iacono, 1999; Johnson, 2005; Nusslock, Young, & Damme, 2014). In this context, hypersensitivity can be viewed as an individual placing extremely high on trait BAS, whereas dysregulation refers to irregular or maladaptive functioning of BAS. Specifically, an individual with bipolar disorder who enters a circumstance stimulating BAS is theorised to be at risk of a manic episode (Johnson, 2005). Conversely, if an individual with bipolar disorder enters a circumstance stimulating BAS but is met with insurmountable obstructions to goal attainment, then they are theorised to be at risk of a depressive episode (Alloy & Abramson, 2010). Under this perspective, mania is linked to extreme and pathological BAS engagement (Johnson, 2005), whereas depression is linked to extreme and pathological BAS disengagement (Alloy & Abramson, 2010; Nusslock et al., 2014).

The BAS theory of bipolar disorder is a diathesis-stress model (Monroe & Simons, 1991), as it proposes that underlying vulnerability is present (BAS abnormality) that is triggered by environmental stimuli (circumstances eliciting approach motivation). This theory is consistent with the notion of a continuous spectrum of bipolar disorder vulnerability, and the manic and depressive episodes that define bipolar disorder have been theorised to reflect the extreme poles of a continuum of dysregulated BAS (Hayden et al., 2008). A model of this continuum is presented below in Figure 4.1.

As observed by Depue and colleagues, phenomena associated with successful versus unsuccessful approach behaviours seemingly parallel the symptoms of bipolar disorder episodes. Positive mood, inflated self-esteem, increased energy, restlessness, increased pursuit of goals, irritability in response to frustrated goal pursuit, and heightened sensitivity to reward are present in normal states of high BAS engagement (Bowins, 2008; Carver & Harmon-Jones, 2009; Corr, 2008). At clinical extremes, these phenomena are described in the diagnostic criteria for a manic episode (APA, 2013). In contrast, negative mood, loss of enjoyment, fatigue, feelings of worthlessness or self-blame, and withdrawal from activity are consistent with the process of disengagement from pursuing a goal that has proven to be unattainable (Bowins, 2008; Corr, 2008). At clinical extremes, these phenomena are described in the diagnostic criteria for a depressive episode (APA, 2013).
Correspondence between the neurological systems implicated in BAS and those implicated in bipolar disorder has also informed the BAS theory of bipolar disorder (Depue & Collins, 1999; Urošević et al., 2008). BAS engagement has been associated with a relative increase in left-frontal electroencephalographic (EEG) activity, and this link is supported by correlations with trait BAS (Harmon-Jones & Allen, 1997). A prospective study screening individuals using the GBI showed that elevated left-frontal activity predicted conversion to BD-I in 76% of cases followed over a 4.7-year period (Nusslock, Alloy, et al., 2012). BAS functioning has also been linked to activity in the ventral striatum, which is believed to signify evaluative processing with regards to potential rewards (Drevets, Öngür, & Price, 1998). Nusslock, Almeida, et al. (2012) found elevated ventro-striatal and orbitofrontal activity in euthymic bipolar disorder patients during the anticipatory phase of a reward-based card-selection task. The substantial overlap between the neural substrates of BAS (Gray & McNaughton, 2000) and the neural substrates where differences and deficits are observed in bipolar disorder (e.g., Keener & Phillips,
The following sections review several lines of research investigating the BAS theory of bipolar disorder. Before proceeding, it should be noted that because different researchers have examined a potential link between BAS and bipolar disorder in different ways, it may be more accurate to think of BAS theories of bipolar disorder, rather than a single BAS theory that has been applied unitarily across studies. In the main, the literature concerned with BAS in bipolar disorder has been driven by the research groups of Johnson (e.g., Johnson, Ruggero, & Carver, 2005) and Alloy (e.g., Alloy et al., 2006), both of whom have also published a number of review articles on the BAS theory of bipolar disorder in addition to their empirical research (see Alloy & Abramson, 2010; Alloy, Bender, Wagner, Abramson, & Urošević, 2009; Alloy, Nusslock, & Boland, 2015; Carver et al., 2009; Johnson, Edge, et al., 2012; Johnson, Fulford, & Carver, 2012; Johnson & Roberts, 1995; Nusslock et al., 2014; Urošević et al., 2008). The review focuses predominantly on trait BAS rather than trait BIS. This is because BAS is viewed as the more important system to bipolar disorder research (Urošević et al., 2008). The literature on bipolar disorder has invested more time in examining the role of BAS, from both a theoretical and empirical standpoint, and BAS may be of more specific importance to bipolar disorder (Alloy & Abramson, 2010; Johnson, Edge, Holmes, & Carver, 2012). For this reason, the present project has maintained focus on trait BAS, whilst trait BIS has been included as a necessary construct in the RST framework. Trait BAS and the research linking it to bipolar disorder inform specific predictions and design choices, whilst the role of trait BIS was examined as a secondary concern and in a more exploratory manner.

4.3. Empirical Exploration of the BAS Theory of Bipolar Disorder

4.3.1. Investigations using clinical groups and vulnerability samples. A subset of the literature investigating the role of BAS in bipolar disorder has conducted analyses using either individuals diagnosed with bipolar disorder or individuals screened and grouped on the basis of vulnerability to bipolar disorder. One prominent series of studies has used a behavioural high-risk design, wherein
participants were selected based on BAS sensitivity and then assessed for manifestations of bipolar disorder phenomenology, or vice versa (Alloy et al., 2006; Alloy et al., 2008; Alloy, Bender, et al., 2012). This approach allows retrospective, concurrent, or prospective longitudinal assessment of whether high trait BAS constitutes a predisposition towards developing bipolar disorder (Alloy et al., 2006). Studies examining diagnosed patients or vulnerability groups are summarised overleaf in Table 4.1.

As summarised in Table 4.1, longitudinal studies using categorical vulnerability groups have generally found support for the role of BAS in bipolar disorder (Alloy et al., 2008; Alloy et al., 2006; Alloy, Urošević, et al., 2012). This is true whether trait BAS is used as a starting point or if trait bipolar disorder vulnerability is used for large-scale screening and diagnosis (Alloy, Bender, et al., 2012). High trait BAS is predictive of higher mania-proneness (Alloy et al., 2006), closer onset of both hypomanic and depressive episodes (Alloy et al., 2008), higher likelihood of manic or hypomanic episode relapse (Salavert et al., 2007), and progression to more severe subtypes of bipolar disorder (Alloy, Urošević, et al., 2012).

Relatively little research has investigated the BAS theory of bipolar disorder using a purely correlational design, with bipolar disorder vulnerability operationalised as a continuous variable. In a large non-clinical sample ($N = 394$), Carver and Johnson (2009) found that hypomanic personality traits were related to all three factors of trait BAS, in addition to the affective intensity of both positive and negative emotions, and positive generalisation. In contrast, depression proneness was related to trait BIS, intensity of negative emotion, and negative overgeneralisation (Carver & Johnson, 2009).

The findings in Table 4.1 do not support a link between BAS and depression in the context of bipolar disorder. Although one study identified an effect of BAS-RR, it was suggested that this occurred due to the consistent overlap between BAS-RR and trait BIS (Alloy et al., 2008). This is problematic to a BAS theory of BD that views abnormalities in BAS functioning as important to both mania and depression. However, the lack of support for a link between BAS and bipolar depression does not necessarily invalidate the BAS theory of bipolar disorder, but instead supports a stronger link between BAS and the manic component of bipolar disorder (Johnson,
Edge, et al., 2012). For this reason, hypothesis-testing throughout the present study was framed around mania-proneness, with depression-proneness.

Although trait BIS is associated with depressive symptoms (Carver & Johnson, 2009), bipolar spectrum disorder groups and controls do not appear to differ in terms of trait BIS (Alloy et al., 2008). However, interaction between trait BAS and trait BIS does predict progression to BD-I, suggesting that higher levels of both RST traits constitute an enhanced risk factor for bipolar disorder (Alloy, Urošević, et al., 2012).
<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Description</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carver &amp; Johnson, 2009</td>
<td>394 students</td>
<td>Correlation and multiple regression on large questionnaire battery</td>
<td>Hypomanic personality symptoms related to BAS-D, BAS-FS, and BAS-RR; depressive symptoms related to trait BIS</td>
</tr>
<tr>
<td>Alloy et al., 2006</td>
<td>28 high trait BAS and 24 moderate trait BAS students</td>
<td>Retrospective design using mean comparison and regression on GBI and BBS data</td>
<td>High trait BAS group higher in mania-proneness; trait BAS marginal predictor of mania-proneness</td>
</tr>
<tr>
<td>Alloy et al., 2008</td>
<td>136 patients and 157 low vulnerability participants</td>
<td>Prospective design using mean comparison and regression on GBI and BBS data over 33-month follow-up</td>
<td>Trait BAS higher in patient group; trait BAS (especially BAS-RR) predicted closer onset of hypomanic episode; BAS-RR predicted closer onset of depressive episode</td>
</tr>
<tr>
<td>Alloy, Bender, et al., 2012</td>
<td>171 high trait BAS and 119 moderate trait BAS adolescents</td>
<td>Prospective mean comparison and logistic regression over average 18-month follow-up</td>
<td>High trait BAS individuals were significantly more likely to develop a bipolar spectrum disorder; ambitious goal-setting also predictive of bipolar spectrum disorder onset</td>
</tr>
<tr>
<td>Alloy, Urošević, et al., 2012</td>
<td>206 patients and 208 low vulnerability participants</td>
<td>Prospective mean comparison and logistic regression over average 54-month follow-up</td>
<td>Trait BAS significantly predictive of progression to BD-I diagnosis; 42.1% of 57 participants with cyclothymic temperament or subsyndromal symptoms progressed to BD-II; 10.5% progressed to BD-I</td>
</tr>
<tr>
<td>Meyer, Johnson, &amp; Carver, 1999</td>
<td>357 students</td>
<td>Concurrent mean comparison and regression on GBI and BBS data</td>
<td>BAS-FS predicts manic symptoms; BAS-RR and BIS predict depressive symptoms; no effect of BAS-D</td>
</tr>
<tr>
<td>Salavert et al., 2007</td>
<td>22 relapsed manic patients and 17 non-relapsed patients</td>
<td>Trait assessment via SPSRQ and mean comparisons after 18-month follow-up</td>
<td>Patients relapsing into mania or hypomania higher in trait BAS</td>
</tr>
<tr>
<td>Van der Gucht, Morriss, Lancaster, Kinderman, &amp; Bentall, 2009</td>
<td>34 manic, 30 depressive, and 43 euthymic patients, with 41 controls</td>
<td>Mean comparisons between groups and trait correlations with symptoms</td>
<td>BAS-FS elevated in mania; BAS-D was elevated in mania but also in controls; BIS elevated in the depression and euthymia; trait BAS correlated with manic symptoms</td>
</tr>
</tbody>
</table>

*Note.* “Patients” refers to individuals diagnosed with a bipolar spectrum disorder either prior to participation or following screening.
4.3.2. BAS-relevant life events moderate the course of bipolar disorder.

The BAS theory of bipolar disorder is also supported by investigations of life events as moderating the course of diagnosed bipolar disorder. (Johnson & Roberts, 1995). Exacerbation of bipolar disorder based on psychosocial stressors has been identified since early research into the disorder (Cohen, Baker, Cohen, Fromm-Reichmann, & Weigert, 1954; Ellicott, Hammen, Gitlin, Brown, & Jamison, 1990; Johnson & Miller, 1997) and reward-seeking behaviours and goal attainment experiences are suggested to be an important component of individual patient phenomenology (e.g., Mansell & Lam, 2003). Hence, the BAS theory of bipolar disorder predicts that life events and ambitions that result in elevated BAS activation are likely to be observed more frequently in bipolar disorder (Johnson & Carver, 2006; Johnson, Edge, et al., 2012). Research focusing on ambitious goal-setting and on life events involving achievement and goal attainment is summarised in Table 4.2.

A common finding across the studies summarised in Table 4.2 is that life events related to BAS activation or pursuit of goals are associated with increased symptoms of mania (Johnson et al., 2000; Urošević et al., 2010), and endorsement of unrealistic goals is associated with hypomanic symptoms (Johnson & Carver, 2006). This association was demonstrated at a state level by Nusslock, Abramson, Harmon-Jones, Alloy, and Hogan (2007), who found that increased hypomanic symptoms were experienced by individuals high in trait bipolar disorder vulnerability taking a university exam. The association between bipolar disorder and life events appears to be specific to BAS-relevant events (e.g., obtaining entry into a competitive graduate position) rather than positive experiences (e.g., receiving a tax refund) more generally (Johnson et al., 2000). Johnson et al. (2000) suggested that the mechanism underlying the association between BAS-relevant events and bipolar disorder could be primarily cognitive in nature, involving hypervigilance and motivational fixation towards goal-oriented aims.

It is noteworthy that across studies depressive symptoms are consistently unrelated to BAS-relevant life events and trait BAS (Johnson et al., 2000; Johnson & Carver, 2006; Johnson, Carver, & Gotlib, 2012; Nusslock, Abramson, Harmon-Jones, Alloy, & Hogan, 2007). As with the findings summarised in Section 4.3.1, this finding suggests that depressive symptomatology and vulnerability are not as
strongly associated with BAS as manic symptomatology and vulnerability appear to be.

The Willingly Approached Set of Statistically Unlikely Pursuits (WASSUP) scale has been used to examine ambitious goal-setting in the context of bipolar disorder (Johnson & Carver, 2006; Johnson, Carver, & Gotlib, 2012). Across studies, popular fame and financial success appear to be most characteristic of bipolar disorder vulnerability or diagnosis. Johnson and Carver (2006) viewed this as indicating that incentive pursuit in bipolar disorder is based most strongly upon extrinsic goals. In the sample studied by Johnson, Carver, & Gotlib (2012) neither number of depressive or manic episodes nor number of hospitalisations for depression or mania were significantly correlated with WASSUP goals cross-sectionally, although WASSUP data was predictive of increased manic symptoms over time.

Urošević et al. (2010) tested the hypothesis that individuals higher in bipolar disorder vulnerability are not only more reactive to emotionally-significant life events (see Urošević et al., 2008, for a review), but actually experience a higher frequency of these events. Using a questionnaire measure and semi-structured interview, life events were rated as either predominantly BAS-activating (involving a striving process and opportunity for reward), BAS-deactivating (involving cessation of approach and obstructed opportunity for reward), or goal-attaining (involving successful attainment of the desired reward). Individuals high in bipolar disorder vulnerability experienced a greater frequency of BAS-activating and BAS-deactivating life events, but not events involving goal attainment, over a six-month period (Urošević et al., 2010). Interestingly, at-risk individuals who progressed to experiencing clinically significant hypomanic or depressive episodes did not differ in their frequency of BAS-activating and BAS-deactivating events from those who did not. This independence from clinical state suggests that BAS is related to bipolar disorder on a consistent basis (Urošević et al., 2010).
<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson et al., 2000</td>
<td>43 outpatients</td>
<td>Correlations conducted using researcher administered measures over two-year time period</td>
<td>Life events involving goal attainment associated with increased manic symptoms</td>
</tr>
<tr>
<td>Johnson &amp; Carver, 2006</td>
<td>1,259 students</td>
<td>Correlations between self-reported RST traits, bipolar disorder symptoms, and WASSUP responses</td>
<td>Trait BAS and trait BIS associated with hypomanic symptoms; external goals such as financial success and popular fame associated with hypomanic symptoms</td>
</tr>
<tr>
<td>Johnson, Carver, &amp; Gotlib, 2012</td>
<td>90 patients and 80 controls</td>
<td>Mean comparison and prospective prediction of symptoms at three-month follow-up</td>
<td>Patients higher than controls in ambition for popular fame but lower in idealised relationships with friends and family; ambitions for popular fame and financial success predict increased manic symptoms</td>
</tr>
<tr>
<td>Nusslock, Abramson, Harmon-Jones, Alloy, &amp; Hogan, 2007</td>
<td>45 high vulnerability students with an impending exam and 23 without</td>
<td>Prospective study screening students for bipolar disorder symptoms and investigating reaction to university exams; analysis conducted using logistic regression</td>
<td>Examination group exhibited noticeably higher rates of hypomania symptoms, moderated by trait BAS</td>
</tr>
<tr>
<td>Wright, Lam, &amp; Brown, 2008</td>
<td>40 patients and 40 controls</td>
<td>Daily diary of experiences completed over 28-day period</td>
<td>Mania associated with prolonged activation following reward; mania and depression associated with slower recovery from frustration</td>
</tr>
<tr>
<td>Urošević et al., 2010</td>
<td>55 high vulnerability and 60 low vulnerability students</td>
<td>BAS-activating, BAS-deactivating, and goal attainment experiences rated and compared via hierarchical regression</td>
<td>High vulnerability group experienced a greater frequency of BAS-activating and BAS-deactivating life events, but not events involving goal attainment over a six-month period</td>
</tr>
</tbody>
</table>

*Note: The terms patients, outpatients, and vulnerability are used here in specific relation to bipolar disorder.*
4.3.3. Cognitive styles linking BAS to bipolar disorder. BAS may influence behaviour in bipolar disorder via cognitive style (Alloy, Abramson, et al., 2009). Cognitive style refers to general patterns of thought that can influence perception of the world and methods of coping with stress (Alloy, Abramson, et al., 2009). Maladaptive cognitive styles can influence the development and maintenance of psychopathology, and may arise from underlying motivational systems such as BAS (Stange, Shapero, et al., 2013). BAS-relevant cognitive styles include those which are conceptually or functionally related to approach motivation or sensitivity to reward, both key elements of BAS (Alloy, Abramson, et al., 2009; Edge, Miller, et al., 2013). These include performance evaluation/perfectionism, autonomy, self-criticism, positive self-appraisal, positive overgeneralisation, and mental rumination over positive events (Alloy, Abramson, et al., 2009; Edge, Miller, et al., 2013). Table 4.3 summarises research that has examined cognitive styles in the context of BAS and bipolar disorder.

The research summarised in Table 4.3 supports a link between trait BAS, BAS-relevant cognitive styles, and hypomanic symptoms, with only Jones, Sham, and Liversidge (2007) finding contrary results. BAS-relevant cognitive styles that have been found to be characteristic of bipolar disorder include perfectionism, autonomy, self-criticism, sociotropy, dependency, and need for approval by others (Alloy, Abramson, et al., 2009). BAS-relevant cognitive styles potentially mediate the relationship between trait BAS and symptoms of bipolar disorder (Alloy, Abramson, et al., 2009; Stange, Shapero et al., 2013), although the effect of cognitive style may vary at different levels of trait BAS (Stange et al., 2012; Stange, Boccia, et al., 2013). Data from Stange, Boccia, et al. (2013) also suggested that the effect of cognitive styles on depressive symptoms is more prominent amongst individuals high in trait BAS. Overall, the cognitive style literature is consistent with a role for BAS in bipolar disorder.
### Table 4.3

**Key Studies Examining BAS-Relevant Cognitive Styles in Bipolar Disorder**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones, Shams, &amp; Liversidge, 2007</td>
<td>1,173 participants</td>
<td>Bivariate correlations and multiple regression</td>
<td>Approach goals, BAS-D, and BAS-FS associated with hypomanic temperament, but no association with cognitive style</td>
</tr>
<tr>
<td>Jones &amp; Day, 2008</td>
<td>402 students</td>
<td>Bivariate correlations and multiple regression on self-report data</td>
<td>Higher positive self-appraisal, increased BAS-FS, and decreased trait BIS related to hypomania-proneness; higher negative self-appraisal and decreased BAS-RR associated with depressed mood</td>
</tr>
<tr>
<td>Alloy, Abramson, et al., 2009</td>
<td>195 patients and 194 controls</td>
<td>Self-report and symptom scale correlations and regression analyses with three-year follow-up</td>
<td>Patients higher on performance evaluation, autonomy, and self-criticism; all three predictive of hypomanic and depressive symptoms over three-year follow-up; autonomy mediates link between trait BAS and hypomania</td>
</tr>
<tr>
<td>Stange et al., 2012</td>
<td>99 high trait BAS and 75 moderate trait BAS participants</td>
<td>Self-report and symptom scale correlations and hierarchical regression analyses with seven-month follow-up</td>
<td>Positive overgeneralisation and trait BAS predict increased hypomania symptoms at follow-up; effect of positive generalisation only pronounced in high trait BAS group</td>
</tr>
<tr>
<td>Stange, Shapero et al., 2013</td>
<td>171 high trait BAS and 119 moderate trait BAS participants</td>
<td>Comparison of trait BAS groups in terms of self-report and symptom measures using means comparisons and logistic regression</td>
<td>The high trait BAS group exhibited higher goal-striving, positive overgeneralisation, depressive brooding, rumination in response to positive affect, perfectionism, and hypomania proneness, with a subset of these cognitive styles mediating the relationship between trait BAS and hypomania symptoms</td>
</tr>
<tr>
<td>Stange, Boccia, et al., 2013</td>
<td>98 high trait BAS and 63 moderate trait BAS participants</td>
<td>Trait and depressive symptom questionnaires only, analysed via regression</td>
<td>Lower emotional clarity, higher ruminative brooding, and the presence of dysfunctional attitudes regarding others’ expectations of performance exacerbate depressive symptoms, with effect of dysfunctional attitudes more pronounced for high trait BAS group</td>
</tr>
<tr>
<td>Edge, Miller, et al., 2013</td>
<td>90 patients and 72 controls</td>
<td>Comparison of mean data from self-report measures</td>
<td>Patients consciously dampen their experience of positive emotion and intentionally avoid positive experiences</td>
</tr>
</tbody>
</table>

*Note.* Patients = individuals diagnosed with bipolar disorder, controls = non-psychiatric comparison samples, participants = non-clinical adults, students = university students.
4.3.4. Summary of research linking BAS to bipolar disorder. Individuals higher in trait BAS tend to be higher in trait mania-proneness and trait BAS is associated with closer onset of hypomanic symptoms (Alloy et al., 2008). BAS-activating life events are experienced more regularly by individuals with bipolar disorder (Urošević et al., 2010), and the experience of hypomanic symptoms during stressful life events is moderated by trait BAS (Nusslock et al., 2007), with individuals with bipolar disorder experiencing heightened reactivity to BAS-activating events (Wright, Lam, & Brown, 2008). The link between trait BAS and bipolar disorder has also been shown by investigations into cognitive style (Alloy, Abramson, et al., 2009). Findings linking mania-proneness to BAS are consistent and moderate in effect size, although relatively little literature has focused on linking bipolar disorder vulnerability viewed as a continuous trait with trait BAS. The BAS theory of bipolar disorder suggests that depression in bipolar disorder may occur as a function of BAS disengagement, however few studies have found evidence linking trait BAS to depression (e.g., Stange, Boccia, et al., 2013). The following sections extend coverage of evidence linking BAS to bipolar disorder by focusing on research using risky decision-making tasks.

4.4. Assessing the BAS Theory of Bipolar Disorder using Risky Decision-Making Tasks

Trait bipolar disorder vulnerability as measured by the GBI has not yet been examined using the risky decision-making tasks described in Chapter 3. However, as argued in Chapter 3, it is plausible that risky decision-making is associated with trait bipolar disorder vulnerability, and that this association captures an aspect of psychopathology of specific importance to bipolar disorder. The following sections review BART, GDT, IGT, and WCST research investigating bipolar disorder at a clinical level, as similar findings may also be present at a vulnerability trait level.

4.4.1. Research applying the BART to bipolar disorder. To date, only three studies have directly applied the BART to the study of bipolar disorder (Hidiroğlu et al., 2014; Holmes et al., 2009; Reddy et al., 2014). The strongest support for a link between BART AMP and trait bipolar disorder vulnerability was reported by Hidiroğlu et al. (2014). Hidiroğlu et al. administered the BART to a
sample of euthymic bipolar disorder patients \((n = 30)\), a group of their first-degree relatives \((n = 25)\), and matched non-psychiatric controls \((n = 30)\). Bipolar disorder patients and their relatives were found to engage in greater risky decision-making than the control group, although no significant difference was present within first-degree relatives. The similar results between patients and relatives suggest that BART risky decision-making is associated with vulnerability to bipolar disorder.

Holmes et al. (2009) did not find a strong association between bipolar disorder and BART AMP, in contrast to the findings of Hidiroğlu et al. (2014). Holmes et al. (2009) compared a sample of individuals diagnosed with bipolar disorder, who either did \((n = 31)\) or did not \((n = 24)\) have a past history of alcohol abuse. A non-psychiatric comparison group \((n = 25)\) was also included. No significant group differences in AMP were found. However, individuals with bipolar disorder and a history of alcohol dependence burst significantly more balloons than the other groups. Multivariate analysis of variance (MANOVA) showed that whilst the control group and the bipolar disorder group without a history of alcohol dependence would pump the BART balloon less during a trial that had been preceded by a popped balloon, the bipolar disorder group with a history of alcohol dependence tended to make a similar number of pumps regardless of whether the previous balloon had popped or not. Holmes et al. suggested that the failure of the bipolar disorder group with a comorbid history of alcohol dependence to learn from negative feedback may be due to an impaired perception of risk, leading to the repetition of unrewarded risky behaviour. However, it should be noted that the key variable in this study was bipolar disorder diagnosis with history of alcohol use, rather than bipolar disorder diagnosis alone.

Finally, Reddy et al. (2014) did not find evidence linking BART AMP to bipolar disorder. Using a large sample of bipolar disorder patients \((n = 68)\), Reddy et al. found no significant difference in BART AMP compared to a non-psychiatric comparison group \((n = 36)\). However, patients with schizophrenia \((n = 38)\) were shown to be relatively risk averse, scoring lower BART AMP than either bipolar disorder patients or the non-psychiatric comparison group (Reddy et al., 2014).

**4.4.2. Research applying the GDT to bipolar disorder.** To date, no study has used the GDT to examine risky decision-making in bipolar disorder, whether as a clinical diagnosis or as trait bipolar disorder vulnerability. Study 2 of the present
project was the first study to use the GDT in an investigation of trait bipolar disorder vulnerability.

4.4.3. Research applying the IGT to bipolar disorder. Several studies have examined bipolar disorder using the IGT, although to date no study has applied the CS-IGT to the study of bipolar disorder. A recent meta-analysis by Edge, Johnson, et al. (2013) addressed whether risky decision-making on the IGT is elevated in bipolar disorder. Edge, Johnson, et al. included five studies in their meta-analysis, with the inclusion criterion being that the studies must have incorporated a non-psychiatric comparison group. Jogia, Dima, Kumari, and Frangou (2012), Yechiam, Hayden, Bodkins, O’Donnell, and Hetrick (2008), Martino, Strejilevich, Torralva, and Manes (2011) found no difference in IGT decision-making between patients with bipolar disorder and comparison participants. Malloy-Diniz et al. (2011) found that bipolar disorder patients with history of a suicide attempt \((n = 41)\) made riskier decisions on the IGT than bipolar patients with no history of suicide attempt \((n = 54)\), who in turn made riskier decisions than comparison participants \((n = 94)\). Adida et al. (2011) compared manic \((n = 45)\), depressed \((n = 32)\), and euthymic \((n = 90)\) bipolar disorder patients to age-, gender-, and intelligence-matched comparison participants \((n = 150)\), finding that risky decision-making was higher than that of comparison participants across all states of bipolar disorder. Aggregating these five studies, Edge, Johnson, et al. found an elevation in IGT risky decision-making in bipolar disorder that was small to medium in effect size \((\text{Hedges’ } g = .35)\), with marginal evidence of heterogeneity across studies. Follow-up data gathered by Edge, Johnson, et al. but not included in their meta-analysis did not show a significant difference between bipolar disorder patients \((n = 55)\) and non-psychiatric comparison participants \((n = 39)\) in terms of IGT decision-making.

Two studies that were not included in the meta-analysis of Edge, Johnson, et al. (2013) have found a link between elevated risky decision-making on the IGT and bipolar disorder. Clark, Iversen, and Goodwin (2001) administered the IGT to bipolar disorder patients and non-psychiatric comparison participants \((n = 30\) per group) as part of a broader neuropsychological battery, finding a significant difference in IGT decision-making between groups. Jollant et al. (2007) tested a broad sample of psychiatric patients \((N = 317)\) that included a subsample with bipolar disorder \((n = 66)\), and found that euthymic bipolar disorder was associated
with increased risky decision-making on the IGT. The modest link between bipolar disorder and elevated risky decision-making appears to hold in studies not included in the meta-analysis conducted by Edge, Johnson, et al.

**4.4.4. Research applying the WCST to bipolar disorder.** Unlike the BART, GDT, and IGT, the WCST does not assess risky decision-making. Instead, the WCST assesses set-shifting taking place in the absence of strong reward cues, such as a cumulative score and the use of money as a scoring metaphor. Therefore, the WCST assesses non-reward-laden, non-affective set-shifting that is mostly cognitive in nature. The WCST was included in the present project so that WCST set-shifting could be contrasted with set-shifting occurring in the reward-laden, affective-cognitive context of risky decision-making on the CS-IGT.

Set-shifting impairment on the WCST consistently characterises bipolar disorder across manic episodes, depressive episodes, and euthymia (Ryan et al., 2012; Stefanopoulou et al., 2009; Yatham et al., 2010). In a meta-analysis, Stefanopoulou et al. (2009) systematically reviewed literature reporting neurocognitive testing in mood disorders with the intent of comparing deficits characteristic of bipolar disorder \((n = 2,508)\), unipolar depression \((n = 197)\), and schizophrenia \((n = 1,067)\) to each other and to non-psychiatric comparison participants \((n = 992)\). Stefanopoulou et al. found that the number of WCST categories achieved was impaired relative to non-psychiatric comparison participants in bipolar disorder, albeit not to the same extent as in schizophrenia. Perseverative errors were impaired equally across bipolar disorder and schizophrenia. Ryan et al. (2012) incorporated the WCST into a study comparing bipolar disorder patients in euthymic \((n = 117)\), depressive \((n = 73)\), and hypomaniac, manic, or mixed \((n = 26)\) stages of illness to a control group \((n = 57)\). Factor scores were aggregated from the outcomes of several neuropsychological tasks in order to analyse cognitive impairment across state. Correct WCST trials and perseverative errors were both grouped under a factor labelled conceptual reasoning and set-shifting. All bipolar disorder groups performed more poorly than controls on the conceptual reasoning and set-shifting factor.

It can be argued that the set-shifting impairment seen in bipolar disorder is a general characteristic of clinical psychopathology, rather than a specific impairment that is also likely to be observable as an indicator of trait bipolar disorder.
vulnerability (Fleck, Shear, Madore, & Strakowski, 2008; Stordal et al., 2005). At a clinical level, set-shifting impairment is not unique to bipolar disorder, with patients diagnosed with schizophrenia consistently exhibiting similar or more severe set-shifting deficits (Rempfer, Hamera, Brown, & Bothwell, 2006; Stefanopoulou et al., 2009; Yatham et al., 2010). Stordal et al. (2005) found that cognitive functioning deficits inclusive of set-shifting impairment were better explained by level of psychopathology than by categorical diagnosis in patients diagnosed with either unipolar depression \( (n = 43) \) or schizophrenia \( (n = 47) \). Smitherman, Huerkamp, Miller, Houle, and O’Jile (2007) examined archival data from various psychiatric patients \( (N = 86) \) and found that self-reported depression and anxiety symptoms were only minimally associated with WCST performance, with this effect decreasing markedly when age and intelligence were controlled for. Although Stordal et al. and Smitherman et al. did not study patients with bipolar disorder, Fleck, Shear, Madore, and Strakowski (2008) found that illness chronicity and clinical state to be modestly associated with set-shifting impairment in patients with bipolar disorder \( (N = 80) \). Taken together, these findings suggest that set-shifting impairment as measured by the WCST occurs across a range of psychological disorders. Hence, it is plausible that non-affective, non-reward-laden set-shifting impairment may occur as a sign of general level of psychopathology, rather than a specific indicator of vulnerability to bipolar disorder.

In contrast to the larger number of studies using the WCST to demonstrate impaired set-shifting across the phases of bipolar disorder, only one study to date has examined set-shifting as an indicator of vulnerability to bipolar disorder. In a 23-year prospective longitudinal study, Meyer et al. (2004) traced offspring of 121 parents with either bipolar disorder, unipolar depression, or no diagnosis. The data indicated that 67% of adolescents eventually diagnosed with bipolar disorder had shown impairment on the WCST in young adulthood, compared with 19% diagnosed with unipolar depression and 17% with no psychiatric diagnosis. However, the generalisability of Meyer et al.’s finding may be limited by the small size of their patient sample \( (n = 9) \), and hence it can still be argued that while a general set-shifting impairment is a characteristic of clinical bipolar disorder, it may not characterise trait vulnerability to bipolar disorder.
4.4.5. Summary of research linking risky decision-making and set-shifting to bipolar disorder. The data linking behavioural measures of risky decision-making to bipolar disorder are equivocal across tasks. This emphasises that how risky decision-making is operationalised will affect whether it is associated with bipolar disorder, and if so, what the strength of this association is. BART AMP may be associated with vulnerability to bipolar disorder (Hidiroğlu et al., 2014), although not all the data supports this finding (Reddy et al., 2014). The GDT has yet to be studied in the context of bipolar disorder. Risky decision-making measured by the IGT appears to be modestly associated with bipolar disorder at a clinical level (Edge, Johnson, et al., 2013). Although set-shifting impairment assessed using the WCST has been linked to bipolar disorder (Yatham et al., 2010), similar results have been found with regards to schizophrenia (Stefanopoulou et al., 2009), and hence it is possible that WCST set-shifting accompanies clinical impairment but is not an indicator of trait bipolar disorder vulnerability per se (Fleck, Shear, Madore, & Strakowski, 2008; Stordal et al., 2005). It is important to note that comparatively few studies using risky decision-making tasks focus specifically on assessing trait vulnerability to bipolar disorder, and neither the 7U7D nor the earlier GBI have been examined in the context of risky decision-making assessed using behavioural tasks.

4.5. Summary of Chapter 4

In summary, the evidence reviewed in Chapter 4 is strongly suggestive of a link between trait BAS and the susceptibility to or experience of mania (Alloy & Abramson, 2010). This evidence converges from a number of methodologies, including neuroimaging (Urošević et al., 2008), trait measurement (Carver & Johnson, 2009), prospective longitudinal studies (Alloy et al., 2008), analysis of life events (Johnson et al., 2000) and ambitious goal setting (Johnson & Carver, 2006), and characteristic patterns of cognition (Alloy, Abramson, et al., 2009). Across these lines of evidence, the dominant theme is that individuals higher in trait BAS are more likely to experience manic or hypomanic symptoms, whilst individuals more vulnerable to manic symptoms are more likely to be higher in trait BAS, and to experience a corresponding increase in BAS-relevant life events and the use of BAS-relevant patterns of cognition. Researching examining the role of BAS in bipolar disorder through risky decision-making has generated equivocal findings to date.
(e.g., Edge, Johnson, et al., 2013), however few of these studies have focused specifically on trait bipolar disorder vulnerability as a continuous variable. The present project was designed to address this gap in the literature.

The following chapter introduces state mood and its relevance to both bipolar disorder and BAS, and describes self-report measurement of state mood and experimental manipulation of state mood. This is an important consideration as state mood constitutes a potential source of variability that is not always assessed in experiments linking personality traits to behavioural task responses (Lauriola et al., 2014; Mischel & Shoda, 1995). Following this, the aims and hypotheses of the present project are outlined in Chapter 6.

5. The Importance of Mood State

5.1. Structure of Chapter 5

State mood refers to an individual’s transient emotional state (Watson & Tellegen, 1985), with abrupt and frequent changes in state mood being referred to as mood lability (Cassidy, Murray, Forest, & Carroll, 1998). State mood is an important phenomenon in bipolar disorder (Cassidy et al., 1998) and in RST (Carver, 2004). Monitoring of mood state is important at the level of specific behaviour, such as performance on the behavioural tasks described in Chapter 4. Hence, acknowledgment and measurement of mood is advantageous when investigating the BAS theory of bipolar disorder using behavioural tasks. Chapter 5 is divided into four sections, each clarifying an important aspect of state mood. Section 5.2 summarises the importance of state mood in bipolar disorder. Section 5.3 introduces Watson and Tellegen’s (1985) two-factor model of mood, encompassing positive affect (PA) and negative affect (NA). Section 5.4 outlines Carver’s (2004) model of the role of mood as a feedback system for BAS, BIS, and FFFS functionality, utilising research investigating links between anger and BAS (e.g., Carver & Harmon-Jones, 2009). Section 5.5 considers the methods available for experimentally manipulating mood, and reviews research that has used a false feedback mood induction paradigm to modulate state mood. Following Chapter 5, Chapter 6 introduces the design, aims, and hypotheses of the three studies that formed the present project.
5.2. Mood Lability as an Integral Aspect of Vulnerability to Bipolar Disorder

The concept of mood is integral to bipolar disorder. At a clinical level, bipolar disorder is classified as a mood disorder and characterised by episodic states of extreme mood symptoms (Alloy & Abramson, 2010; APA, 2013; Goodwin & Jamieson, 2007; Hofmann & Meyer, 2006). Mood lability in bipolar disorder is common during manic and mixed episodes (Cassidy et al., 1998), and also occurs during depressive episodes, although this finding may reflect mixed features (Benazzi 2004; Cassidy et al., 1998). Inter-episode mood lability is also common during euthymia (Benazzi, 2004; Malhi, Bargh, Coulston, Das, & Berk, 2013). The ability to regulate mood state is important to both bipolar disorder phenomenology and treatment (Edge, Miller, et al., 2013). Mood lability is also a prominent indicator of vulnerability to bipolar disorder, with a recent meta-analysis suggesting that mood lability is one of the most consistent predictors of a bipolar disorder diagnosis in prospective studies (Faedda et al., 2015). Mood lability may in part constitute a genetic vulnerability indicator in the offspring of individuals with bipolar disorder (Birmaher et al., 2013).

Although mood lability involves fluctuation in state mood, mood lability can also be examined on a trait basis (Akiskal et al., 2006). The trait predisposition towards mood lability has been referred to as cyclothymic temperament (Akiskal et al., 2006), and self-report instruments assessing cyclothymic temperament are commonly used to assess bipolar disorder vulnerability (Akiskal et al., 2006; DeGeorge, Walsh, Barrantes-Vidal, & Kwapis, 2014; Van Meter & Youngstrom, 2015). In measuring trait bipolar disorder vulnerability, the 7U7D can be conceptualised as capturing aspects of cyclothymic temperament (Depue et al., 1981; Youngstrom et al., 2013), although it does this by assessing mania-proneness and depression-proneness separately, with mood lability viewed as an aspect of mania-proneness (Depue et al., 1981; Youngstrom et al., 2013).

Because of the importance of mood lability to bipolar disorder (Cassidy et al., 1998), and because trait bipolar disorder vulnerability can be viewed as a predisposition towards mood lability (Akiskal et al., 2006; Faedda et al., 2015), it is useful to separately measure or manipulate state mood in studies of trait bipolar disorder vulnerability. This is especially true in a research context where an affective...
trait such as bipolar disorder vulnerability is being investigated with regards to specific situational demands, as occur during risky decision-making tasks (Lauriola et al., 2014; Mischel & Shoda, 1995), and where trait bipolar disorder vulnerability is being investigated in the context of RST, which also considers state mood (Carver & Scheier, 1990). State mood can be measured using self-report questionnaires (Watson, Clark, & Tellegen, 1988), and can be manipulated experimentally using mood induction procedures (Farmer et al., 2006). Both of these methods were utilised to assess state mood in the present project. The following section introduces a widely-used two-factor model of state mood (Watson & Tellegen, 1985), with subsequent sections discussing the role of state mood in RST (Carver & Scheier, 1990) and presenting a summary of mood induction procedures.

5.3. Mood as Positive Affect and Negative Affect

Watson and Tellegen’s (1985) influential two-factor PA/NA model of mood reconciles findings from a number of different studies of mood, affect, emotionality, and temperament. The two core factors presented in Watson and Tellegen’s model are PA and NA. At a conceptual level, these factors reflect separable mood constructs, although statistically they tend to be moderately negatively correlated (Tellegen, Watson, & Clark, 1999; Watson, Wiese, Vaidya, & Tellegen, 1999). Both factors are effectively unipolar, in that higher levels of each affective dimension reflect a more intense emotional state, whilst lower levels of each affective dimension reflect a less intense emotional state (Tellegen, Watson, & Clark, 1999; Watson, Wiese, Vaidya, & Tellegen, 1999). Positive affect is a state characterised by energy, activity, excitement, enthusiasm, and similar emotions. Lack of positive affect is characterised by feeling drowsy, dull, and fatigued. In contrast, negative affect is a state characterised by distress, fear, hostility, nervousness, and similar emotions. Lack of negative affect is characterised by feelings of calmness, restfulness, and relaxation (Tellegen, Watson, & Clark, 1999; Watson, Wiese, Vaidya, & Tellegen, 1999).

PA and NA have been argued to be the affective dimensions most basic to experience of mood and emotion (Watson et al., 1999). The existence of two basic affective dimensions is consistent across a variety of affect and personality models, and is represented at a personality trait level in the constructs of extraversion and
neuroticism, at a motivational level as approach motivation and avoidance motivation, and at a clinical level as mania and depression (Carver, 2004; Gable, Reis, & Elliot, 2000; Gray, 1972; Murray, Goldstone, & Cunningham, 2007; Watson et al., 1999). The PA/NA model is compatible with similar two-factor models of mood, such as the valence/arousal model (Russell, 1980; Watson et al., 1999). The PA/NA model is also compatible with more complex models of emotion, as more specific emotions can either be categorised as subordinate to PA and NA, or may reflect a combination of PA and NA (Watson, Clark, & Mineka, 1994).

The most commonly used measure of PA and NA is the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988; see Appendix 3). The PANAS is a brief self-report measure that consists of 20 emotional descriptors, 10 assessing PA and 10 assessing NA (Watson et al., 1988). The two-factor PA/NA model has been shown to be a useful conceptual framework that fits mood data across a wide range of studies (see Watson et al., 1999), whilst the PANAS has been extensively validated (Watson et al., 1988) and is frequently used.

5.4. Mood as a Feedback System in Reinforcement Sensitivity Theory

In discussing the evolutionary significance of PA and NA, Watson et al. (1999) viewed PA and NA as reflecting the emotional output of more basic motivational systems associated with approach and avoidance. In this sense, PA and NA can be seen as the affective concomitants of the BAS and BIS/FFFS systems within the RST framework (Gable et al., 2003; Watson et al., 1999). PA and NA are viewed as adaptive, as the desirable and hence reinforcing qualities of PA promote pursuit of goals, whilst the undesirable and hence punishing qualities of NA promote apprehension of threats (Corr, 2008; Watson et al., 1999). In this manner, experiences of positive mood have been conceptually associated with BAS and experiences of negative mood have been conceptually associated with BIS and FFFS (Corr, 2004).

The link between BAS and PA and BIS/FFFS and NA is supported by both neurophysiological and phenomenological data (Davidson, 1992; Gable, Reis, & Elliot, 2000). In electroencephalography research, increased relative left-frontal cortical activation has been associated with trait BAS and experience of positive emotion in the form of mania, whilst increased relative right frontal cortical
activation has been associated with trait BIS and the experience of negative emotion in the form of depression (Carver & Harmon-Jones, 2009; Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997). In phenomenological research, diary data collected by Gable, Reis, and Elliott (2000) has shown a link between BAS-relevant events and PA and BIS-relevant events and NA, and suggested that these phenomena fluctuate in tandem over time.

Despite their similarities, it is likely to be overly simplistic to view BAS and PA and BIS and NA as wholly interchangeable concepts, or exact motivational/emotional equivalents (Carver, 2004). Carver and Scheier (1990) proposed a control-process model of the function of affect within the motivational framework of RST (see Figure 5.1). In this model, affective processes are secondary to the BAS and BIS/FFFS systems, which are viewed as primary. Affectivity functions as feedback on the success with which the basic motivational systems are being engaged (Carver, 2004). A BAS process resulting in successful action (moving an individual towards a reward) should thereby result in increased PA, whereas a BAS process failing to achieve success (attempts to gain a reward that have been rendered improbable or impossible) would thereby result in decreased positive affect (Carver, 2004). The same mechanism can be applied to the avoidant motivation characteristic of BIS/FFFS, with successful withdrawal from a threatening situation resulting in positive affect but failure to remove oneself from threat resulting in negative affect (Carver & Scheier, 1990; Carver, 2004).
Figure 5.1. The control-process model of affect in the context of reinforcement sensitivity theory.

Figure 5.1 shows how affective experience can serve as a gauge of success for BAS, BIS, and FFFS engagement. For example, successful implementation of BAS in the form of achievement of a goal might be accompanied by feelings of elation, whilst unsuccessful implementation of BAS in the form of an obstruction to goal pursuit might be accompanied by feelings of sadness or anger (Carver, 2004). A similar principle applies to avoidance processes governed by BIS or FFFS, where anxiety or fear are likely to accompany an impending threat, whilst relief and calm would characterise averting a threatening situation (Carver, 2004). In this manner PA and NA are theoretically associated with both motivational systems, with the affective experience determined by the degree of success with which BAS, BIS, and FFFS are engaged (Carver, 2004).

The control-process model of affective functioning in RST has received consistent empirical support, primarily via studies that examine the occurrence of anger (see Carver & Harmon-Jones, 2009, for a comprehensive review). Anger is important as it is regarded as a negative emotion, and hence typically subsumed under NA, but one of its functions is to promote increased exertion and determination when progress towards a goal is at risk of being frustrated (Carver, 2004; Corr, 2008). Hence anger is a negative affect that under most circumstances should heighten BAS engagement (Carver & Harmon-Jones, 2009). The literature investigating BAS and anger has found associations present at cortical (Harmon-
Jones & Allen, 1998), situationally reactive (Carver, 2004), and mood state/personality trait (Carver, 2004) levels of analysis. Through the study of anger, a very strong level of support for the control-process model has been demonstrated (Carver & Harmon-Jones, 2009). This link between anger and positive affect also matches the phenomenology of bipolar disorder, where mania, a state associated with increased PA (Alloy & Abramson, 2010) can be characterised both by euphoria and by irritability (APA, 2013).

In summary, the control-process model appears to be a useful addendum for describing the role of affect in RST. The control-process model does not invalidate Watson and Tellegen’s (1985) PA/NA model, but it does suggest that additional complexities need to be acknowledged when applying the constructs of PA and NA to the RST framework. The control-process model also underscores the importance of considering the different types of affect that occur subordinate to the broader PA and NA structure, and considering the situations that can elicit PA and NA (Carver & Harmon-Jones, 2009). The model also emphasises the importance of examining or attempting to control for self-reported PA and NA during investigations focusing on trait BAS and trait BIS rather than simply assuming a correspondence between these variables.

5.5. False Feedback Mood Induction

5.5.1. Types of mood induction procedure considered for the present study. The best practice method of experimentally manipulating state affect is to administer a mood induction procedure (Westermann, Spies, Stahl, & Hesse, 1996). This umbrella term refers to any sort of experimental protocol that is intended to alter the mood of a participant (Martin, 1990). Administering a mood induction prior to participation in a behavioural task ensures a standardised pre-task context and promotes a similar mood state across participants (Martin, 1990; Westermann et al., 1996). Common mood induction procedures include (i) the International Affective Picture Schedule (IAPS; Lang, Bradley, & Cuthbert, 2008), a slideshow of emotionally evocative photographs; (ii) reflective focusing on self-referent memories, such as past experiences of great happiness or great sadness (Clark, 1983); (iii) the use of emotionally poignant or transcendent video or audio clips from popular film and music (Clark, 1983); and (iv) the implementation of false feedback
during or following a goal-directed task (Farmer et al., 2006; Roiser et al., 2009). The procedure most relevant for the present study was a false feedback mood induction (Farmer et al., 2006; Roiser et al., 2009). However, before introducing research utilising the false feedback mood induction technique, it is important to review the limitations of alternative mood induction techniques in the context of the present study.

Mood induction procedures involving emotive imagery, self-referent memories, or audio-visual clips were all judged to be inappropriate for the present study for a number of reasons. Firstly, there is no one assembled and validated set of IAPS photographs. Different studies have utilised different sets of pictures (e.g., Bradley, Hamby, Löw, & Lang, 2007), and many of the positively-valenced images are pornographic in content, which may cause ethical concerns and prevent participants from engaging in the research process (Sugimoto, Nittono, & Hori, 2007). Secondly, self-referent memories are individually subjective by definition, and therefore depend on the participant’s past experience. There is a possibility that participants could be re-traumatised should they focus on traumatic memories, raising ethical concerns (Van der Kolk, 2007). Thirdly, the use of popular music and film does not control for past experience and corresponding sensitisation or desensitisation to emotional music or film scenes. These stimuli might not be equally emotionally salient to all participants, as participant music and film preferences may differ. Finally, all of these techniques are procedurally jarring when inserted into a behavioural task research protocol, as the participant is performing one action (e.g., watching a slideshow of photographs) and then performing a very different action (e.g., completing a risky decision-making task).

5.5.2. The false feedback mood induction protocol. In contrast to the above procedures, a false feedback mood induction holds a number of advantages for inducing mood within a behavioural task protocol. False feedback mood induction is based on the assumption that participants are likely to experience (a) an increase in positive mood in response to feedback that their task performance is highly competent or better than expected; and (b) an increase in negative mood in response to feedback that their task performance is lacking in competence or poorer than expected (Farmer et al., 2006; Roiser et al., 2009). False feedback mood induction procedures are well suited to behavioural task paradigms, because as the feedback is
administered following a behavioural task the participant remains immersed in the experimental design. Arguably, false feedback mood induction procedures are especially appropriate for RST research, because the manipulation of feedback and performance expectations emphasises goal attainment and is consistent with Carver’s (2004) model of affect as a feedback system for BAS, BIS, and FFFS.

False feedback during a behavioural task has been used to investigate mood state in diagnosed bipolar disorder samples (Farmer et al., 2006; Roiser et al., 2009). Farmer et al. (2006) administered a false positive feedback mood induction to a sample of euthymic patients diagnosed with bipolar disorder (n = 15) and non-psychiatric controls (n = 19). The participants completed a two-minute behavioural task, after which they were told that their performance was “very fast” and that their accuracy was 70%, regardless of actual performance. Following this, participants completed the two-minute task once more, this time receiving 10 pence per button pressed correctly. This positive mood induction was accompanied by an increase to ratings of bidirectional mood on a scale from 0 (Sad) to 100 (Happy). This increase remained elevated in the patient sample, whilst happiness began to return to pre-elevated levels in the control sample. Roiser et al. (2009) repeated the false feedback procedure in a different sample (bipolar disorder n = 15, control n = 19), obtaining similar results to Farmer et al. Neither Farmer et al. nor Roiser et al. observed any effect of their mood induction procedure across a selection of affective reaction time tasks. However, these studies demonstrate that false feedback is capable of influencing mood both in patients with bipolar disorder and non-psychiatric comparison participants, although the procedure has yet to be used in the context of trait bipolar disorder vulnerability.

In applying the false feedback mood induction procedure to trait bipolar disorder vulnerability, the present project sought to remediate several limitations present in the studies of Farmer et al. (2006) and Roiser et al. (2009). Firstly, the sample size was low in both studies, which may have impaired statistical power. Secondly, self-report validation of the mood induction was primarily reliant on simple bidirectional scaling rather than being framed within a more established model of mood state. PA and NA were considered by Farmer et al. (2006), however this yielded the somewhat incongruent finding that the positive false feedback actually diminished negative affect rather than increasing positive affect. Roiser et
al. (2009) did not attempt to replicate or investigate this finding further. Thirdly, only one valence of induction was attempted, with the effect of negative false feedback left untested, although the logic of the task suggests that false negative feedback would induce a negative mood. Finally, a repeated measures design was not implemented, so it could not be determined (i) whether participant performance differed from performance under pre-existing, non-induced mood, and (ii) whether the lack of difference on affective response tasks between patients and controls was present in the sample prior to the false feedback. Testing under baseline conditions would ideally consist of a neutral, or placebo, mood induction consisting of intermediate false feedback that is not particularly emotionally salient towards either valence. These are limitations that the present project sought to address.

5.6. Summary of Chapter 5

State mood is commonly measured as PA and NA using the self-report PANAS (Tellegen, Watson, & Clark, 1999), and is an important variable to consider in relation to trait bipolar disorder vulnerability, trait BAS, and risky decision-making. This is because (i) trait and state mood lability are fundamentally characteristic of bipolar disorder (Faedda et al., 2015); (ii) the control-process model postulates that state mood acts as a feedback system for the effectiveness at which behaviours arising from BAS and BIS are being successfully pursued (Carver, 2004); and (iii) state variables may be useful in linking general traits to situationally specific behaviours, such as those that occur on risky decision-making tasks (Lauriola et al., 2014; Mischel & Shoda, 1995). One method of experimentally manipulating state mood is to use a false feedback mood induction (Farmer et al., 2006), whereby positive feedback is expected to elicit a positive mood state, whilst negative feedback is expected to elicit a negative mood state. The present project examined state mood statistically using the PANAS and experimentally using a false feedback mood induction procedure.
6. The Present Project

6.1. Overarching Aim and Structure of the Present Project

Bipolar disorder is a serious mental disorder which remains poorly understood despite decades of research. One approach, termed here the BAS theory of bipolar disorder, is theoretically plausible and generative, and has received a broad range of empirical support. Although the BAS construct has a strong behavioural focus, there has been no systematic investigation of the relationship between trait vulnerability to bipolar disorder, BAS, and commonly used risky decision-making tasks, which arguably measure important features of BAS activation that align with the symptoms of bipolar disorder. The overarching aim of the present project was to investigate the proposed association between trait vulnerability to bipolar disorder and BAS (see Figure 6.1).

Three empirical studies were conducted to meet this broad aim. The primary aim of Study 1 was to evaluate the relationship between trait bipolar disorder vulnerability and trait BAS using cross-sectional self-report methodology. The primary aim of Study 2 was to evaluate the relationship between trait bipolar disorder vulnerability and risky decision-making in the form of behavioural task responses. Finally, the primary aim of Study 3 was to experimentally monitor the potential effect of state mood on risky decision-making responses, and to test whether this effect was modulated by trait bipolar disorder vulnerability. These specific study aims supported the overarching aim by establishing a relationship between trait bipolar disorder vulnerability and BAS at both trait level and behavioural level, whilst testing whether these relationships vary based on state mood. In turn, this will expand understanding of the BAS theory of bipolar disorder by providing evidence of whether non-clinical findings are continuous with previous clinical evidence (see Chapter 4).
Figure 6.1. Concepts and variables of the present project.
As the concept map in Figure 6.1 shows, vulnerability to bipolar disorder was operationalised as mania-proneness and depression-proneness scores derived from the 7U7D, whilst trait BAS was operationalised as BAS-D, BAS-FS, and BAS-RR scores derived from the BBS. The BBS was also used to measure trait BIS. Study 1 examined the psychometric properties of and correlations between these variables.

Of the two 7U7D variables, mania-proneness was of primary interest in the present project, as less evidence for a link between BAS and depression has been found (see Section 4.3.1) and it is vulnerability to mania that defines bipolar disorder as distinct from unipolar depression (APA, 2013; Depue et al., 1981). Of the three BBS trait BAS variables, BAS-D was selected as the key variable of interest in the present project (see Section 2.7.4). BAS-D was prioritised for three reasons. Firstly, because its item content assesses pursuit of rewarding stimuli, BAS-D most closely resembles the trait outcomes of BAS described by RST (Corr, 2008). Secondly, BAS-FS has been consistently found to overlap with impulsivity more generally (Smillie, Pickering, & Jackson, 2006). Thirdly, BAS-RR has been consistently found to share variance with trait BIS (Alloy et al., 2006). This overlap with other closely related constructs arguably makes BAS-FS and BAS-RR less suitable as primary operationalisations of trait BAS (Alloy et al., 2006; Smillie, Pickering, & Jackson, 2006). Although of less interest here, depression-proneness, BAS-FS, BAS-RR, and trait BIS were still included in analyses, due to their importance in the theoretical models from which mania-proneness and BAS-D derive from.

Risky decision-making was examined as a putative behavioural manifestation of BAS (see Section 3.2.2). The differing task demands and environments across behavioural tasks provided three different operationalisations of risky decision-making for Study 2, using metrics drawn from the BART, GDT, and CS-IGT. BART AMP provided a measure of risky decision-making within a dynamic context of escalating risk. Advantageous decisions minus disadvantageous decisions on the GDT provided a measure of risky decision-making within an explicit context of static probabilities of reward. Finally, advantageous selections minus disadvantageous selections on trials 81 through 100 of the CS-IGT provided a measure of risky decision-making in an implicit context. As they occur prior to any rule shifts, performance on these trials is directly comparable to those of the standard, unmodified IGT. The PANAS was used to examine the influence of state
mood upon behavioural task responses. Study 2 examined whether the proposed relationship between trait BAS and these risky decision-making metrics was mediated by trait bipolar disorder vulnerability, and simultaneously explored the assumption that risky decision-making would be associated with trait BAS.

Set-shifting in the context of risky decision-making was also examined in Study 2. Risky decision-making tasks are reward-laden, because the task environment is designed to emphasise reward-based cues. Set-shifting was a useful ability to examine because it can be compared across reward-laden and non-reward-laden contexts. If set-shifting were impaired in a reward-laden context but not in a non-reward-laden context, then this would provide evidence to support the specific importance of BAS and BAS-relevant behavioural task responses in trait bipolar disorder vulnerability. In contrast, if set-shifting were impaired across reward-laden and non-reward-laden contexts, then this might suggest that an association between elevated risky decision-making and trait bipolar disorder vulnerability is a sign of more general deficits in decision-making flexibility. Reward-laden set-shifting was assessed by examining the difference in CS-IGT selections between 20-trial blocks, focusing especially on blocks following shifts in deck rules during the final 120 trials of the CS-IGT. Non-reward-laden set-shifting was assessed by examining total error percentage and perseverative error percentage on the WCST.

Finally, it was important to address the possibility that performance on behavioural task measures was biased by uncontrolled state mood effects (see Section 5.2). Study 3 assessed the effect of positive and negative false feedback mood induction procedures on BART AMP. This provided a direct empirical gauge of the effect of state mood on risky decision-making, as opposed to the statistical examination of state mood afforded by the PANAS. Administration of a false feedback mood induction also enabled exploration of whether trait bipolar disorder vulnerability or trait BAS rendered participants more reactive to the false task feedback. Study 3 also administered the PANAS in order to validate the false feedback mood induction procedure in the context of Watson and Tellegen’s (1985) two-factor model of mood.

In summary, the present project comprised three studies conducted with the overarching aim of investigating the link between BAS and trait bipolar disorder vulnerability, with risky decision-making examined as a putative behavioural
manifestation of BAS. The trait variables of interest were mania-proneness and trait BAS, whilst risky decision-making was assessed using BART AMP, GDT selections, and CS-IGT selections. Due to the novelty of applying a vulnerability trait approach to a multi-method appraisal of the BAS theory of bipolar disorder, scales and tasks were not designed exclusively for the present project, but were instead selected from pre-existing literature. Specific hypotheses were set based on the theory and relevant previous research reviewed above, but given the novelty of the project and the investment in complex behavioural task designs, exploratory analyses of all 7Up7Down and BBS variables as predictors were also conducted. Three studies were conducted to assess the link between mania-proneness and trait BAS at the level of trait correlations, risky decision-making responses and set-shifting, and in the context of reaction to false task feedback. These studies are reported below, with specific aims and hypotheses provided in Section 7.2, Section 8.2, and Section 9.2.

7. Study 1

7.1. Structure of Chapter 7
Chapter 7 presents the aims and hypotheses of Study 1, a description of methodology, the results, and a brief review of findings. Within the method section, participant characteristics, materials used, the data collection procedure, and the process used to analyse the data are described. Within the results section, EFA, CFA, descriptive statistics, and bivariate correlations are reported.

7.2. Specific Aims and Hypotheses of Study 1
Study 1 had two aims. The primary aim of Study 1 was to evaluate the relationship between trait bipolar disorder vulnerability and trait BAS using cross-sectional self-report methodology. The secondary aim of Study 1 was to assess the factor structure of the 7U7D and BBS. This was a useful step as the 7U7D is a new measure (Youngstrom et al., 2013), whilst mixed findings have been reported regarding the factor structure of the BBS (see Section 2.7.2). EFA was used to assess the appropriate number of factors and to examine cross-loading, whilst single-factor CFA were used to confirm that each factor identified through EFA was
unidimensional and that the items adequately represented the latent construct. This also allowed the 7U7D and BBS to be modified on the basis of the factor analysis to reduce error variance in Study 2 and Study 3, as these studies utilised similar samples to Study 1. Hypotheses addressing the secondary aim were necessarily tested prior to hypotheses addressing the primary aim. Following factor analysis and scale revision, Pearson’s product-moment correlations were conducted between the 7U7D and BBS trait variables.

The following specific hypotheses were tested in Study 1:

**Hypothesis 1.1.** It was predicted that a two-factor solution would fit the 7U7D, with one factor representing mania-proneness and a second factor representing depression-proneness, as per Youngstrom et al. (2013).

**Hypothesis 1.2.** It was predicted that a four-factor solution would fit the BBS, yielding factors representing BAS-D, BAS-FS, BAS-RR, and trait BIS, as per Carver and White (1994).

**Hypothesis 1.3.** It was predicted that item deletions would be necessary to improve fit and to minimise cross-loading within the BBS factor solution. Specifically, it was hypothesised that the reverse-coded Item 2 and Item 22 would not load on trait BIS, and hence internal consistency would be improved by their deletion, as in Campbell-Sills et al. (2004) and Cogswell et al. (2006).

**Hypothesis 1.4.** With regards to correlations between the 7U7D and BBS variables, a moderate strength positive correlation between mania-proneness and BAS-D was hypothesised, as suggested by previous research linking BAS to bipolar disorder (Carver & Johnson, 2009).

**Hypothesis 1.5.** A moderate strength positive correlation between depression-proneness and trait BIS was hypothesised, consistent with Carver and Johnson (2009).

**Hypothesis 1.6.** A moderate strength positive correlation between mania-proneness and depression-proneness was predicted, consistent with Youngstrom et al. (2013).

**Hypothesis 1.7.** Moderate strength positive correlations between BAS-D, BAS-FS, and BAS-RR were also anticipated, in accordance with the idea that these variables represent conceptually linked constructs that can be described as aspects of trait BAS (Carver & White, 1994).
Hypothesis 1.8. A moderate strength positive correlation between BAS-RR and trait BIS was hypothesised, as this correlation has consistently emerged in previous studies (e.g., Carver & White, 1994; Alloy et al., 2006).

Other correlations examined in Study 1, such as those between mania-proneness and trait BIS, and depression-proneness and BAS-D, BAS-FS, and BAS-RR, were left as exploratory.

7.3. Study 1 Method

7.3.1. Participants. The total Study 1 sample comprised 754 participants ($M = 25.60$ years, $SD = 9.35$ years), with ages ranging from 16 to 63 (median = 21). Of these, 571 (75.1%) were female ($M = 25.72$ years, $SD = 9.42$ years) and 185 (24.3%) were male ($M = 25.12$ years, $SD = 9.14$ years), with no significant difference in age between genders, $t(750) = 0.75$, $p = .455$ (homoscedasticity assumed). Four participants did not provide their gender, whilst four participants did not provide their age.

With regards to country of origin, 69.2% of the total sample reported being born in Australia, whilst 82.1% endorsed that Australia was their primary country of residence. Of the remainder, the majority were born (12.5%) and/or residing (12.2%) in the USA, with most others born and/or residing in Britain, mainland Europe, or Asia. In terms of employment, 69.5% were currently employed, and 92.4% were enrolled in some form of study. Almost all participants had completed secondary education (95.9%), with 19.1% having completed an undergraduate degree and 7.0% having completed a postgraduate degree. The proportion of the sample who reported being in enrolled in a psychology or social science course of study was 76.8%.

7.3.2. Materials. The following sections detail the questionnaire measures administered in Study 1.

7.3.2.1. The 7 Up 7 Down Inventory. The 14-item 7U7D (Youngstrom et al., 2013) was used to assess mania-proneness (seven items) and depression-proneness (seven items). Items are rated in terms of frequency on a four-point Likert-type scale from 0 (Never or hardly) to 3 (Very often or almost constantly), with these responses summed to yield a total score for each trait ranging from 0 to 21, with higher scores indicating a greater level of the relevant trait. In its original validation study, the 7U7D was shown to possess excellent reliability (mania-proneness Cronbach’s $\alpha =$
.83, depression-proneness Cronbach’s α = .95) and validity, demonstrating (i) the ability to identify bipolar disorder patients (mania-proneness); (ii) the ability to differentiate mood disorder patients from those with other diagnoses (depression-proneness); and (iii) convergent correlations with temperament, creativity, and seasonal mood variation (Youngstrom et al., 2013). Youngstrom et al. (2013) found the 7U7D mania-proneness and depression-proneness scales to be highly correlated with their GBI equivalents (mania-proneness $r = .88$, depression-proneness $r = .93$), however mania-proneness and depression-proneness are less intercorrelated on the 7U7D ($r = .41$) than their equivalents on the GBI ($r = .78$).

**7.3.2.2. The BIS/BAS Scales.** The 24-item BBS (Carver & White, 1994) was used to assess trait BAS as the three separable scales of BAS-D (four items), BAS-FS (four items), and BAS-RR (five items), and also assessed trait BIS (seven items). Items are rated on a four-point Likert-type scale from 1 (*Very true for me*) to 4 (*Very false for me*). When scoring, these responses are all reverse-coded except for Item 2 and Item 22, both loading on trait BIS, which are worded in the opposite direction to the remainder of the scale (as discussed in Chapter 2). Four items (Items 1, 6, 11, and 17) are included as “filler” items and do not contribute to the calculation of scale scores. Summing responses for each scale yields a score where higher values indicate greater levels of the relevant trait. In its original validation study, the BBS demonstrated adequate reliability (BAS-D Cronbach’s α = .76, BAS-FS Cronbach’s α = .66 BAS-RR Cronbach’s α = .73, trait BIS Cronbach’s α = .74) and validity in terms of expected correlations with affect, temperament, extraversion, optimism, hypomania, experimentally-elicited experience of anxiety, and experimentally-elicited experience of happiness (Carver & White, 1994). These reliability and validity characteristics have been replicated in an Australian university sample (Huebeck et al., 1998), although factor analyses of the BBS have consistently noted irregularities in the BBS factor structure (as reviewed in Chapter 2).

**7.3.3. Procedure.** The questionnaire battery was administered online via the Opinio survey software (ObjectPlanet, Oslo, Norway) and presented in order of (i) basic demographic questions; (ii) the Australian Personality Inventory (Murray et al., 2009, measuring a five-factor model measure of personality not analysed in the present thesis); (iii) the full 73-item GBI containing the 14 7U7D items; and (iv) the BBS. The Australian Personality Inventory and full GBI were administered as part of
separate research projects not reported in the current thesis. As argued above (see 1.4.3), the 7U7D items were extracted from the GBI for use in the present project, as the 7U7D was judged as a more useful measure due to (a) its brevity; (b) its simplicity of factor structure; and (c) the minimal overlap between 7U7D mania-proneness and 7U7D depression-proneness as compared to their GBI equivalents (Youngstrom et al., 2013). Completion of the online questionnaire battery took approximately 30 minutes.

An informed consent statement was presented at the beginning of the questionnaire battery providing participants with information regarding anonymity, voluntary participation, right to withdrawal, and in the case of Swinburne University of Technology students, an assurance that their decision to participate or not would not impact their academic grading in any way. Participants were informed that their consent to participate was implied by submission of the online questionnaire battery after completing the final set of questionnaire items.

Participants were recruited by advertising the study on-campus at Swinburne University of Technology and in online first-year psychology subjects run by Swinburne University of Technology. In addition, the online questionnaire battery was advertised on social networking websites via snowball sampling beginning with a sample of convenience, and linked to via a selection of USA-based psychological survey websites. The online questionnaire battery remained open for responses from September 2010 through to May 2012. The rationale, design, and procedure of Study 1 were approved by the Swinburne University Human Research Ethics Committee (see Appendix 4).

7.3.4. Data reduction and analysis. From an original pool of 997 responses to the online questionnaire battery within the testing period, respondents were deleted based on failure to complete all measures and when pattern of response suggested spurious responding (for example, selecting the same response for every item across scales). The questionnaire battery was set up in such a way as to notify the respondent that they had missed an item, and due to this consideration the presence of missing values was not possible on an individual item basis, but rather indicated that the participant had decided not to complete an entire section of the questionnaire battery. Following the deletion of incomplete or invalid responses (24.37% of respondents), a final analysis sample of 754 participants was reached.
The factor structure of the 7U7D and BBS was assessed using both EFA and CFA. Because the goal of these analyses was not to validate a newly-designed scale, it was judged appropriate for both EFA and CFA to be conducted on the same data set, without dividing the data into two randomised sub-samples. The logic of performing both analyses on the one overall sample allowed for assessment of problematic items across both EFA and CFA, whilst minimising the possibility that any issues not replicated across analyses were due to differences between sub-samples rather than a true issue with item suitability.

Initial pilot EFA were conducted to ascertain whether new factors could be extracted by pooling the 7U7D and BBS items. However, aggregating the two scales did not produce useful results. In several EFA attempts the resulting pattern matrix was uninterpretable. In the few attempts where the pattern matrix was interpretable, it simply revealed a factor structure approximating the 7U7D and BBS as published, the only substantial difference being that both scales were represented in the one pattern matrix. Due to these results, and because hypothesis testing was framed around the 7U7D and BBS as separate scales, factor analysis of the aggregated 7U7D and BBS was viewed as not being a fruitful avenue for more detailed analysis. For reasons of clarity, the pilot EFA conducted on the aggregated 7U7D and BBS item pool are not reported below.

To test hypotheses regarding the number of factors to retain, EFA was performed separately on the 7U7D and BBS item data. Filler items were excluded from the BBS analysis, consistent with Carver and White (1994). Maximum likelihood was used as the extraction method in order to acknowledge the high error variance that characterises measurement of abstract psychological constructs. Although PCA has been used as an analysis technique across the majority of BBS research, maximum likelihood EFA is more appropriate to psychological survey data (Guadagnoli & Velicer, 1988; Henson & Roberts, 2006). This is because when using maximum likelihood EFA the underlying factor is viewed as driving variance in the items, whereas in PCA variance in the items drives formation of a component as an aggregation or simplification of this variance (Matsunaga, 2010; Tabachnick & Fidell, 2012). Despite their differing theoretical assumptions and mathematical computation, it should be noted that maximum likelihood EFA will typically provide
similar results to PCA, and hence the factor structure reported in Study 1 can be compared with past PCA solutions (Guadagnoli & Velicer, 1988).

As inter-factor correlations have been consistently reported for both the 7U7D, EFA was commenced by applying Promax ("Procrustean maximisation") rotation. Promax is an oblique rotation that allows factor structure to be visualised whilst facilitating correlations between factors (Tabachnick & Fidell, 2012). An oblique rotation is the optimum starting rotation method for psychological variables, due to the likelihood of overlapping variance (Preacher & McCallum, 2003). Alternatively, if correlation between factors is low, an orthogonal rotation is optimally reported (Tabachnick & Fidell, 2012). Orthogonal rotations maximise the variance between factors, and hence should not fit solutions where the underlying factors are highly correlated. However, oblique rotations are more statistically parsimonious than oblique rotations, and allow meaningful quantification of the variance explained by each factor (Tabachnick & Fidell, 2007). For this reason, maximum likelihood EFA was performed by first applying a Promax (Kaiser normalisation, \( \kappa = 4 \)) rotation and then separately testing an orthogonal rotation, varimax ("variance maximisation"; Kaiser, 1958). However, for both the 7U7D and the BBS, the orthogonal rotation did not provide an interpretable simple structure, and hence only Promax rotations are included below. Note that the use of oblique rotation meant that variance explained as a function of the sum of squared loadings (SSL) could not be interpreted.

Three techniques were used to judge the optimal number of factors to retain. These techniques were (i) application of Kaiser’s (1960) criterion, whereby factors possessing eigenvalues of greater than one are retained; (ii) Velicer’s (1976) minimum average partial (MAP) test; and (iii) Horn’s (1965) parallel analysis. Visual examination of a scree plot of the eigenvalues (Cattell, 1968) was not utilised due to its subjectivity (Courtney, 2013). Convergence in estimated number of factors across the three techniques was used to judge whether the hypotheses regarding the number of factors to retain were supported. In the event of conflicting estimates between techniques, the least number of factors was prioritised as most conservative provided that simple structure was achieved. In the event of alternative solutions, factor structures most closely resembling the scale as scored were prioritised for retention. Only the pattern matrices depicting the rotated factor solutions are
presented and interpreted below. Factor loadings ≥ .30 within the pattern matrix were viewed as indicating that an item loaded substantially on a given factor (Tabachnick & Fidell, 2012).

Decisions regarding item retention during EFA were based on several core criteria: (i) the conceptual importance of the item content; (ii) the communality coefficient of the item, a measure of the degree of variance in the item explained by the latent factors; (iii) factor loading and absence of cross-loading on multiple factors; (iv) corrected item-total correlation, the correlation between an item and the aggregate of the remaining items loading on the relevant factor; (v) effect on the internal consistency of the factor grouping; and (vi) the effect that item retention exerts on the goodness-of-fit statistic (Armstrong, 1967; Tabachnick & Fidell, 2012). Reliability was tested using Cronbach’s (1951) alpha statistic to establish internal consistency.

Within the maximum likelihood EFA, goodness-of-fit was assessed via chi-square test. In this context, non-significant chi-square values are viewed as indicating that the factor solution is an adequate fit to the data. However, it should be noted that this goodness-of-fit test is highly conservative, assumes that the data is normally distributed, and is biased towards significance by greater numbers of participants (Tabachnick & Fidell, 2012). Hence, EFA solutions were not discarded solely based on poor fit indicated via chi-square test. More complex fit indices were provided during CFA.

Following EFA, maximum likelihood CFA was applied to identify the degree to which each underlying factor identified through EFA fit the data. CFA was applied separately to each 7U7D and BBS scale as a series of single-factor models, leading to CFA models for mania-proneness, depression-proneness, BAS-D, BAS-FS, BAS-RR, and trait BIS. EFA solutions were used to inform the items that were included in the subsequent CFA models. Interpretation of CFA has a subjective component in terms which fit indices are used. Therefore, the use of multiple fit indices is desirable (Hu & Bentler, 1999; Marsh, Hau, & Wen, 2004). The comparative fit index (CFI), goodness of fit index (GFI), normed fit index (NFI), and incremental fit index (IFI) were used as the primary indicators of fit, whilst the root mean square error of approximation (RMSEA) statistic was used as a supplementary indicator. To infer that a model adequately represented the underlying data, primary
indicator values > .95 and RMSEA values < .06 were desired. Deletion of items in the event of inadequate fit was conducted based on high standardised residual covariance values (> 1.00), with decision-making relying on item content in the event of multiple items with high standardised residual covariance. The metric of all latent variables were set by fixing the factor loading of the first item for each factor at 1.00.

Following EFA and CFA, scale scores were calculated and bivariate correlations were conducted to examine the hypotheses concerning correlations between the 7U7D and BBS variables. Scale scores were calculated in keeping with modifications suggested by the results of the EFA and CFA. These modifications were implemented to reduce error variance, and were retained for Study 2 and Study 3. However, where the EFA and CFA data were equivocal, the 7U7D and BBS scales were not modified and were retained as scored. For all correlation-based analyses in the project, coefficients approximating .1 were judged as signifying a weak correlation, coefficients approximating .3 were judged as signifying a moderate correlation, and coefficients approximating .5 or greater were judged as signifying a strong correlation (Cohen, Cohen, West, & Aiken, 2003). All EFA, descriptive statistics, and bivariate correlations were conducted using the Statistical Package for the Social Sciences (SPSS), Version 21.0 (International Business Machines [IBM] Corporation, New York, USA), whilst CFA was conducted by using the SPSS structural equation modelling (SEM) Analysis Of Moment Structures (AMOS) accompaniment package.

Due to the large sample size and the number of correlations being tested, a more conservative significance threshold than $p < .05$ was judged as appropriate for determining whether or not the correlational hypotheses were supported, in order to minimise the likelihood of Type I statistical error (false positive findings). However, given the size of the sample, dividing the significance threshold by the five hypotheses that were ventured was judged to be inappropriate, as the resulting corrected threshold was not conservative enough. For this reason, the $p$-value required for significance was obtained by dividing the standard threshold of $p < .05$ by 12, the number of variables being examined multiplied by two, reflecting the top row and first column of the correlation matrix. The corrected significance threshold used to test the correlational hypotheses was $p < .004$. 
7.4. Study 1 Results

7.4.1. Exploratory factor analysis of the 7U7D. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO; Kaiser, 1970) indicated that the 7U7D data were appropriate for factor analysis, as a high proportion of variance in the item responses appeared to result from variance in the underlying factors, KMO = .89 (determinant < .001). Bartlett’s test of sphericity indicated that the 7U7D data possessed sufficient intercorrelation to be suitable for factor analysis, $\sim \chi^2(91) = 6558.79, p < .001$. With regards to number of factors, Kaiser’s criterion, and MAP testing suggested that two factors should be extracted, whilst parallel analysis suggested that three factors should be extracted. A two-factor solution was chosen as two of the three techniques suggested this number of factors and because this was the factor solution of the scale as scored. The two-factor solution contained 6 (6%) non-redundant residuals with absolute values greater than .05. Factor 1 corresponded to depression-proneness (Cronbach’s $\alpha = .94$) whilst Factor 2 corresponded to mania-proneness (Cronbach’s $\alpha = .86$). These factors are presented in Table 7.1.1, along with item-level means and standard deviations as well as corrected item-total correlations and alpha if item deleted values in Table 7.1.2, and factor correlations in Table 7.1.3.

As demonstrated in Table 7.1.1, maximum likelihood EFA conducted on the Study 1 data was able to replicate the previously established 7U7D factor structure, with Factor 1 corresponding to depression-proneness and Factor 2 corresponding to mania-proneness. However, the factor solution still failed to demonstrate adequate goodness of fit, $\chi^2(64) = 266.01, p < .001$. However, given the conservative nature of the chi-square goodness-of-fit test (especially in large samples) and the positively-skewed nature of the 7U7D data (mean item-level skew across both scales = 0.97), this result was not viewed as a reason to discard the present factor solution.

Descriptive data and correlations for resulting mania-proneness and depression-proneness factors are presented along with data for the BBS factors following the CFA in Table 7.3, so that any modifications suggested by the CFA data can be included. Bivariate correlations are then examined in Table 7.4, as these reflect scale scores more accurately than the weighted factor correlation reported in Table 7.1.3.
Table 7.1.1
Study 1 TUC Pattern Matrix obtained via Maximum Likelihood Extraction with Promax Rotation

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1: Depression-proneness</th>
<th>Factor 2: Mania-proneness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have you had periods of extreme happiness and intense energy lasting several days or more when you also felt much more anxious or tense (jittery, nervous, uptight) than usual (other than related to the menstrual cycle)?</td>
<td>.14</td>
<td>.65</td>
</tr>
<tr>
<td>2. Have there been times of several days or more when you were so sad that it was quite painful or you felt that you couldn't stand it? (GBI 23)</td>
<td>.69</td>
<td>.15</td>
</tr>
<tr>
<td>3. Have there been times lasting several days or more when you felt you must have lots of excitement, and you actually did a lot of new or different things?</td>
<td>-.11</td>
<td>.78</td>
</tr>
<tr>
<td>4. Have you had periods of extreme happiness and intense energy (clearly more than your usual self) when, for several days or more, it took you over an hour to get to sleep at night?</td>
<td>-.04</td>
<td>.76</td>
</tr>
<tr>
<td>5. Have there been long periods in your life when you felt sad, depressed, or irritable most of the time?</td>
<td>.83</td>
<td>.05</td>
</tr>
<tr>
<td>6. Have you had periods of extreme happiness and high energy lasting several days or more when what you saw, heard, smelled, tasted, or touched seemed vivid or intense?</td>
<td>-.03</td>
<td>.77</td>
</tr>
<tr>
<td>7. Have there been periods of several days or more when your thinking was so clear and quick that it was much better than most other people's?</td>
<td>-.02</td>
<td>.62</td>
</tr>
<tr>
<td>8. Have there been times of a couple days or more when you felt that you were a very important person or that your abilities or talents were better than most other people's?</td>
<td>.03</td>
<td>.57</td>
</tr>
<tr>
<td>9. Have them been times when you have hated yourself or felt that you were stupid, ugly, unlovable, or useless?</td>
<td>.85</td>
<td>-.11</td>
</tr>
<tr>
<td>10. Have there been times of several days or more when you really got down on yourself and felt worthless?</td>
<td>.89</td>
<td>-.04</td>
</tr>
<tr>
<td>11. Have you had periods when it seemed that the future was hopeless and things could not improve?</td>
<td>.86</td>
<td>-.03</td>
</tr>
<tr>
<td>12. Have there been periods lasting several days or more when you were so down in the dumps that you thought you might never snap out of it?</td>
<td>.87</td>
<td>.01</td>
</tr>
<tr>
<td>13. Have you had times when your thoughts and ideas came so fast that you couldn't get them all out, or they came so quickly that others complained that they couldn't keep up with your ideas?</td>
<td>.19</td>
<td>.57</td>
</tr>
<tr>
<td>14. Have there been times when you have felt that you would be better off dead?</td>
<td>.75</td>
<td>.04</td>
</tr>
</tbody>
</table>

Eigenvalues
Extraction SSL
Rotation SSL

Note: SSL = sum of squared loadings (initial SSL are equivalent to the eigenvalues).
Table 7.1.2
Item-Level Properties of the Study 1 7U7D obtained via Exploratory Factor Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Communalities (extraction)</th>
<th>$M$ item response ($SD$)</th>
<th>Corrected item-total correlation</th>
<th>Cronbach’s $\alpha$ if item deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1 (M)</td>
<td>.54</td>
<td>0.61 (.79)</td>
<td>.65</td>
<td>.84</td>
</tr>
<tr>
<td>Item 2 (D)</td>
<td>.62</td>
<td>0.79 (.90)</td>
<td>.75</td>
<td>.93</td>
</tr>
<tr>
<td>Item 3 (M)</td>
<td>.53</td>
<td>0.76 (.81)</td>
<td>.65</td>
<td>.84</td>
</tr>
<tr>
<td>Item 4 (M)</td>
<td>.55</td>
<td>0.73 (.87)</td>
<td>.66</td>
<td>.84</td>
</tr>
<tr>
<td>Item 5 (D)</td>
<td>.73</td>
<td>0.99 (.99)</td>
<td>.82</td>
<td>.92</td>
</tr>
<tr>
<td>Item 6 (M)</td>
<td>.57</td>
<td>0.49 (.77)</td>
<td>.68</td>
<td>.84</td>
</tr>
<tr>
<td>Item 7 (M)</td>
<td>.37</td>
<td>0.80 (.81)</td>
<td>.59</td>
<td>.85</td>
</tr>
<tr>
<td>Item 8 (M)</td>
<td>.34</td>
<td>0.65 (.80)</td>
<td>.56</td>
<td>.85</td>
</tr>
<tr>
<td>Item 9 (D)</td>
<td>.63</td>
<td>1.04 (.94)</td>
<td>.75</td>
<td>.93</td>
</tr>
<tr>
<td>Item 10 (D)</td>
<td>.76</td>
<td>0.93 (.92)</td>
<td>.83</td>
<td>.92</td>
</tr>
<tr>
<td>Item 11 (D)</td>
<td>.71</td>
<td>0.90 (.90)</td>
<td>.81</td>
<td>.93</td>
</tr>
<tr>
<td>Item 12 (D)</td>
<td>.76</td>
<td>0.80 (.91)</td>
<td>.84</td>
<td>.92</td>
</tr>
<tr>
<td>Item 13 (M)</td>
<td>.48</td>
<td>0.59 (.82)</td>
<td>.64</td>
<td>.84</td>
</tr>
<tr>
<td>Item 14 (D)</td>
<td>.60</td>
<td>0.68 (.89)</td>
<td>.75</td>
<td>.93</td>
</tr>
</tbody>
</table>

Note. M = mania-proneness item, D = depression-proneness item. Mania-proneness Cronbach’s $\alpha = .86$, depression-proneness Cronbach’s $\alpha = .94$. Standard deviations are presented in parentheses following the mean. Corrected item-total correlations and alpha if item deleted analyses were performed at a subscale (i.e., factor) level. Item numbers correspond to the items presented in the previous table.

Table 7.1.3
Matrix of Factor Correlations for the Two-Factor Study 1 7U7D Factor Solution

<table>
<thead>
<tr>
<th>Factor</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1: Depression-proneness</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Factor 2: Mania-proneness</td>
<td>.56</td>
<td>–</td>
</tr>
</tbody>
</table>

7.4.2. Exploratory factor analysis of the BBS. For the BBS data, there was disagreement between the techniques used for estimating the number of factors to retain. MAP testing suggested retention of two factors, Kaiser’s criterion suggested retention of five factors, and parallel analysis suggested retention of seven factors. Simple structure could not be achieved within a two-factor solution, and two of the factors within a seven-factor solution possessed no loadings greater than .30. For these reasons, the five-factor solution was regarded as the most suitable. This solution also bore the closest resemblance to the four-factor scale as scored. However, based on Kaiser’s criterion, the suggested fifth factor only contained the
two reverse-coded items, Item 2 and Item 22, as hypothesised. This factor was judged to be methodologically spurious and was deleted. Hence, the BBS data were most appropriately represented by a four-factor solution.

Only data for the final four-factor solution excluding Item 2 and Item 22 is reported here. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy indicated that the BBS data were appropriate for factor analysis, as a high proportion of variance in the item responses appeared to result from variance in the underlying factors, KMO = .88 (determinant = .002). Bartlett’s test of sphericity indicated that the BBS data possessed sufficient intercorrelation to be suitable for factor analysis, $\chi^2(153) = 4868.55, p < .001$. The four-factor solution contained 13 (8%) non-redundant residuals with absolute values greater than .05. Factor 1 corresponded to trait BIS (Cronbach’s $\alpha = .79$), Factor 2 corresponded to BAS-D (Cronbach’s $\alpha = .81$), Factor 3 corresponded to BAS-RR (Cronbach’s $\alpha = .94$), and Factor 4 corresponded to BAS-FS (Cronbach’s $\alpha = .78$). These factors are presented below in Table 7.2.1, along with item-level means and standard deviations as well as corrected item-total correlations and alpha if item deleted values in Table 7.2.2, and factor correlations in Table 7.2.3.

As demonstrated in Table 7.2.1, maximum likelihood EFA conducted on the Study 1 data was able to replicate the previously established BBS factor structure provided that the reverse-coded items were excluded. However, the factor solution still failed to demonstrate adequate chi-square goodness of fit, $\chi^2(87) = 314.77, p < .001$. This might be expected given the conservative nature of the chi-square goodness-of-fit test (especially in large samples), although the BBS data were not highly skewed (mean item-level skew across scales = -0.38). One reason for the poor goodness of fit statistic could be two incidences of cross-loading that were apparent in the pattern matrix. Item 5 (“I'm always willing to try something new if I think it will be fun.”) cross-loaded across both the BAS-FS and BAS-RR factors, and loaded more strongly on BAS-RR, despite being categorised as a BAS-FS item in the scale as scored (Carver & White, 1994). Item 21 (“When I go after something I use a ‘no holds barred’ approach.”) cross-loaded on all three trait BAS factors, although it loaded most strongly upon the BAS-D factor, as per the scale as scored. Further analyses were conducted excluding Item 5 and Item 21, however these failed to yield
an interpretable factor structure. Because of this, both items were retained despite cross-loading and categorised as per the scale as scored.

Descriptive data and correlations for resulting mania-proneness and depression-proneness factors are presented along with data for the BBS factors following the CFA in Table 7.3, so that any modifications suggested by the CFA data can be included. Bivariate correlations are then examined in Table 7.4, as these reflect scale scores more accurately than the weighted factor correlation reported above.
Table 7.2.1

Study 1 BBS Pattern Matrix obtained via Maximum Likelihood Extraction with Promax

**Rotation**

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1: BIS</th>
<th>Factor 2: BAS-D</th>
<th>Factor 3: BAS-RR</th>
<th>Factor 4: BAS-FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. I go out of my way to get things I want.</td>
<td>-.11</td>
<td>.78</td>
<td>.13</td>
<td>-.13</td>
</tr>
<tr>
<td>4. When I'm doing well at something I love to keep at it.</td>
<td>-.00</td>
<td>.13</td>
<td>.76</td>
<td>-.21</td>
</tr>
<tr>
<td>5. I'm always willing to try something new if I think it will be fun.</td>
<td>-.22</td>
<td>-.12</td>
<td>.66</td>
<td>.34</td>
</tr>
<tr>
<td>7. When I get something I want, I feel excited and energized.</td>
<td>.12</td>
<td>.12</td>
<td>.61</td>
<td>.00</td>
</tr>
<tr>
<td>8. Criticism or scolding hurts me quite a bit.</td>
<td>.62</td>
<td>-.04</td>
<td>.04</td>
<td>-.02</td>
</tr>
<tr>
<td>9. When I want something I usually go all-out to get it.</td>
<td>-.01</td>
<td>.85</td>
<td>.07</td>
<td>-.04</td>
</tr>
<tr>
<td>10. I will often do things for no other reason than that they might be fun.</td>
<td>-.09</td>
<td>-.06</td>
<td>.22</td>
<td>.55</td>
</tr>
<tr>
<td>12. If I see a chance to get something I want I move on it right away.</td>
<td>-.02</td>
<td>.57</td>
<td>.19</td>
<td>.05</td>
</tr>
<tr>
<td>13. I feel pretty worried or upset when I think or know somebody is angry at me.</td>
<td>.66</td>
<td>-.10</td>
<td>.10</td>
<td>-.05</td>
</tr>
<tr>
<td>14. When I see an opportunity for something I like I get excited right away.</td>
<td>.17</td>
<td>.21</td>
<td>.31</td>
<td>.21</td>
</tr>
<tr>
<td>15. I often act on the spur of the moment.</td>
<td>-.00</td>
<td>.07</td>
<td>-.03</td>
<td>.56</td>
</tr>
<tr>
<td>16. If I think something unpleasant is going to happen I usually get pretty “worked up.”</td>
<td>.67</td>
<td>.01</td>
<td>-.17</td>
<td>.05</td>
</tr>
<tr>
<td>18. When good things happen to me, it affects me strongly.</td>
<td>.25</td>
<td>.03</td>
<td>.30</td>
<td>.17</td>
</tr>
<tr>
<td>19. I feel worried when I think I have done poorly at something important.</td>
<td>.60</td>
<td>-.05</td>
<td>.10</td>
<td>-.03</td>
</tr>
<tr>
<td>20. I crave excitement and new sensations.</td>
<td>.01</td>
<td>-.10</td>
<td>.01</td>
<td>.83</td>
</tr>
<tr>
<td>21. When I go after something I use a “no holds barred” approach.</td>
<td>.04</td>
<td>.53</td>
<td>-.33</td>
<td>.47</td>
</tr>
<tr>
<td>23. It would excite me to win a contest.</td>
<td>.15</td>
<td>.05</td>
<td>.35</td>
<td>.16</td>
</tr>
<tr>
<td>24. I worry about making mistakes.</td>
<td>.70</td>
<td>.02</td>
<td>-.03</td>
<td>-.09</td>
</tr>
</tbody>
</table>

**Note.** SSL = sum of squared loadings; the initial SSL are equal to the eigenvalues. Items 1, 6, 11, and 17 of the BBS are “filler” items not intended to reflect variance in a construct relevant to the scale (Carver & White, 1994), and hence were excluded from the factor analysis. Items 2 and 22 were excluded based on these reverse-coded items factoring separately from the other trait BIS items. Factor loadings of -.00 are not true zero values, but indicate loadings of < .01 in the negative direction.
Table 7.2.2

*Item-Level Properties of the Study 1 BBS obtained via Exploratory Factor Analysis*

<table>
<thead>
<tr>
<th>Item</th>
<th>Communalities (extraction)</th>
<th>( M ) item response (SD)</th>
<th>Corrected item-total correlation</th>
<th>Cronbach’s α if item deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 3 (BAS-D)</td>
<td>.60</td>
<td>2.76 (.77)</td>
<td>.65</td>
<td>.75</td>
</tr>
<tr>
<td>Item 4 (BAS-RR)</td>
<td>.55</td>
<td>3.37 (.68)</td>
<td>.52</td>
<td>.75</td>
</tr>
<tr>
<td>Item 5 (BAS-FS)</td>
<td>.55</td>
<td>3.15 (.76)</td>
<td>.51</td>
<td>.70</td>
</tr>
<tr>
<td>Item 7 (BAS-RR)</td>
<td>.54</td>
<td>3.33 (.70)</td>
<td>.66</td>
<td>.70</td>
</tr>
<tr>
<td>Item 8 (BIS)</td>
<td>.39</td>
<td>3.09 (.82)</td>
<td>.55</td>
<td>.75</td>
</tr>
<tr>
<td>Item 9 (BAS-D)</td>
<td>.74</td>
<td>2.75 (.79)</td>
<td>.74</td>
<td>.71</td>
</tr>
<tr>
<td>Item 10 (BAS-FS)</td>
<td>.39</td>
<td>2.80 (.81)</td>
<td>.59</td>
<td>.65</td>
</tr>
<tr>
<td>Item 12 (BAS-D)</td>
<td>.50</td>
<td>2.74 (.77)</td>
<td>.60</td>
<td>.77</td>
</tr>
<tr>
<td>Item 13 (BIS)</td>
<td>.47</td>
<td>3.13 (.81)</td>
<td>.60</td>
<td>.73</td>
</tr>
<tr>
<td>Item 14 (BAS-RR)</td>
<td>.46</td>
<td>3.00 (.73)</td>
<td>.57</td>
<td>.73</td>
</tr>
<tr>
<td>Item 15 (BAS-FS)</td>
<td>.33</td>
<td>2.63 (.80)</td>
<td>.48</td>
<td>.72</td>
</tr>
<tr>
<td>Item 16 (BIS)</td>
<td>.41</td>
<td>2.78 (.81)</td>
<td>.53</td>
<td>.76</td>
</tr>
<tr>
<td>Item 18 (BAS-RR)</td>
<td>.34</td>
<td>3.09 (.71)</td>
<td>.52</td>
<td>.75</td>
</tr>
<tr>
<td>Item 19 (BIS)</td>
<td>.42</td>
<td>3.28 (.73)</td>
<td>.56</td>
<td>.75</td>
</tr>
<tr>
<td>Item 20 (BAS-FS)</td>
<td>.64</td>
<td>2.84 (.82)</td>
<td>.57</td>
<td>.66</td>
</tr>
<tr>
<td>Item 21 (BAS-D)</td>
<td>.56</td>
<td>2.40 (.79)</td>
<td>.53</td>
<td>.81</td>
</tr>
<tr>
<td>Item 23 (BAS-RR)</td>
<td>.32</td>
<td>3.20 (.75)</td>
<td>.50</td>
<td>.76</td>
</tr>
<tr>
<td>Item 24 (BIS)</td>
<td>.45</td>
<td>3.11 (.80)</td>
<td>.57</td>
<td>.74</td>
</tr>
</tbody>
</table>

*Note.* BAS-D Cronbach’s α = .81, BAS-FS Cronbach’s α = .74, BAS-RR Cronbach’s α = .78, trait BIS Cronbach’s α = .79. Standard deviations are presented in parentheses following the relevant mean. Corrected item-total correlations and alpha if item deleted analyses were performed at a subscale (i.e., factor) level, rather than at the level of the overall scale, with items allocated to the factor that they had traditionally been associated with in the event of cross-loading (hence Item 5 was categorised under Factor 4 whilst Item 21 was categorised under Factor 2). Item numbers correspond to the items presented in the previous table. Items 1, 6, 11, and 17 of the BBS are “filler” items not intended to reflect variance in a construct relevant to the scale (Carver & White, 1994), and as such they were excluded from the factor analysis.

Table 7.2.3

*Matrix of Factor Correlations for the Four-Factor Study 1 BBS Factor Solution*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1: BIS</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 2: BAS-D</td>
<td>.17</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 3: BAS-RR</td>
<td>.44</td>
<td>.48</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Factor 4: BAS-FS</td>
<td>.28</td>
<td>.52</td>
<td>.48</td>
<td>–</td>
</tr>
</tbody>
</table>
7.4.3. Confirmatory factor analysis of the 7U7D. A CFA was performed to assess the fit of the seven items composing the mania-proneness scale. All items were anticipated as suitable based on the results of the EFA. However, both primary and secondary indicators of fit indicated that the initial seven-item mania-proneness model did not adequately represent the underlying data. Following this initial CFA, Item 7 (“Have there been periods of several days or more when your thinking was so clear and quick that it was much better than most other people's?”) was deleted from the model based on high standardised residual covariance. The resulting six-item model adequately fit the underlying data. This six-item single-factor model is presented below in Figure 7.1.

Figure 7.1. Confirmatory factor analysis of Study 1 7U7D mania-proneness.

The six-item model displayed in Figure 7.1 adequately fit the underlying data, CFI = .974, GFI = .977, NFI = .969, IFI = .974. Although the RMSEA statistic was higher than desired, RMSEA = .080, given the positive skew of the responses, the simple structure evident in the EFA, and the strong primary indicator values the judgement was made to retain the modified six-factor solution. The modified six-item mania-proneness scale was used for all further analyses within the present
A second CFA was performed to assess the fit of the seven items composing the depression-proneness scale. All items were anticipated as suitable based on the results of the EFA. This single-factor model is presented below in Figure 7.2.

The primary indicators of fit all revealed that the depression-proneness model in Figure 7.1 adequately represented the underlying data, $CFI = .979$, $GFI = .963$, $NFI = .975$, $IFI = .979$. Although the RMSEA statistic was higher than desired, $RMSEA = .091$, given the positive skew of the responses, the simple structure evident in the EFA, and the strong primary indicator values the judgement was made to retain the scale as scored and accept the above factor solution. The chi-square goodness of fit test remained significant for depression-proneness, $\chi^2(14) = 101.63$, $p < .001$. 

Figure 7.2. Confirmatory factor analysis of Study 1 7U7D depression-proneness.
7.4.4. **Confirmatory factor analysis of the BBS.** Four single-factor CFA were performed to assess the fit of the four BBS scales. The first CFA was conducted to assess the fit of the four items composing the BAS-D scale. The results of the EFA indicated that Item 21 might not load on BAS-D as strongly as the other items, however Item 21 was still included in the CFA as its exclusion did not lead to an interpretable EFA solution. The single-factor BAS-D model is presented below in Figure 7.3.

The primary indicators of fit all revealed that the BAS-D model adequately represented the underlying data, CFI = .998, GFI = .997, NFI = .996, IFI = .998. The RMSEA statistic also supported the fit of the model, RMSEA = .035. Although the results of the EFA suggested that Item 21 might load non-specifically across BAS-D, BAS-FS, and BAS-RR, given the strength of fit demonstrated by the CFA and desire to adhere to established factor structure where possible, the four-item BAS-D model from the scale as-scored was retained as an acceptable factor solution that adequately represented the latent BAS-D construct. The chi-square goodness of fit test was non-significant for BAS-D, providing a further indication of suitable fit, $\chi^2(2) = 3.89, p = .143$. 

*Figure 7.3. Confirmatory factor analysis of Study 1 BBS BAS-D.*
CFA was then performed to assess the fit of the four items composing the BAS-FS scale. The results of the EFA indicated that Item 5 might not load on BAS-FS as strongly as the other items, and that it might be more appropriately placed on BAS-RR. In addition, the EFA also suggested that Item 21, categorised as assessing BAS-D in the scale as scored, might be placed on BAS-FS. As such, four separate single-factor BAS-FS models were run with (i) the four-item scale as scored; (ii) Item 21 added to the model; (iii) Item 5 deleted and Item 21 not present; and (iv) Item 21 added to the model with Item 5 deleted. However, all of these alternate models provided a poorer CFA solution than simply retaining the scale as scored. The more suitable four-item single-factor model is presented below in Figure 7.4.

![Figure 7.4. Confirmatory factor analysis of Study 1 BBS BAS-FS.](image)

The primary indicators of fit all revealed that the four-item BAS-FS model adequately represented the underlying data, CFI = .985, GFI = .992, NFI = .982, IFI = .985. However, the RMSEA value remained above the desired threshold, RMSEA = .079. Given the strength of fit characteristic of the four-item model, the superiority of this fit over the alternate models, and the desire to adhere to established factor structure where possible, the four-item BAS-FS model from the scale as-scored was retained as an acceptable factor solution that adequately represented the latent BAS-
FS construct. The standard chi-square goodness of fit test remained significant for the four-item BAS-FS model, $\chi^2(2) = 11.53, p = .003$.

CFA was next performed to assess the fit of the five items composing the BAS-RR scale. The results of the EFA indicated that Item 21, categorised as assessing BAS-D in the scale as scored, might be placed on BAS-RR. As such, two separate single-factor BAS-FS models were run with (i) the five-item scale as scored; and (ii) the addition of Item 21 to create an alternative six-item BAS-RR model. However, the alternative six-item model provided a poorer CFA solution than simply retaining the scale as scored, with Item 21 possessing the weakest factor loading and causing large standardised residual covariance. The more suitable five-item single-factor model is presented below in Figure 7.5.

![Figure 7.5. Confirmatory factor analysis of Study 1 BBS BAS-RR.](image)

The primary indicators of fit all revealed that the four-item BAS-RR model adequately represented the underlying data, CFI = .985, GFI = .990, NFI = .980, IFI = .985. The RMSEA value remained above the desired threshold, albeit only slightly so, RMSEA = .061. Given the strength of fit characteristic of the five-item model, the superiority of this fit over the alternate model, and the desire to adhere to established factor structure where possible, the five-item BAS-RR model from the scale as-scored was retained as an acceptable factor solution that adequately
represented the latent BAS-RR construct. The chi-square goodness of fit test remained significant for the five-item BAS-RR model, $\chi^2(5) = 19.21, p = .002.$

The final CFA was performed to assess the fit of the seven items composing the trait BIS scale. A preliminary CFA testing the original seven-item BIS model was a poor fit due to the presence of Item 2 and Item 22, convergent with the results of the EFA. A five-factor trait BIS model created by deleting Item 2 and Item represented an improvement, but nevertheless failed to achieve adequate fit. Examination of the standardised residual covariances revealed that Item 19 (“I feel worried when I think I have done poorly at something important.”) and Item 24 (“I worry about making mistakes.”) were impacting the fit of the model. Item 19 was removed from the model based on inspection of item content, as it was judged to less reflect the core concept of trait BIS than Item 24. Following the deletion of Item 19, a four-item model of trait BIS achieved adequate fit. This more suitable four-item single-factor model is presented below in Figure 7.6.

![Figure 7.6. Confirmatory factor analysis of Study 1 BBS trait BIS.](image)

The primary indicators of fit all revealed that the four-item BIS model adequately represented the underlying data, CFI = .996, GFI = .997, NFI = .993, IFI = .996. The RMSEA value also indicated that the four-item model was a suitable fit, RMSEA = .040. Given the strength of fit characteristic of the four-item model, the superiority of this fit over the preceding models that were attempted, and the
published arguments regarding flaws in the original seven-item BIS model, the four-item BIS model depicted above was retained as an acceptable factor solution that adequately represented the latent trait BIS construct. The modified four-item trait BIS scale was used for all further analyses within the present project, across Study 1, Study 2, and Study 3. The standard chi-square goodness of fit test also supported the suitability of the four-item model, $\chi^2(2) = 4.38, p = .112$.

7.5. Descriptive Statistics and Correlations between the 7U7D and BBS Variables

Descriptive statistics for the 7U7D and BBS variables are presented below in Table 7.3. For mania-proneness and trait BIS, these descriptive statistics are derived from the modified versions of the scales created during CFA.

Table 7.3

Descriptive Statistics for the Study 1 7U7D and BBS Variables

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>Actual range</th>
<th>Potential range</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>Cronbach’s $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7U7D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>3.82 (3.68)</td>
<td>0-18</td>
<td>0-18</td>
<td>1.03</td>
<td>.62</td>
<td>.85</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>6.13 (5.50)</td>
<td>0-21</td>
<td>0-21</td>
<td>0.92</td>
<td>.12</td>
<td>.94</td>
</tr>
<tr>
<td><strong>BBS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS-D</td>
<td>10.64 (2.49)</td>
<td>4-16</td>
<td>4-16</td>
<td>0.08</td>
<td>-.16</td>
<td>.81</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>11.41 (2.40)</td>
<td>4-16</td>
<td>4-16</td>
<td>-.22</td>
<td>-.01</td>
<td>.74</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>15.98 (2.61)</td>
<td>5-20</td>
<td>5-20</td>
<td>-0.56</td>
<td>.52</td>
<td>.78</td>
</tr>
<tr>
<td>Trait BIS</td>
<td>12.11 (2.45)</td>
<td>4-16</td>
<td>4-16</td>
<td>-0.40</td>
<td>-.01</td>
<td>.75</td>
</tr>
</tbody>
</table>

N = 760

Note. Standard deviations are presented in parentheses following the relevant mean.

As shown in Table 7.3, despite the sample filling out the scoring range for all measures, some level of skew was present, with this being strongest for both BAS-RR and Hypomania. All scales possessed adequate reliability. A series of $t$-tests revealed that females scored significantly higher than males on BAS-RR and trait BIS, BAS-RR $\Delta M = 1.02, t(754) = 4.76, p < .001$, BIS $\Delta M = 1.39, t(754) = 6.98, p < .001$ (heteroscedasticity assumed for both tests). In contrast, males scored significantly higher than females in terms of mania-proneness, $\Delta M = .82, t(754) =$
2.67, \( p = .008 \) (heteroscedasticity assumed). No other gender differences were apparent across the trait measures. In terms of trait associations with age, mania-proneness, depression-proneness, and BAS-D all exhibited significant negative correlations with age in years, however these correlations were weak and no other age-trait associations were present, depression-proneness Pearson’s \( r(n = 754) = -.09, p = .017 \), mania-proneness Pearson’s \( r(n = 754) = -.20, p < .001 \), BAS-D Pearson’s \( r(n = 754) = -.08, p = .031 \). Bivariate correlations between the 7U7D and BBS variables were also analysed and are displayed below in Table 7.4.

Table 7.4

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mania-proneness</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Depression-proneness</td>
<td>.54***</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. BAS-D</td>
<td>.11**</td>
<td>-.12**</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. BAS-FS</td>
<td>.13***</td>
<td>-.10</td>
<td>.47***</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. BAS-RR</td>
<td>-.11**</td>
<td>-.19***</td>
<td>.51***</td>
<td>.52***</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>6. Trait BIS</td>
<td>-.09</td>
<td>.21***</td>
<td>.07</td>
<td>.15***</td>
<td>.39***</td>
<td>–</td>
</tr>
</tbody>
</table>

\( N = 760 \)

** ** \( p < .004 \) (corrected threshold), *** \( p < .001 \)

Table 7.4 shows that a significant positive correlation was present between mania-proneness and BAS-D. A weak yet significant positive correlation was also present between depression-proneness and trait BIS score. The direction and significance of these correlations were as predicted, however they were weaker than anticipated. As predicted, a moderate-strength positive correlation was present between mania-proneness and depression-proneness, consistent with the idea of mania and depression as related yet separable traits. Moderate strength positive correlations were found between BAS-D, BAS-FS, and BAS-RR, also as hypothesised. Finally, a predicted moderate strength positive correlation between BAS-RR and trait BIS score was also present.

In terms of exploratory correlations, mania-proneness exhibited a weak positive correlation with BAS-FS, whereas the weak correlation between mania-proneness and BAS-RR was negative. BAS-D and BAS-RR exhibited weak negative correlations with depression-proneness. Although no correlation was present
between BAS-D and trait BIS score, BAS-FS exhibited a weak but significant correlation with trait BIS score.

7.6. Bridging Discussion of Study 1

A brief review of hypothesis outcomes is provided in this section. Detailed discussion of the findings and limitations of Study 1 are provided in Chapter 10. Study 1 sought to re-examine the factor structure of the 7U7D and BBS using EFA and CFA, and then use these scales to investigate correlations between the 7U7D and BBS variables.

Hypothesis 1.1, the prediction that the 7U7D data would best fit a two-factor solution, was supported, with mania-proneness and depression-proneness identified as factors. The BBS data would best fit a four-factor solution, with BAS-D, BAS-FS, BAS-RR, and trait BIS identified as factors, supporting Hypothesis 1.2. In accordance with Hypothesis 1.3, the four-factor solution BBS solution was only obtained once the two reverse-coded BBS items were found to load not on trait BIS, as in the scale as scored, but instead on a methodologically spurious fifth factor. The reverse-coded BBS items were hence deleted. After arriving at these factor solutions through EFA, CFA was applied to the 7U7D and BBS variables, resulting in the deletion of one mania-proneness item and one trait BIS item.

The correlational hypotheses were broadly supported. However, instead of a moderate-strength positive correlation, a weak positive correlation was found between mania-proneness and BAS-D, only offering partial support for Hypothesis 1.4. Moderate-strength positive correlations were found between (a) depression-proneness and trait BIS; (b) mania-proneness and depression-proneness; (c) BAS-D, BAS-FS, and BAS-RR; and (d) BAS-RR and trait BIS, supporting Hypotheses 1.5, 1.6, 1.7, and 1.8 respectively. A weak positive relationship between BAS-FS and mania-proneness and a weak negative relationship between BAS-RR and mania-proneness were also found, as were weak negative correlations of BAS-D and BAS-RR with depression-proneness.
8. Study 2

8.1. Structure of Chapter 8

Chapter 8 presents the aims and hypotheses of Study 2, a description of methodology, the results, and a brief review of findings. Within the method section, participant characteristics, materials used, the data collection procedure, and the process used to analyse the data are reported. Each of the behavioural tasks administered in Study 2 are more fully reviewed in Chapter 4, with the method section of Study 2 focusing only on how these tasks were administered within the present study. Bivariate correlations between the 7U7D and BBS variables are presented in an attempt to replicate the results of Study 1. Bivariate correlations between the behavioural task metrics are also presented in order to assess overlapping variance before hypotheses are tested. Following this, bivariate correlations between the 7U7D and BBS variables and the behavioural task metrics are examined. A series of hierarchical multiple regression analyses were then conducted to control for PA and NA. Finally, several formal mediation models were conducted to assess whether the results found via hierarchical multiple regression are reflective of statistical mediation.

8.2. Specific Aims and Hypotheses of Study 2

The primary aim of Study 2 was to evaluate the relationship between trait bipolar disorder vulnerability and risky decision-making, measured in the form of BART, GDT, and CS-IGT responses. The 7U7D and BBS were administered to assess mania-proneness and BAS-D respectively as independent variables. The PANAS was administered to assess and statistically control for state mood using hierarchical multiple regression analyses. In addition, the possibility that the effect of 7U7D and BBS trait variables on behavioural task responses is mediated by state mood was explored using formal mediation modelling.

Four tasks were administered as dependent variables in Study 2. The BART was used to assess risky decision-making within an explicit environment of dynamically escalating risk. The GDT was used to assess risky decision-making within an explicit rule-based context, but with static probabilities rather than the
dynamically escalating probabilities of the BART. The CS-IGT was included to assess risky decision-making in an implicit context and also to assess set-shifting in a reward-laden context. Finally, the WCST was included to assess set-shifting in a context with minimal reward cues.

The following specific hypotheses regarding risky decision-making were tested in Study 2:

**Hypothesis 2.1.** It was hypothesised that a moderate strength positive correlation would be found between mania-proneness and risky decision-making, with risky decision-making measured as BART AMP.

**Hypothesis 2.2.** It was hypothesised that a moderate strength negative correlation would be found between mania proneness and risky decision-making, with risky decision-making measured as number of advantageous minus number of disadvantageous GDT selections. The expected correlation was in the negative direction, as higher numbers indicate more conservative decision-making following the calculation of advantageous minus disadvantageous GDT selections.

**Hypothesis 2.3.** It was hypothesised that a moderate strength negative correlation would be found between mania-proneness and risky decision-making, with risky decision-making measured as number of advantageous minus number of disadvantageous CS-IGT selections for trials 81 through 100. The CS-IGT was divided into 20-trial blocks for hypothesis-testing during the present project, and hence trials 81 through 100 formed Block 5 of the CS-IGT. These trials are functionally identical in nature to the final 20 trials of the standard IGT protocol as developed by Bechara et al. (1994), and this hypothesis was formed based on the meta-analysis of IGT findings published by Edge, Johnson, et al. (2013). Trials 81 through 100 were selected for hypothesis-testing as earlier and intermediate CS-IGT blocks are likely to be biased by learning effects (see Section 3.7.1). The expected correlation was in the negative direction, as higher numbers indicate more conservative decision-making following the calculation of advantageous minus disadvantageous CS-IGT selections.

Risky decision-making was included in the present project as a putative behavioural manifestation of BAS. However, there is little evidence that risky decision-making outcomes are correlated with trait BAS (see Section 3.2.2). For this reason, the assumption that risky decision-making is associated with trait BAS was
tested as an exploratory hypothesis. For every relationship that was predicted between mania-proneness and risky decision-making above, an identical test was also conducted using BAS-D in place of mania-proneness.

Relationships between depression-proneness, BAS-FS, BAS-RR, and trait BIS and risky decision-making as measured by BART, GDT, and CS-IGT outcomes were also explored, but directional hypotheses were not set.

Specific predictions were also formed regarding set-shifting:

**Hypothesis 2.4.** It was hypothesised that mania-proneness would be associated with greater set-shifting difficulties in a reward-laden context, as measured using the CS-IGT. In the present project, greater set-shifting difficulties on the CS-IGT were operationalised as CS-IGT selections on a subsequent block minus CS-IGT selections on a preceding block (e.g., Block 2 selections – Block 1 selections, with “selections” referring to the standard advantageous minus disadvantageous selections IGT metric). A strong positive correlation with mania-proneness was expected for CS-IGT selection differences on blocks immediately following a shift in deck rules (Block 6 - 5, Block 8 - 7, and Block 10 - 9), although difference scores for all CS-IGT blocks were explored. In contrast to Hypothesis 2.3, the expected correlation for Hypothesis 2.4 was in the positive direction, as higher numbers following the calculation of difference scores indicate a greater gap in CS-IGT selections between trials.

WCST set-shifting was included in Study 2 to explore whether trait bipolar disorder vulnerability would be associated with difficulties in reward-laden set-shifting (measured using the CS-IGT), but not with difficulties in non-affective, non-reward-laden set-shifting as measured by the WCST. Accordingly, no significant correlation was predicted between mania-proneness and WCST error percentage, with both total error percentage and perseverative error percentage tested. A significant CS-IGT finding contrasted with a non-significant WCST finding would support the idea that a deficit in set-shifting in the context of trait bipolar disorder vulnerability is more specific to the reward-laden nature of the CS-IGT.

As per the risky decision-making hypotheses, Hypothesis 2.4 was also explored with regards to BAS-D in place of mania-proneness. The relationships between depression-proneness, BAS-FS, BAS-RR, and trait BIS and set-shifting as
measured by CS-IGT and WCST outcomes were also explored, however directional hypotheses were not set.

Specific predictions were formed regarding the effect of state mood:

**Hypothesis 2.5.** It was hypothesised that controlling for PA and NA using hierarchical regression would diminish the correlation between mania-proneness and risky decision-making as measured via the BART, GDT, and CS-IGT.

As per the risky decision-making and set-shifting hypotheses, state mood effects were explored for BAS-D. The effect of controlling for PA and NA when examining depression-proneness, BAS-FS, BAS-RR, and trait BIS was also explored, however directional hypotheses were not set.

Formal mediation modelling was used to test whether any effects of state mood identified using hierarchical regression were the result of statistical mediation. However, these analyses were purely exploratory as little prior research has been conducted to examine state mood as a mediator of risky decision-making. Hence, no hypotheses were formulated regarding the possible outcome of the mediation models.

### 8.3. Study 2 Method

**8.3.1. Participants.** Two procedures were used to recruit participants for Study 2. The first part of the sample was recruited through Swinburne University of Technology’s Research Experience Program, where students enrolled in a first-year introductory psychology subject are encouraged to participate in research as a learning experience that also attracts course credit. The second part of the sample was recruited by collecting a sample of convenience via advertising on social networking internet sites.

The total sample comprised 118 participants ($M = 21.66$ years, $SD = 5.29$ years), with ages ranging from 17 to 50 (median = 20). Of these, 87 (73.7%) were female ($M = 21.03$ years, $SD = 4.54$ years) and 31 (26.3%) were male ($M = 23.42$ years, $SD = 6.75$ years), with no significant difference in age present between genders, $t(40.07) = 1.83$, $p = .075$ (test corrected for heteroscedasticity).

Test administration sessions were split between 86 (72.9%) first-year psychology students participating in the experiment for course credit ($M = 20.34$ years, $SD = 5.14$ years) and 32 (27.1%) individuals recruited as a sample of
convenience \((M = 25.22 \text{ years}, SD = 3.90 \text{ years})\). The first-year psychology students were significantly younger than the individuals in the sample of convenience, \(t(116) = 4.88, p < .001\).

With regards to country of origin, 85.6% of the total sample reported that they were born in Australia, whilst 96.6% endorsed that Australia was their primary country of residence. In terms of employment, 68.6% were currently employed, and 92.4% were enrolled in some form of study. All participants had completed their secondary education, with 14.4% having completed an undergraduate degree and 5.6% having completed a postgraduate degree. The proportion of the sample who reported being in enrolled in a psychology or social science course of study was 75.4%.

First-year students were compensated for their time and effort by being provided with 90 minutes of credit towards their research participation requirements. The sample of convenience were compensated for their time and effort with $10 Australian currency. These compensation methods were selected to be approximately equivalent, and to be sufficiently minimal so as to not constitute coercion. Participants were informed that they would be compensated for their time via these methods before they elected to participate in the study.

8.3.2. Behavioural tasks. The following sections detail the behavioural tasks that were used to assess risky decision-making and set-shifting in Study 2.

8.3.2.1. The Balloon Analogue Risk Task. The BART was used to assess risky decision-making within an explicit environment of dynamically escalating risk. The design of the BART is described and reviewed in Chapter 3. For Study 2 of the present project, the BART was administered in its standard format. Specifically, 30 trials (“balloons”) were presented. A probability algorithm of 1/128 was applied to each trial, wherein the balloon possessed a 1/128 chance of exploding on the first pump, with this escalating to 1/127 for the second pump, 1/126 for the third pump, and so on until the chance of balloon exploding on the 128th pump is 1/1. This meant that the optimum number of pumps for each trial was set at 64. The BART metric used for analyses in Study 2 was AMP, with higher AMP indicative of greater risky decision-making. The BART administered in Study 2 featured sound effects accompanying task actions and consequences.
8.3.2.2. **The Game of Dice Task.** The GDT was used to assess risky decision-making within an explicit rule-based context, but with static probabilities rather than the dynamically escalating probabilities of the BART. The design of the GDT is described and reviewed in Chapter 3. For Study 2 of the present project, the GDT was administered in a 30-trial format rather than the standard 18-trial format as part of an unrelated study testing the effect of task length. Only the first 18 GDT trials are analysed and reported in Study 2. It should be noted that conducting analyses using all 30 trials did not alter the pattern of results. The GDT metric used for analyses in Study 2 was the number of advantageous decisions minus the number of disadvantageous decisions, with lower values indicative of greater risky decision-making. This metric is abbreviated to the simpler GDT selections when discussing the analyses below. The GDT administered in Study 2 featured sound effects accompanying task actions and consequences.

8.3.2.3. **The Contingency-Shifting Iowa Gambling Task.** The CS-IGT was included to assess risky decision-making in an implicit context (initial 100 trials) and also to assess set-shifting in a reward-laden context (latter 120 trials). The design of the CS-IGT is described and reviewed in Chapter 3. The CS-IGT administered in Study 2 did not feature sound effects. For Study 2 of the present project, the CS-IGT was administered as per Turnbull et al. (2006). This CS-IGT consisted of 220 trials, divided into 11 20-trial blocks for the purposes of analysis. The first 100 trials (Block 1 through Block 5) are identical to the standard IGT. The latter 120 trials were characterised by a change in the pattern of underlying deck rules every 40 trials (on Block 6, Block 8, and Block 10).

Two CS-IGT metrics were used for hypothesis-testing in Study 2. Risky decision-making was measured using number of advantageous selections minus number of disadvantageous selections for each 20-trial block of the CS-IGT, with lower values indicative of greater risky decision-making. This metric was used to establish a characteristic learning curve across CS-IGT blocks, and also to test Hypotheses 2.3 and 2.5, focusing on Block 5 CS-IGT selections. This metric is abbreviated to the simpler CS-IGT selections when discussing the analyses below.

The second metric used on the CS-IGT was difference score between CS-IGT selections for each 20-trial block, with CS-IGT selections here referring to the number of advantageous minus disadvantageous selections metric outlined above as
a measure of risky decision-making. Difference scores were used to compare risky
decision-making on each block of the CS-IGT to the preceding block (e.g., Block 2
selections – Block 1 selections). This metric is referred to as simply CS-IGT
difference score when discussing the analyses below. Higher CS-IGT difference
scores indicate a larger difference in risky decision-making between blocks. CS-IGT
difference scores were used to measure reward-laden set-shifting occurring in the
context of a risky decision-making task with changing rules.

8.3.2.4. The Wisconsin Card Sorting Task. The WCST was included to
assess set-shifting in a context with minimal reward cues. The design of the WCST
is described and reviewed in Chapter 3. For Study 2 of the present project,
participants were asked to sort the WCST cards with reference to colour, shape, and
number. Each sorting condition was cycled through twice, in order of colour, shape,
number, colour, shape, number. Card-sorting feedback was provided in the form of
on-screen prompts of “Correct” or “Incorrect”. Participants moved to the next sorting
condition by making correct sorting selections four consecutive times, leading to a
variable number of WCST trials per participant. The task was discontinued
regardless of performance at 128 trials. The lowest number of trials for a participant
to complete the WCST in the present study was 30, whilst the highest was 128. The
WCST metrics used for analyses in Study 2 were percentage of total errors and
percentage of perseverative errors, with higher values on these metrics indicating
poorer set-shifting and poorer reversal learning (a specific form of set-shifting)
respectively. The WCST administered in Study 2 did not feature sound effects.

8.3.3. Questionnaire Measures. The following sections detail the
questionnaire measures administered in Study 2.

8.3.3.1. The 7 Up 7 Down Inventory. The 7U7D was administered to assess
mania-proneness and depression-proneness, as per Study 1. As with Study 1, the
7U7D items were administered within the greater GBI item set, in order to collect
data for an unrelated study. Item 7 of the mania-proneness scale was deleted for the
purpose of calculating mania-proneness scores in order to reduce measurement error,
concordant with the findings of Study 1.

8.3.3.2. The BIS/BAS Scales. The BBS was administered to assess BAS-D,
BAS-FS, BAS-RR, and trait BIS, as per Study 1. BAS-D, BAS-FS, and BAS-RR
were administered in accordance with the scale as scored. Item 2 and Item 22, both pertaining to trait BIS, were deleted in order to reduce measurement error, concordant with the findings of Study 1.

**8.3.3.3. The Positive and Negative Affect Schedule.** The 20-item PANAS (Watson, Clark, & Tellegen, 1988) was used to assess state mood (see Chapter 5) in terms of PA (10 items) and NA (10 items). Single-word affective descriptors are rated on a scale ranging from 1 (*Very slightly or not at all*) to 5 (*Extremely*) with regards to how the participant is feeling “right now, that is, in the present moment”. This leads to a potential scoring range of 10 to 50 per mood variable, with higher scores indicating greater intensity of the mood variable in question. The PANAS has exhibited excellent internal consistency (PA Cronbach’s $\alpha = .89$, NA Cronbach’s $\alpha = .85$) and has demonstrated validity in terms of expected correlations with established measures of depression, anxiety, distress, and other affective constructs (Watson, Clark, & Tellegen, 1988).

**8.3.4. Study design.** Participants completed Study 2 in the order of (i) basic demographic questions; (ii) the PANAS; (iii) the WCST; (iv) the BART; (v) the CS-IGT; (vi) the GDT; (vii) a second administration of the PANAS; (viii) the 7U7D; and (ix) the BBS. After completion of the WCST but prior to commencement of the BART, an announcement was made notifying them that they would receive a chocolate bar if an aggregate of their BART, CS-IGT, and GDT monetary earnings placed them in the top 20% of respondents. This was an attempt to elicit greater engagement on the risky decision-making tasks by motivating participants to feel competitive. Data collection for Study 2 was carried out in group testing sessions.

The order of task administration was specially chosen to minimise cross-task interference. The WCST was administered first so that it could be separated from the announcement regarding the chocolate bar, therefore maintaining its lack of reward cues. The BART was administered second in order to separate the WCST from the CS-IGT, which was administered third. This separation was desirable in case the presence of an earlier set-shifting task inadvertently primed greater set-shifting ability on a consecutive set-shifting task. The GDT was administered fourth as this task has the greatest probability of loss in the form of negative scores, and it was possible that this could alter responses to the other risky decision-making tasks. Two administrations of the PANAS were made, once prior to the behavioural tasks and
once following their completion, in order to check for a change in state mood over the course of behavioural task administration. Finally, the 7U7D and BBS were administered at the conclusion of the Study 2 protocol as it was judged that self-report trait questionnaires would be less susceptible to fatigue effects than behavioural task responses. As the nature of the tasks necessitated this specific order of administration, counterbalancing could not be implemented to check for order or practice effects.

To enhance external validity, the administration of Study 2 included two strategies to maximise participants’ motivation towards rewards across tasks. These strategies were implemented so that participants would be more emotionally and motivationally engaged with the risky decision-making tasks, more closely approximating a real-life risky decision-making context. Intrinsic and extrinsic motivation were targeted separately (Ryan & Deci, 2000). Intrinsic motivation was fostered by encouraging competition between participants, using group testing sessions where participants were informed that their goal was to obtain as high a monetary earning as possible, and that a leader-board comparing scores would be maintained. Extrinsic motivation was fostered by offering a chocolate bar as a reward for performance placing participants in the top 20% of the leader-board. A 100-gram bar of plain milk chocolate was chosen in order to present a reward that was likely to be desirable and instantly gratifying to participants. Plain chocolate was selected so as to appeal to a majority of participants by minimising extra ingredients that might bias personal preference, with the most recently available market research indicating that Cadbury brand chocolate bars were the most popular Australian chocolate bar in 2011 (Paish, 2012). A chocolate bar was also chosen due to its objectively low financial value, due to the ethical consideration of not making participants feel coerced into participating.

Study 2 involved a small element of deception. As noted above, participants were informed that they would only receive a chocolate bar if their combined BART, CS-IGT, and GDT monetary earnings placed them in the top 20% of respondents. However, all participants received a chocolate bar following completion of Study 2 and no leader-board of participant monetary earnings was actually maintained in testing sessions. Participants were debriefed regarding the nature of the deception immediately following participation. Deception was deemed necessary in order to
increase the participant engagement in the behavioural tasks whilst still providing a fair and consistent reward. Fairness was an especially important consideration given that the probabilistic nature of risky decision-making tasks means that monetary earnings are more the result of chance than of individual participant skill. Monetary scoring for the BART, CS-IGT, and GDT was depicted as Australian dollars, and participants were made fully aware that their monetary earnings on the behavioural tasks would not be converted into real currency.

**8.3.5. Procedure.** After agreeing to participate, participants booked themselves into one of ten different sessions, either via an online booking system (five sessions for first-year psychology students) or through direct communication with the lead investigator (five sessions for the sample of convenience). Participants completed the demographic questions, cognitive tasks, and self-report measures in a computer room with other participants who were completing the protocol at the same time. Administration of the entire protocol took 90 minutes on average. The entire protocol was administered online using the Inquisit program (Millisecond Software, Seattle, Washington), which automatically transferred data to an online spreadsheet. The researcher was present in the computer room for the entirety of all testing sessions.

Upon being seated, participants were provided with an informed consent form broadly outlining the research protocol and informing them of their right to withdraw from the study at any time. Prior to commencing the task, participants were instructed to mute their mobile phone, log into a computer, set the computer’s audio output to a level of 15, and to ensure that their computer monitor was set to the recommended display resolution (1440 × 900 for the majority of computers used). Participants were also asked to adjust the brightness and display height of the computer monitor to a level that they found comfortable to maintain focus on. Participants were informed that they could expect to hear sounds from the computers of other participants whilst they were completing the behavioural tasks, but that they should focus on their own computer and their own progression through the Study 2 protocol.

Once the protocol commenced, participants completed the demographic questions and WCST, at which time they reached the message informing them that their combined total score for the next three tasks (“a balloon game, a card game,
and a dice game”, referring to the BART, CS-IGT, and GDT respectively) could yield a chocolate bar as a reward should their score place them within the top 20% of participants. Participants were instructed to wait patiently at this message until all participants in their testing session had reached the same point, at which time the researcher reiterated the message verbally, presented the participants with the box of chocolate bars that were to be available as rewards, and instructed the participants to continue with the protocol. From this point in the experiment the box of chocolate bars was placed on the researcher’s desk at the front of the room within full view of the participants. Participants who completed the protocol were asked to simply sit quietly and wait for the remainder of the participants in their testing session to finish.

Once all participants in the testing session had completed the protocol, the lead investigator debriefed them as to the element of deception involved in the study. Participants were provided with the contact details of Swinburne University Human Research Ethics Committee and the Swinburne Psychology Clinic in the event that participation in the experiment had caused them distress, and were asked not to disclose the deception involved in the protocol to their peers until after the date of the final testing session. Following this, participants were provided with one chocolate bar each. The rationale, design, and procedure of Study 2 were approved by the Swinburne University Human Research Ethics Committee (see Appendix 5).

8.3.6. Data reduction and analysis. Once all testing sessions were completed, the data were downloaded from the online storage facilities of the Inquisit website and prepared for analysis by identifying the chosen metrics for each behavioural task and collating this data by participant. Data were then analysed using SPSS Version 21.0.

Bivariate correlations were conducted as the primary means of hypothesis testing in Study 2. To minimise the likelihood of Type I statistical error, a more conservative significance threshold was set by dividing the conventional significance threshold of \( p < .05 \) by two. The corrected significance threshold used throughout Study 2 was thus \( p < .025 \). This threshold was chosen to be less conservative than the corrected threshold used for Study 1 due to the smaller number of participants in Study 2 and the more exploratory nature of the study.

Hierarchical multiple regression analyses controlling for PA and NA were used to assess the effect of state mood. Mediation modelling was then used to assess
whether relationships identified by either bivariate correlations or by the hierarchical regression analyses were due to formal mediation pathways. For both the hierarchical multiple regression analyses and mediation modelling, results from the first administration of the PANAS were used. This decision was made as the first administration of the PANAS occurred immediately prior to administration of the behavioural tasks. Exploratory testing conducted using the second administration of the PANAS, provided immediately following the behavioural tasks, demonstrated no difference in pattern of results based on which PANAS administration was used.

Due to its length and complexity, the CS-IGT was analysed as blocks of 20 trials each rather than as one unitary measure. Initially, correlations with other task outcomes were examined using CS-IGT selections for individual blocks as a measure of risky decision-making. Prior to testing Hypothesis 2.4, concerning set-shifting, a prototypical CS-IGT learning curve was created by examining mean CS-IGT selections for each block of the CS-IGT. This allowed identification of trends in deck selections that occurred over time and in response to shifts in underlying deck rule. To examine set-shifting on the CS-IGT, difference scores between consecutive blocks were then analysed for the purpose of hypothesis testing.

Mediation modelling was used to assess whether any changes in correlation resulting from the inclusion of PA and NA in the hierarchical regression analyses could be explained as statistical mediation. Mediation modelling was conducted using the procedure published by Preacher and Hayes (2004). This procedure expands on Baron and Kenny’s (1986) procedure for testing mediation by allowing for differentiation and quantification of the effect of multiple mediating variables. Unstandardised $B$ coefficients, although not directly comparable, are judged to be more appropriate to interpret for this form of regression (Preacher & Hayes, 2004), and hence standardised $\beta$ coefficients are not provided. Indirect mediating pathways are computed via bootstrapping, whereby the estimated population characteristics used in the pathway computations are obtained by randomly selecting a large series of sub-samples and extrapolating population parameters from the central tendency and variation across these sub-samples. For the present study, bootstrapping utilised 5,000 sub-samples. Random selection of sub-samples means that bootstrapped estimates will vary slightly in the event that an analysis is replicated. Estimation of significance for bootstrapped indirect mediation pathways assessed via bootstrapping.
was performed using the 95% confidence interval rather than conventional null-hypothesis significance testing (Preacher & Hayes, 2004). A pathway was judged to be significant when the 95% confidence interval did not contain zero. Bias-corrected confidence intervals were used for determining significance in order to adjust for variability across bootstrapping samples.

8.4. Study 2 Results

8.4.1. Overview of analyses. Prior to analysis, the data were screened for outliers and missing values. Descriptive statistics for the 7U7D and BBS data were then examined, followed by bivariate correlations between the 7U7D and BBS variables. Bivariate correlations between the different behavioural task outcomes used for hypothesis-testing were also analysed. Descriptive statistics and correlations with the 7U7D and BBS variables were then examined for (i) the BART, the GDT, and Block 5 of the CS-IGT (testing Hypotheses 2.1, 2.2, and 2.3 respectively); (ii) difference in selections between blocks on the CS-IGT (testing Hypothesis 2.4); and (iii) the WCST (providing a contrast with the results of Hypothesis 2.4).

Block 5 of the CS-IGT was examined along with the BART and GDT, separately to full analysis of the CS-IGT. This was done because Block 5 of the CS-IGT is functionally identical to the final block of trials on the standard IGT, and hence in this context Block 5 CS-IGT selections operated as a measure of risky decision-making with no set-shifting occurring. Prior to full analysis of the CS-IGT data, mean selections were examined to generate a prototypical learning curve over the course of the task. This analysis informed interpretation of the analysis of set-shifting using difference score correlations.

Following the analysis of bivariate correlations, hierarchical multiple regression analyses were then conducted to control for PA and NA. Finally, formal mediation models were conducted to assess whether relationships identified during the hierarchical multiple regression analyses were occurring due to statistical mediation. With regards to the CS-IGT, these analyses were only conducted to examine risky decision-making, and hence were not conducted for the CS-IGT difference scores used to assess reward-laden set-shifting.

8.4.2. Data screening and treatment of missing values. The data were screened for the presence of outliers and the assumption of normality was tested.
Several univariate outliers were discovered with regards to the trait data. However, no change in pattern of results occurred whether or not these outliers were included in the analysis. Hence, the decision was made to retain these outliers to maintain the data as collected and to allow a wider distribution of scores. No outliers were identified within the behavioural task responses.

All variables approximated a normal distribution, with the exception of mania-proneness and depression-proneness, which were strongly positively skewed. This was to be expected as the 7U7D assesses psychopathological constructs, extremes of which are statistically rare in the population. Because the level of skew was intrinsic to the variable and for the value of transparently retaining the data as collected form, the decision was made not to transform the 7U7D data in order to force a normal distribution. This approach was supported by a lack of change in pattern of results when testing using transformed data was attempted for comparison.

The online Study 2 protocol was configured in a way that did not allow missing values. However, two participants experienced a problem where their computer screen resolution was set at a level where their monitor could not display all of the 7U7D questions, and hence these participants had to be manually progressed to the next step in the protocol. This meant that for two participants no 7U7D data could be collected. This error was corrected for all subsequent trials of the GBI, and the data from the two participants was retained for use in analyses involving the BBS constructs and behavioural task outcomes. However, note that while the total sample $N$ of 118 is provided for simplicity in the tables below, for all Study 2 analyses involving 7U7D data, the specific $N$ is in fact 116, with pairwise deletion of missing data.

8.4.3. Correlations between BBS and 7U7D constructs. Descriptive statistics and bivariate correlations between the 7U7D and BBS variables are presented below in Tables 8.1 and 8.2.
Table 8.1

Descriptive Statistics for the Study 2 7U7D and BBS Variables

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>Actual range</th>
<th>Potential range</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>7U7D</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>4.09 (3.04)</td>
<td>0-13</td>
<td>0-18</td>
<td>.97</td>
<td>.71</td>
<td>.74</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>5.22 (5.11)</td>
<td>0-21</td>
<td>0-21</td>
<td>1.20</td>
<td>.72</td>
<td>.94</td>
</tr>
<tr>
<td>BBS</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>BAS-D</td>
<td>10.81 (2.13)</td>
<td>4-16</td>
<td>4-16</td>
<td>-.26</td>
<td>.54</td>
<td>.73</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>12.10 (1.98)</td>
<td>7-16</td>
<td>4-16</td>
<td>-.11</td>
<td>-.33</td>
<td>.61</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>17.33 (1.69)</td>
<td>11-20</td>
<td>5-20</td>
<td>-.50</td>
<td>.50</td>
<td>.54</td>
</tr>
<tr>
<td>Trait BIS</td>
<td>12.61 (1.93)</td>
<td>8-16</td>
<td>4-16</td>
<td>-.18</td>
<td>-.60</td>
<td>.61</td>
</tr>
</tbody>
</table>
N = 118

Note. Standard deviations are presented in parentheses following the relevant mean.

Table 8.2

Intercorrelation between the 7U7D and BBS Variables in Study 2

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mania-proneness</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. Depression-proneness</td>
<td>.41***</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. BAS-D</td>
<td>.08</td>
<td>.26**</td>
<td>–</td>
<td></td>
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<td></td>
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<tr>
<td>4. BAS-FS</td>
<td>.32**</td>
<td>.17</td>
<td>.25***</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. BAS-RR</td>
<td>.17</td>
<td>-.03</td>
<td>-.42***</td>
<td>.34***</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>6. Trait BIS</td>
<td>-.01</td>
<td>.32***</td>
<td>-.07</td>
<td>-.00</td>
<td>.32***</td>
<td>–</td>
</tr>
</tbody>
</table>
N = 118

Note. Two participants did not complete the GBI, hence for correlations with the GBI N = 116.

Correlations of .00 indicate that the actual correlation was lower than .001
* p < .25 (corrected threshold), ** p < .01, *** p < .001

Several discrepancies in pattern of correlation were present between the smaller Study 2 sample and the larger Study 1 sample. In Study 2, mania-proneness was no longer significantly correlated with BAS-D, BAS-RR, or BIS, despite weak yet significant correlations occurring in Study 1. A stronger positive correlation was found between mania-proneness and BAS-FS in Study 2 than was found in Study 1. Depression-proneness was no longer significantly correlated with BAS-FS and BAS-RR in Study 2, despite weak yet significant correlations being demonstrated in Study 1.
Before commencing hypothesis-testing, bivariate correlations between the behavioural task outcomes were examined. Table 8.3 shows that no significant correlations between metrics from the BART, GDT, CS-IGT, and WCST were found. Within the CS-IGT, selections for several blocks were correlated, with selections on earlier blocks tending to be positively correlated with one another, whilst selections on later blocks tending to negatively correlated with one another. As expected, the two WCST metrics were strongly albeit negatively correlated, indicating that the greater the participants’ WCST errors relative to their total number of trials, the lower their number of perseverative errors relative to their total number of errors.
Table 8.3

Correlations between Study 2 Task Outcomes

<table>
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<th>1.</th>
<th>2.</th>
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<th>4.</th>
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<th>11.</th>
<th>12.</th>
<th>13.</th>
<th>14.</th>
<th>15.</th>
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</thead>
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<tr>
<td>1. BART AMP</td>
<td>-</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. GDT</td>
<td>-.12</td>
<td>-.25</td>
<td>-.36</td>
<td>-.41</td>
<td>.06</td>
<td>.06</td>
<td>.35</td>
<td>.08</td>
<td>.30</td>
<td>-.07</td>
<td>-.05</td>
<td>-.09</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
</tr>
<tr>
<td>3. CS-IGT 1</td>
<td>-.16</td>
<td>-.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4. CS-IGT 2</td>
<td>-.01</td>
<td>.03</td>
<td>.37</td>
<td>.34</td>
<td>.02</td>
<td></td>
<td></td>
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<td>5. CS-IGT 3</td>
<td>-.04</td>
<td>.05</td>
<td>.37</td>
<td>.34</td>
<td>.02</td>
<td></td>
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<tr>
<td>6. CS-IGT 4</td>
<td>-.13</td>
<td>.09</td>
<td>.13</td>
<td>.33</td>
<td>.52</td>
<td>.39</td>
<td>.52</td>
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<tr>
<td>7. CS-IGT 5</td>
<td>-.10</td>
<td>-.13</td>
<td>.14</td>
<td>.22</td>
<td>.05</td>
<td>.12</td>
<td>-.17</td>
<td>.24</td>
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<td>8. CS-IGT 6</td>
<td>-.15</td>
<td>.03</td>
<td>.18</td>
<td>-.02</td>
<td>-.03</td>
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<td>.25</td>
<td>.36</td>
<td>.41</td>
<td>.06</td>
<td>.06</td>
<td>.30</td>
<td>.05</td>
</tr>
<tr>
<td>9. CS-IGT 7</td>
<td>-.10</td>
<td>-.13</td>
<td>.10</td>
<td>.00</td>
<td>-.36</td>
<td>-.36</td>
<td>-.45</td>
<td>.16</td>
<td>.08</td>
<td>.30</td>
<td>.05</td>
<td>.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. CS-IGT 8</td>
<td>-.09</td>
<td>.10</td>
<td>.00</td>
<td>-.25</td>
<td>-.36</td>
<td>-.41</td>
<td>.06</td>
<td>.06</td>
<td>.30</td>
<td>.05</td>
<td>.39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. CS-IGT 9</td>
<td>-.17</td>
<td>.20</td>
<td>.10</td>
<td>-.19</td>
<td>-.17</td>
<td>-.36</td>
<td>-.45</td>
<td>.16</td>
<td>.08</td>
<td>.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. CS-IGT 10</td>
<td>-.01</td>
<td>.03</td>
<td>.00</td>
<td>.05</td>
<td>.05</td>
<td>.02</td>
<td>-.08</td>
<td>.20</td>
<td>.07</td>
<td>.05</td>
<td>.09</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
</tr>
<tr>
<td>13. CS-IGT 11</td>
<td>.07</td>
<td>.08</td>
<td>.05</td>
<td>-.13</td>
<td>-.04</td>
<td>-.14</td>
<td>-.06</td>
<td>.13</td>
<td>-.27</td>
<td>.00</td>
<td>.05</td>
<td>.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. WCST Error %</td>
<td>-.03</td>
<td>-.06</td>
<td>.00</td>
<td>.05</td>
<td>-.12</td>
<td>-.06</td>
<td>-.15</td>
<td>.11</td>
<td>-.01</td>
<td>.03</td>
<td>.06</td>
<td>.11</td>
<td>.10</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td>15. WCST Pers. %</td>
<td>.09</td>
<td>.02</td>
<td>-.03</td>
<td>.01</td>
<td>.14</td>
<td>.09</td>
<td>.16</td>
<td>-.12</td>
<td>-.04</td>
<td>-.08</td>
<td>-.19</td>
<td>-.12</td>
<td>-.03</td>
<td>-.03</td>
<td>-.03</td>
</tr>
</tbody>
</table>

Note. GDT metric defined as number of advantageous decisions minus number of disadvantageous decisions on the GDT. CS-IGT metric defined as number of advantageous selections minus number of disadvantageous selections within each CS-IGT block. WCST Pers. % refers to the percentage of total WCST errors that were perseverative errors. Note that significance in this table is tested at $p < .05$, as no hypotheses were ventured regarding inter-task correlations. * $p < .25$ (corrected threshold), ** $p < .01$, *** $p < .001$
8.4.4. Hypothesis-testing for risky decision-making outcomes. Descriptive statistics and bivariate correlations for BART AMP and GDT selections (advantageous minus disadvantageous) are depicted below in Table 8.4 and Table 8.5. Bivariate correlations are also presented for Block 5 of the CS-IGT, although descriptive statistics for each block of the CS-IGT are not presented until full analysis of the CS-IGT in Section 8.3.2.3.

Table 8.4

<table>
<thead>
<tr>
<th></th>
<th>$M$ ($SD$)</th>
<th>Actual Range</th>
<th>Potential Range</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>BART AMP</td>
<td>29.95 (11.58)</td>
<td>3.59-60.67</td>
<td>0-127</td>
<td>0.29</td>
<td>-0.06</td>
</tr>
<tr>
<td>GDT Selections</td>
<td>4.92 (9.54)</td>
<td>-18-18</td>
<td>-18-18</td>
<td>-0.70</td>
<td>0.35</td>
</tr>
<tr>
<td>Block 5 CS-IGT Selections</td>
<td>2.12 (10.05)</td>
<td>-20-20</td>
<td>-20-20</td>
<td>.21</td>
<td>-.49</td>
</tr>
</tbody>
</table>

Note. The values provided for BART AMP under the column Potential Range are provided for clarity and completeness, but are entirely probability-driven and beyond the participant’s direct control; it is highly improbable that scores would approach the maximum point of the AMP range. For the BART parameters set in the present study, the theoretical optimum number of pumps was 64 per trial.

The mean BART AMP results shown above are similar to the means found in previous research (e.g., Aklin et al., 2005, Lejuez et al., 2002, and Lejuez et al., 2005), although mean GDT selections were lower than those found by Brand et al. (2008). Block 5 CS-IGT selections appeared similar to the results of non-clinical participants in prior IGT research (Overman & Pierce, 2013).
Table 8.5

Correlations between 7U7D and BBS Variables and Risky Decision-Making Outcomes in Study 2

<table>
<thead>
<tr>
<th></th>
<th>BART AMP</th>
<th>GDT Selections</th>
<th>Block 5 CS-IGT Selections</th>
</tr>
</thead>
<tbody>
<tr>
<td>7U7D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>-.16</td>
<td>-.08</td>
<td>.04</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>-.28**</td>
<td>-.09</td>
<td>-.02</td>
</tr>
<tr>
<td>BBS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS-D</td>
<td>.09</td>
<td>-.06</td>
<td>.06</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>.13</td>
<td>.04</td>
<td>-.05</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>.07</td>
<td>.13</td>
<td>.05</td>
</tr>
<tr>
<td>BIS</td>
<td>-.09</td>
<td>-.01</td>
<td>-.05</td>
</tr>
</tbody>
</table>

N = 118

* p < .25 (corrected threshold), ** p < .01, *** p < .001

Hypothesis 2.1 was not supported, as mania-proneness was not significantly correlated with BART AMP, GDT selections, or Block 5 CS-IGT selections. Also contrary to hypotheses, the non-significant association between mania-proneness and BART-AMP was in the negative direction. A negative correlation was found between BART AMP and depression-proneness. No significant correlations were found.

8.4.5. Analysis of CS-IGT learning patterns. In order to inform analysis of CS-IGT performance, the data were first subjected to a within-groups analysis of variance (ANOVA), in order to identify key points during task administration that reflected participant adaptation to the three shifts in underlying deck rule. The 220 CS-IGT trials were broken down into eleven 20-trial blocks. Mean CS-IGT selections (advantageous minus disadvantageous) per block are displayed in Table 8.6.
Table 8.6
Descriptive Statistics for each Block of the Study 2 CS-IGT

<table>
<thead>
<tr>
<th>Block</th>
<th>Trials</th>
<th>M (SD)</th>
<th>Actual Range</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Original IGT protocol</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS-IGT 1</td>
<td>1-20</td>
<td>-3.64 (6.59)</td>
<td>-16-20</td>
<td>.59</td>
<td>1.05</td>
</tr>
<tr>
<td>CS-IGT 2</td>
<td>21-40</td>
<td>-1.14 (8.93)</td>
<td>-20-20</td>
<td>.34</td>
<td>.61</td>
</tr>
<tr>
<td>CS-IGT 3</td>
<td>41-60</td>
<td>0.56 (9.53)</td>
<td>-20-20</td>
<td>.41</td>
<td>-.14</td>
</tr>
<tr>
<td>CS-IGT 4</td>
<td>61-80</td>
<td>0.88 (10.20)</td>
<td>-20-20</td>
<td>.21</td>
<td>-.30</td>
</tr>
<tr>
<td>CS-IGT 5</td>
<td>81-100</td>
<td>2.12 (10.05)</td>
<td>-20-20</td>
<td>.21</td>
<td>-.49</td>
</tr>
<tr>
<td><strong>First contingency shift</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS-IGT 6</td>
<td>101-120</td>
<td>-3.00 (7.78)</td>
<td>-20-20</td>
<td>-.34</td>
<td>.04</td>
</tr>
<tr>
<td>CS-IGT 7</td>
<td>121-140</td>
<td>-3.27 (8.50)</td>
<td>-20-20</td>
<td>.04</td>
<td>.31</td>
</tr>
<tr>
<td><strong>Second contingency shift</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS-IGT 8</td>
<td>141-160</td>
<td>-0.93 (8.92)</td>
<td>-20-20</td>
<td>.00</td>
<td>.02</td>
</tr>
<tr>
<td>CS-IGT 9</td>
<td>161-180</td>
<td>-1.03 (9.55)</td>
<td>-20-20</td>
<td>-.12</td>
<td>.2-</td>
</tr>
<tr>
<td><strong>Third contingency shift</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS-IGT 10</td>
<td>181-200</td>
<td>1.38 (7.85)</td>
<td>-20-20</td>
<td>.01</td>
<td>.42</td>
</tr>
<tr>
<td>CS-IGT 11</td>
<td>201-220</td>
<td>4.07 (8.57)</td>
<td>-20-20</td>
<td>-.10</td>
<td>.45</td>
</tr>
</tbody>
</table>

N = 118

Note. The absolute potential scoring range for each block was -20 (all selections disadvantageous) to 20 (all selections advantageous).

A one-way repeated measures analysis of variance was performed to compare CS-IGT selections across the eleven 20-trial blocks. Although repeated measures ANOVA is robust to heterogeneity of variance provided that intervals possess equal numbers of participants, Greenhouse-Geisser correction was used to provide a more conservative estimation of significance. The results of the ANOVA showed that there were significant differences in CS-IGT performance over time, $F(10, 1170) = 9.28, p < .001$, $MSE = 74.77$, partial $\eta^2 = .07$, observed power = 1.00. To identify these differences, planned contrasts were run comparing each block’s mean to that of the previous block. The planned contrasts revealed that a significant change in CS-IGT performance had occurred for Block 2 - 1, Block 3 - 2, Block 4 - 3, Block 5 - 4, Block 6 - 5, Block 7 - 4, Block 10 - 9, and Block 11 – 10 (all contrasts $p < .05$). A graph of CS-IGT performance over the course of the task is displayed below in Figure 8.1. Higher values indicate a greater frequency of advantageous selections, whereas lower values indicated a greater frequency of disadvantageous selections.
Figure 8.1 demonstrates the presence of an unexpected average pattern of learning effects across the CS-IGT, inconsistent with that found by Turnbull et al. (2006). CS-IGT performance was initially poor but steadily improved as participants became familiar with the task. As expected, performance worsened abruptly when the first rule shift occurred in Block 6. However, rather than the reoccurring decline in advantageous selections and later improvement following each rule shift found by Turnbull et al. (2006), in the present study average performance across the sample steadily improved despite subsequent rule changes in Block 8 and Block 10. Hypothesis testing related to CS-IGT must be understood in the context of this unexpected pattern of performance.

8.4.6. Hypothesis-testing for CS-IGT set-shifting. Bivariate correlations between CS-IGT difference scores and the 7U7D and BBS variables are shown in Table 8.7 across all 11 blocks of the CS-IGT.
Table 8.7

Correlations between 7U7D and BBS Variables and Difference in Decision-Making Between CS-IGT Blocks in Study 2

<table>
<thead>
<tr>
<th></th>
<th>CS-IGT 2-1</th>
<th>CS-IGT 3-2</th>
<th>CS-IGT 4-3</th>
<th>CS-IGT 5-4</th>
<th>CS-IGT 6-5</th>
<th>CS-IGT 7-6</th>
<th>CS-IGT 8-7</th>
<th>CS-IGT 9-8</th>
<th>CS-IGT 10-9</th>
<th>CS-IGT 11-10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7U7D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>.06</td>
<td>.03</td>
<td>-.05</td>
<td>-.02</td>
<td>.04</td>
<td>-.04</td>
<td>-.04</td>
<td>.00</td>
<td>.11</td>
<td>-.07</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>-.11</td>
<td>.09</td>
<td>-.12</td>
<td>.00</td>
<td>-.03</td>
<td>-.03</td>
<td>.11</td>
<td>.08</td>
<td>-.16</td>
<td>.12</td>
</tr>
<tr>
<td><strong>BBS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS_D</td>
<td>.20</td>
<td>-.06</td>
<td>.02</td>
<td>-.15</td>
<td>-.03</td>
<td>.15</td>
<td>-.15</td>
<td>-.02</td>
<td>.08</td>
<td>-.05</td>
</tr>
<tr>
<td>BAS_FS</td>
<td>.07</td>
<td>-.05</td>
<td>-.05</td>
<td>.01</td>
<td>-.02</td>
<td>.01</td>
<td>.02</td>
<td>.05</td>
<td>-.12</td>
<td>.00</td>
</tr>
<tr>
<td>BAS_RR</td>
<td>.15</td>
<td>-.01</td>
<td>.00</td>
<td>-.06</td>
<td>-.02</td>
<td>-.02</td>
<td>-.04</td>
<td>.02</td>
<td>.00</td>
<td>-.08</td>
</tr>
<tr>
<td>Trait BIS</td>
<td>-.06</td>
<td>.05</td>
<td>-.10</td>
<td>-.03</td>
<td>.01</td>
<td>.02</td>
<td>.08</td>
<td>.04</td>
<td>-.22*</td>
<td>.16</td>
</tr>
</tbody>
</table>

*N = 118

* p < .25 (corrected threshold), ** p < .01, *** p < .001
Contrary to hypotheses, no significant correlations between differences in CS-IGT selections and any of the trait variables were present for Block 6 - 5, Block 8 - 7, and Block 10 - 9. Significant correlations were not found for any pair of CS-IGT blocks. The correlation between BAS-D and CS-IGT Block 2 - 1 approached significance ($p < .05$), as did the correlation between trait BIS and CS-IGT Block 10 - 9. Correlation coefficients for CS-IGT difference scores where a shift in rule took place (CS-IGT Block 5 - 6, CS-IGT Block 8 - 7, and CS-IGT Block 11 - 10) did not appear to differ from those for block pairs that did not involve a shift in rule.

8.4.7. **Hypothesis-testing for WCST set-shifting.** Descriptive statistics and bivariate correlations for WCST total error percentage and WCST perseverative error percentage are presented below in Table 8.8 and Table 8.9.

### Table 8.8

*Descriptive Statistics for Study 2 WCST Performance*

<table>
<thead>
<tr>
<th></th>
<th>$M$ (SD)</th>
<th>Actual Range</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Errors (%)</td>
<td>48.20 (14.08)</td>
<td>16.67-80.73</td>
<td>.09</td>
<td>-0.46</td>
</tr>
<tr>
<td>Perseverative errors (%)</td>
<td>30.36 (22.29)</td>
<td>0-100</td>
<td>1.19</td>
<td>1.34</td>
</tr>
<tr>
<td>$N$ = 118</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* The potential range for WCST total error percentage and WCST perseverative error is 0% through 100%, however the number of trials that this percentage is obtained from fluctuates per participant based on participant performance. WCST perseverative error percentage was calculated as the percentage of total errors that were perseverative in nature, not the percentage of total trials.

### Table 8.9

*Correlations between 7U7D and BBS Variables and WCST Error Percentages in Study 2*

<table>
<thead>
<tr>
<th></th>
<th>WCST Error %</th>
<th>WCST Pers. %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7U7D</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>.03</td>
<td>-.02</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>-.04</td>
<td>-.05</td>
</tr>
<tr>
<td><strong>BIS/BAS Scales</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS-D</td>
<td>.02</td>
<td>.04</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>-.18</td>
<td>.14</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>.00</td>
<td>-.02</td>
</tr>
<tr>
<td>BIS</td>
<td>.06</td>
<td>-.08</td>
</tr>
<tr>
<td>$N$ = 118</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$, ** $p < .01$, *** $p < .001$
As Table 8.9 demonstrates, none of the 7U7D or BBS variables exhibited a significant correlation with either WCST error percentage metric. Contrary to the hypotheses, this result was not contrasted with a significant association with CS-IGT selections.

8.4.8. Summary of correlational data. Hypothesised correlations of mania-proneness with risky decision-making measured by the BART, GDT, and CS-IGT were not supported. Exploratory analyses found a significant negative correlation between BART AMP and depression-proneness, indicating that individuals higher in depression-proneness were less prone to risky decision-making during the BART. Hypothesised correlations of mania-proneness with CS-IGT difference scores were also not supported. No significant correlations were found between any of the 7U7D or BBS variables and WCST total error percentage or perseverative error percentage.

8.4.9. Hierarchical multiple regression analysis controlling for PA and NA. A series of two-step hierarchical multiple regression analyses were run to explore whether correlations between the 7U7D or BBS variables and the behavioural task outcomes would alter when state mood was controlled for. Prior to running the regression analyses, bivariate correlations between the 7U7D and BBS variables and PA and NA were examined. Descriptive statistics and bivariate correlations between PA and NA and the 7U7D and BBS variables are presented below in Table 8.10 and Table 8.11. Note that only PA and NA assessed during the first administration of the PANAS were used for analysis. PA and NA were not significantly correlated, \( r(n = 118) = -.16, p = .076 \).
Table 8.10

Descriptive Statistics for Study 2 PA and NA

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>Actual range</th>
<th>Potential range</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td>30.76 (7.65)</td>
<td>12-50</td>
<td>10-50</td>
<td>-.36</td>
<td>-.04</td>
<td>.91</td>
</tr>
<tr>
<td>NA</td>
<td>13.97 (4.68)</td>
<td>10-33</td>
<td>10-50</td>
<td>1.87</td>
<td>3.78</td>
<td>.85</td>
</tr>
</tbody>
</table>

N = 118

Table 8.11

Correlations between PA and NA and the 7U7D and BBS Variables in Study 2

<table>
<thead>
<tr>
<th></th>
<th>PA</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7U7D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>.03</td>
<td>.26**</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>-.24*</td>
<td>.57***</td>
</tr>
<tr>
<td>BBS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS-D</td>
<td>-.00</td>
<td>-.16</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>.13</td>
<td>.10</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>.39***</td>
<td>.04</td>
</tr>
<tr>
<td>Trait BIS</td>
<td>.10</td>
<td>.37***</td>
</tr>
</tbody>
</table>

N = 118

Note. Correlations of -.00 represent correlations of less than -.01, rather than true zero values.

* p < .25 (corrected threshold), ** p < .01, *** p < .001

Table 8.11 shows that depression-proneness was negatively correlated with PA, whilst BAS-RR was positively correlated with PA. Both mania-proneness and depression-proneness were positively correlated with NA, with the correlation between depression-proneness and NA being particularly strong. Trait BIS score was also positively correlated with NA.

Separate regression analyses were conducted for each of the three risky decision-making task metrics. PA and NA were entered as predictor variables in Step 1 of the regression, whilst the 7U7D and BBS variables were entered in Step 2 of the regression. This decision was made as preliminary analyses demonstrated no change in the pattern of results when (a) PA and NA were controlled in separate regressions; or (b) the 7U7D variables and BBS variables were entered in separate regressions. Table 8.12, Table 8.13, and Table 8.14 summarise the results of the 15 regression
analyses. Note that the $R^2$ index of model suitability is not summarised below, as the focus of these analyses was on exploring which variables appeared to be the primary contributors over and above basic affect, rather than examining the group of predictors as a holistic model.

Table 8.12

Study 2 Standardised Regression Coefficients for Hierarchical Multiple Regression Analyses Predicting Risky Decision-Making whilst Controlling for PA and NA

<table>
<thead>
<tr>
<th>BART AMP</th>
<th>GDT Selections</th>
<th>Block 5 CS-IGT Selections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>.17</td>
<td>-.06</td>
</tr>
<tr>
<td>NA</td>
<td>-.31*</td>
<td>-.15</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>.15</td>
<td>-.21</td>
</tr>
<tr>
<td>NA</td>
<td>-.25</td>
<td>-.17</td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>-.12</td>
<td>-.06</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>-.11</td>
<td>-.08</td>
</tr>
<tr>
<td>BAS-D</td>
<td>.00</td>
<td>-.25</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>.21</td>
<td>.07</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>-.04</td>
<td>.32*</td>
</tr>
<tr>
<td>Trait BIS</td>
<td>.03</td>
<td>-.02</td>
</tr>
</tbody>
</table>

$N = 118$

*Note. All values presented are standardised regression coefficients ($\beta$). $R^2$ is not presented as the focus of analysis was the individual variables rather than the model as a whole.

* $p < .25$ (corrected threshold), ** $p < .01$, *** $p < .001$

No support was found for Hypothesis 2.5, as no change in the effect of mania-proneness on risky decision-making was observable when controlling for PA and NA. The series of regressions revealed a number of relationships that were obscured when not controlling for PA and NA. However, these relationships were primarily identified for the BBS variables, with only one significant result emerging for the 7U7D variables that was not observed at a bivariate level. No predictors of BART AMP emerged when controlling for PA and NA. Depression-proneness was no longer a significant predictor of BART AMP in the hierarchical multiple regression analysis, although BAS-FS approached significance ($p < .05$) as a positive predictor. BAS-RR was a positive predictor of GDT selections, whilst BAS-D
approached significance as a negative predictor. Risky decision-making on the CS-IGT was not predicted by any of the 7U7D or BBS variables when PA and NA were controlled for. PA and NA were rarely significant predictors of the behavioural task outcomes, with the only significant association being that NA was a negative predictor of BART AMP in Step 1 of the BART AMP regression.

8.4.10. Indirect pathway analysis via formal mediation modelling. A series of formal mediation models were tested using the technique outlined by Preacher and Hayes (2004). Mediation models were tested based on the presence of significant relationships identified through either bivariate correlation (see 8.4.5) or through hierarchical multiple regression controlling for PA and NA (see 8.4.9). Accordingly, three potential mediation pathways were assessed. Table 8.15 summarises the outcome of each mediation model.

Table 8.13

<table>
<thead>
<tr>
<th>Summary of Study 2 Mediation Model Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Bivariate-</strong></td>
</tr>
<tr>
<td><strong>Regression-</strong></td>
</tr>
<tr>
<td><strong>Occurrence of mediation?</strong></td>
</tr>
<tr>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Depression-proneness → BART-AMP</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Mediated by both PA and NA</td>
</tr>
<tr>
<td>BAS-D → GDT Selections</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Not mediated by PA or NA</td>
</tr>
<tr>
<td>BAS-RR → GDT Selections</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Not mediated by PA or NA</td>
</tr>
</tbody>
</table>

*Note. All mediation models conducted with both PA and NA entered as potential mediating variables. Bivariate-level refers to significant relationships observable at the level of bivariate correlations, whilst regression-level refers to significant relationships found when controlling for PA and NA during hierarchical multiple regressions. Relationships that are not mediated by PA or NA are those for which no significant indirect effect has been found, with significance in this case defined as the absence of zero within the 95% confidence interval.*

As summarised in Table 8.15, only one of the three mediation models that were tested supported the occurrence of mediation. The relationship between depression-proneness and BART-AMP that had been evident a bivariate level was shown to be mediated by both PA and NA. Figure 8.2, below, presents this indirect pathway, quantified using unstandardised regression weights.
Figure 8.2. PA and NA as significant mediators of the relationship between depression-proneness and BART AMP.

As shown in Figure 8.2, both PA and NA mediated the relationship between depression-proneness and BART AMP, PA CI = [-.28, -.01], NA CI = [-.65, -.11]. Because the direct relationship between depression-proneness and BART AMP was non-significant, with only the indirect pathways demonstrating significance, full mediation can be said to have occurred. Although the unstandardized regression weight for NA was greater than that of PA, this difference was not statistically significant, contrast CI = [-.02, .56].

8.5. Bridging Discussion of Study 2

A brief review of hypothesis outcomes is provided in this section. Detailed discussion of the findings and limitations of Study 2 are provided in the main discussion towards the end of this document. Study 2 aimed to examine the link between bipolar disorder vulnerability and trait BAS using a behavioural task.
approach focusing on risky decision-making (BART, GDT, CS-IGT) and set-shifting (CS-IGT, WCST). Hypothesised associations of mania-proneness with increased risky-decision-making on the BART, CS-IGT, and GDT were not supported, nor did any hypothesised associations emerge by controlling for PA and NA or assessing mediation via PA and NA. The expected lack of association of mania-proneness and BAS-D with WCST total error percentage and WCST perseverative error percentage was supported. However, this null hypothesis was made as a contrast with the CS-IGT hypothesis tests, and in the absence of predicted relationships occurring, the inferences that can be drawn from the WCST results are limited. Although hypotheses were not supported, exploratory analyses identified two novel findings in Study 2. Depression-proneness was associated with decreased BART AMP, and this relationship was fully mediated by PA and NA. Higher BAS-RR predicted greater advantageous minus disadvantageous decisions on the GDT, but only when PA and NA were controlled for.

9. Study 3

9.1. Structure of Chapter 9

Chapter 9 presents the aims and hypotheses of Study 3, a description of methodology, the results, and a brief review of findings. Within the method section, participant characteristics, materials used, the data collection procedure, and the process used to analyse the data are reported. The results section begins with descriptive statistics for the 7U7D and BBS variables and for BART AMP, presented for the total sample and then by mood induction group. Following this, the hypotheses assessing the effect of the false feedback mood induction are tested using three mixed design ANOVA, examining group differences and changes in PA, NA, and BART AMP. Finally, hypothesis testing concerning the modulation of the false feedback mood induction by the 7U7D and BBS variables is examined via ANCOVA.

9.2. Specific Aims and Hypotheses of Study 3

The primary aim of Study 3 was to experimentally monitor the potential effect of state mood on risky decision-making responses, and to test whether this
effect was modulated by trait bipolar disorder vulnerability. Study 3 adopted a mixed
design involving between-group and repeated measures elements. A false feedback
mood induction was used to induce either positive or negative mood in two separate
groups of participants. Within these independent groups, participants completed a
repeated measures paradigm where a neutral mood induction was administered
followed by a valenced mood induction dependent on group.

The secondary aim of Study 3 was to assess the impact of the false feedback
mood induction on PA and NA and also to changes in risky decision-making
response. For Study 3, risky decision-making was operationalised solely as BART
AMP, as the false feedback mood induction procedure did not lend itself to a multi-
task protocol. BART AMP was chosen due to its explicit rule set and continuous
model of risky decision-making.

Investigation of the false feedback mood induction procedure served as a
manipulation check prior to investigating the primary aim of Study 3. Specific
predictions were tested regarding the effect of false feedback:

**Hypothesis 3.1.** It was hypothesised that participants in the positive false
feedback group would exhibit greater PA post-induction than pre-induction.

**Hypothesis 3.2.** It was hypothesised that participants in the negative false
feedback group would exhibit greater NA post-induction than pre-induction.

**Hypothesis 3.3.** It was hypothesised that the positive false feedback group
would exhibit greater PA post-induction than the negative false feedback group.

**Hypothesis 3.4.** It was also hypothesised that the negative false feedback
group would exhibit greater NA post-induction than the positive false feedback
group.

Specific predictions were also tested regarding the effect of the false
feedback mood induction on risky decision-making as measured by BART AMP:

**Hypothesis 3.5.** It was hypothesised that participants in the positive false
feedback group would exhibit increased BART AMP post-induction than pre-
induction.

**Hypothesis 3.6.** It was hypothesised participants in the negative false
feedback group would exhibit decreased BART AMP post-induction.
**Hypothesis 3.7.** Between groups, it was hypothesised that the positive false feedback group would exhibit greater BART AMP post-induction than the negative false-feedback group.

The final set of specific hypotheses for Study 3 addressed the primary aim of investigating the role of mania-proneness and trait BAS in changes to risky decision-making following false feedback mood induction:

**Hypothesis 3.8.** It was hypothesised that mood-based responsiveness to the positive false feedback mood induction, operationalised as the difference between pre-induction and post-induction PA, would covary based on mania-proneness, assessed using analysis of covariance (ANCOVA), with greater post-induction increase in PA occurring with greater mania-proneness.

**Hypothesis 3.9.** It was hypothesised that behavioural responsiveness to the positive false feedback mood induction, operationalised as the difference between pre-induction and post-induction BART AMP, would covary based on mania-proneness, assessed using ANCOVA, with greater post-induction increase in BART AMP occurring with greater mania-proneness.

As per Study 2, Hypotheses 3.8 and 3.9 were also explored with regard to BAS-D, in order to check the assumption that risky decision-making was a behavioural indicator of BAS. Similarly, effects based on depression-proneness, BAS-FS, BAS-RR, trait BIS and negative false feedback were explored in Study 3, but directional hypotheses were not set.

**9.3. Study 3 Method**

**9.3.1. Participants.** Recruitment for Study 3 was accomplished by providing the task and questionnaire battery as a voluntary learning exercise for students of an introductory psychology subject offered online by Swinburne University of Technology. Participants were not compensated for their time monetarily as in Study 2, but were expected to gain greater insight into one of their mandatory major assessment tasks by participating.

The total sample comprised 106 participants ($M = 34.96$ years, $SD = 9.75$ years), with ages ranging from 16 to 64 (median = 34). Of these, 82 (77.4%) were female ($M = 35.04$ years, $SD = 10.22$ years) and 24 (22.6%) were male ($M = 34.71$ years, $SD = 8.12$ years), with no significant difference in age present between
genders, \( t(104) = .14, p = .885 \) (heteroscedasticity assumed). With regards to country of origin, 83.0% of the total sample reported that they were born in Australia, whilst 97.2% endorsed that Australia was their primary country of residence.

Participants were haphazardly allocated to either the positive mood induction group or negative mood induction group. The positive mood induction group consisted of 50 participants (\( M = 35.88 \) years, \( SD = 9.83 \) years), with ages ranging from 18 to 57 years (median = 35). Of these, 40 (80.0%) were female (\( M = 36.15 \) years, \( SD = 10.52 \) years) and 10 (20.0%) were male (\( M = 34.80 \) years, \( SD = 6.71 \) years). The negative mood induction group consisted of 56 participants (\( M = 34.14 \) years, \( SD = 9.69 \) years), with ages ranging from 16 to 64 years (median = 33.5). Of these, 42 (75.0%) were female (\( M = 33.98 \) years, \( SD = 9.94 \) years) and 14 (25.0%) were male (\( M = 34.64 \) years, \( SD = 9.25 \) years). The positive mood induction group accounted for 47.17% of the total sample whilst the negative mood induction group accounted for 52.83% of the total sample. No significant difference in age was present between the mood induction groups, \( t(104) = .92, p = .362 \) (heteroscedasticity assumed), nor were any significant age differences present between genders within either of the mood induction groups, positive mood induction group \( t(48) = .39, p = .702 \), negative mood induction group \( t(54) = .22, p = .826 \).

9.3.2. Behavioural tasks. Two behavioural tasks were utilised in Study 3.

9.3.2.1. Stop-signal task. A computerised stop-signal task (SST; Logan, 1994; Verbruggen, Logan, & Stevens, 2008) was used to provide a context for the false feedback mood induction. Although the SST has traditionally been used as a measure of motor impulsivity in the form of the ability to inhibit a prepotent response (Logan, 1994), in the present study the SST was used purely as part of the false feedback procedure, and the SST scores were not analysed. The task consisted of a series of arrows presented on a computer monitor. Participants were instructed to press the “D” key on the keyboard with their left index finger if the arrow that was presented was pointing left, and the “K” key on the keyboard with their right index finger if the arrow was pointing right. Participants were asked to respond to the presented arrows as quickly as possible. However, if the arrow was accompanied by a sound (a monotone chime, serving as the “stop” signal) following its presentation, then participants were asked to halt their response and to simply wait for the next
trial to begin. Participants were informed that they would find it easy to halt their responses on approximately 50% of the “stop” trials, but that they were likely to find it difficult on the remaining 50% of stop trials. Participants were provided with false feedback on their SST performance in accordance with the mood induction condition that they had been allocated to (see Section 9.3.5, below).

9.3.2.2. Balloon Analogue Risk Task. The BART was administered to assess risky decision-making, operationalised as BART AMP. The BART was administered on two occasions due to the repeated measures element of the design. Both administrations of the BART used identical task parameters to those set in Study 2.

9.3.3. Questionnaire measures. The following sections detail the questionnaire measures administered in Study 3.

9.3.3.1. The 7 Up 7 Down Inventory. The 7U7D was administered to assess mania-proneness and depression-proneness, as per Study 1. As with Study 1, the 7U7D items were administered within the greater GBI item set, in order to collect data for an unrelated study. Item 7 of the mania-proneness scale was deleted for the purpose of calculating mania-proneness scores in order to reduce measurement error, concordant with the findings of Study 1.

9.3.3.2. The BIS/BAS Scales. The BBS was administered to assess BAS-D, BAS-FS, BAS-RR, and trait BIS, as per Study 1. BAS-D, BAS-FS, and BAS-RR were administered in accordance with the scale as scored. Item 2, Item 19, and Item 22, all pertaining to trait BIS, were deleted in order to reduce measurement error, concordant with the findings of Study 1.

9.3.3.3. The Positive and Negative Affect Schedule. The PANAS was administered to assess state mood, as per Study 2.

9.3.4. False feedback mood induction procedure. Study 3 implemented a false feedback mood induction following the logic of the procedure used by Farmer et al. (2006) and Roiser et al. (2009). Within Study 3, participants completed an initial SST administration and were provided with neutral false feedback (i.e., an indication of intermediate performance), and this served as a reference point for false feedback provided after a subsequent SST trial, where participants were provided with either positive (i.e., an indication of excellent performance) or negative (i.e., an indication of poor performance) dependent on mood induction group.
The SST was selected as the basis of the false feedback mood induction because (a) it belongs to the same genre of task as the “go” task used by Farmer et al. and Roiser et al.; (b) it is relatively quick to administer but provides no objective feedback cues and is a reasonably challenging task to master, rendering false feedback harder for participants to dispute; and (c) it is a behavioural decision-making task like the BART, and hence was unlikely to clash with the nature of the experiment and alert participants to the possibility of deception. Participants were not informed of the intention of the false feedback task during the experiment, as conscious awareness risks attenuating the mood induction effect (Schwarz, 1990), possibly prompting participant resistance or compensatory responding.

False feedback was provided with respect to error rate and reaction time as soon as the participant had completed the relevant administration of the SST. All participants were informed that their correct response rate following the first administration of the SST was 48.2%. Following the second SST administration, participants in the positive mood induction group were informed that their correct response rate was 87.5%, whilst participants in the negative mood induction group were informed that their correct response rate was 26.8%. In a similar manner, all participants were provided with feedback that their response speed was “Moderately Fast” following the first SST administration. Following the second series of trials the positive mood induction group were informed that their response speed was “Very Fast”, whilst the negative mood induction group was informed that their response speed was “Slow”. It was expected that when participants thought that their performance had improved relative to their first SST administration then they would experience increased positive mood, whilst when participants thought that their performance had improved relative to their first SST administration then they would experience increased negative mood.

9.3.5. Study design. Study 3 utilised a mixed design consisting of a within-groups condition (BART 1 performance versus BART 2 performance) and a between-groups condition (positive mood induction group versus negative mood induction group). Participants were haphazardly allocated to one of two mood induction conditions, affecting the feedback on their SST performance that they received prior to the administration of the second BART. This was the only difference in experimental procedure between the two groups. The mixed design of
Study 3 was judged to be more appropriate than a pure repeated measures design, where all participants experienced both positive and negative mood induction conditions, due to a paucity of published data on (i) the duration of mood induction effects; (ii) the relative strength of mood induction effects; (iii) the capacity of one mood induction effect to override with or interfere with another; and (iv) possible habituation or desensitisation to mood induction effects with repeated exposure and task fatigue.

After completing initial demographic questions, participants completed the SST followed by the BART. This was followed by a subsequent administration of the SST and BART (the within-groups element of the design). Participants then completed the 7U7D and BBS self-report questionnaires. The PANAS was administered on five occasions throughout the Study 3 protocol: (i) following the demographic questions; (ii) following the first SST administration (neutral false feedback); (iii) following the first BART administration; (iv) following the second SST administration (positive or negative false feedback dependent on group); and (v) following the second BART administration.

The second and fourth administrations of the PANAS were the focus of interest in Study 3, as these were the state mood measures administered immediately following either neutral or valenced false feedback. PA and NA scores assessed via the second administration of the PANAS are described in the analyses below as pre-induction PA and pre-induction NA respectively. PA and NA scores assessed via the fourth administration of the PANAS are described in the analyses below as post-induction PA and post-induction NA respectively. Scores from the first, third, and fifth administrations of the PANAS were not examined within the present project.

Counterbalancing of the repeated measures conditions in Study 3 was precluded by the logic of the false feedback mood induction procedure. If positive feedback was provided followed by neutral feedback, then the neutral feedback could be seen as negative in relation to previous performance, creating a negative mood induction. In contrast, if negative feedback was provided followed by neutral feedback, then the neutral feedback could be seen as positive in relation to previous performance, creating a positive mood induction. Hence, the first administration of the BART always followed neutral SST feedback, whilst the second administration always followed either positive or negative SST feedback dependent on condition.
9.3.6. Procedure. Study 3 was run as a voluntary undergraduate learning exercise that informed a major assessment task for introductory psychology students studying online at Swinburne University of Technology. It was hoped that participants who had a vested interest in familiarising themselves with the experiment would be more engaged when completing the task. The task and questionnaire battery was administered online using the Inquisit software application, with participants accessing the task through their university website. The experiment was made available for the first two weeks of the semester.

Group allocation was based on student number. Two links were provided to the task on the university website, one to the positive feedback condition and one to the negative feedback condition. Participant distribution between conditions was haphazardly randomised by requesting that participants select a link based on the second-last digit of their student identification number. Although participants were aware that should they participate in the study they would gain insight into the task being reported on in their major assessments, it was made clear that they would not be automatically disadvantaged by lack of participation, and that they could gain similar insight through reading about the study materials or by completing the task without submitting it. Participants were informed that their commencement and completion of the study protocol would be taken as implied consent for their data to be used in the analysis of the results.

The false feedback mood induction procedure raised a number of ethical considerations due to the use of deception. Before participating in the study, potential participants were able to access an information statement describing the purpose of the research and the layout of the study design. Participants were also informed that their participation in the study was voluntary, and that they had the right to withdraw from the study at any time. However, participants were not informed of the mood induction element of the study until a debriefing statement was made available following the experiment and explaining the nature of the mood manipulation. The study was approved by the Swinburne University Human Research Ethics Committee (see Appendix 6).

9.3.7. Data reduction and analysis. Two separate 2 (Mood state) × 2 (False feedback group) mixed design analyses of variance (ANOVA) were used to test the effect of the false feedback mood induction on state mood. The first ANOVA
examined pre-induction PA and post-induction PA, whilst the second ANOVA examined pre-induction NA and post-induction NA. A third 2 (BART AMP) × 2 (False feedback group) mixed design analysis of variance (ANOVA) was used to test the effect of the false feedback mood induction on risky decision-making, operationalised as pre-induction BART AMP and post-induction BART AMP. Planned contrasts were conducted to enable hypothesis-testing. Four hypotheses were tested by each ANOVA. Contrasts were tested at a significance level of \( p = .013 \), obtained by dividing the conventional significance level of \( p = .05 \) by the number of hypotheses being tested. A series of repeated measures ANCOVA were conducted to investigate whether any differences between pre-induction PA, NA, and BART AMP and post-induction PA, NA, and BART AMP covaried with any of the 7U7D and BBS variables. For all ANOVA and ANCOVA, lower bound correction was used for significance testing. Due to the large number of variables being tested and the exploratory nature of the project, the conventional significance threshold of \( p < .05 \) was divided by two to arrive at a more conservative threshold of \( p < .025 \).

9.4. Study 3 Results

9.4.1. Descriptive statistics. Descriptive statistics for the 7U7D and BBS variables across both mood induction groups are shown below in Table 9.1. Means and standard deviations are then presented by mood induction group in Table 9.2.
Table 9.1

Study 3 Descriptive Statistics for the 7U7D and BBS Variables across False Feedback Group

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>Actual range</th>
<th>Potential range</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7U7D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>2.89 (2.85)</td>
<td>0-11</td>
<td>0-21</td>
<td>.80</td>
<td>-.28</td>
<td>.78</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>6.15 (5.18)</td>
<td>0-21</td>
<td>0-21</td>
<td>.91</td>
<td>.36</td>
<td>.95</td>
</tr>
<tr>
<td><strong>BBS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS-D</td>
<td>11.02 (2.57)</td>
<td>4-16</td>
<td>4-16</td>
<td>-.24</td>
<td>.10</td>
<td>.85</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>11.74 (2.44)</td>
<td>6-16</td>
<td>4-16</td>
<td>-.23</td>
<td>-.46</td>
<td>.80</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>16.72 (2.34)</td>
<td>10-20</td>
<td>5-20</td>
<td>-.60</td>
<td>.08</td>
<td>.78</td>
</tr>
<tr>
<td>Trait BIS</td>
<td>12.58 (2.30)</td>
<td>6-16</td>
<td>4-16</td>
<td>-.49</td>
<td>-.12</td>
<td>.79</td>
</tr>
</tbody>
</table>

N = 106

Table 9.2

Study 3 Means and Standard Deviations for the 7U7D and BBS Variables by False Feedback Group

<table>
<thead>
<tr>
<th></th>
<th>Positive Group (n = 50)</th>
<th>Negative Group (n = 56)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td><strong>7U7D</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mania-proneness</td>
<td>2.72 (2.67)</td>
<td>3.04 (3.02)</td>
</tr>
<tr>
<td>Depression-proneness</td>
<td>6.84 (5.22)</td>
<td>5.54 (5.12)</td>
</tr>
<tr>
<td><strong>BBS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS-D</td>
<td>10.90 (2.65)</td>
<td>11.12 (2.49)</td>
</tr>
<tr>
<td>BAS-FS</td>
<td>11.12 (2.63)</td>
<td>12.29 (2.13)</td>
</tr>
<tr>
<td>BAS-RR</td>
<td>16.70 (2.33)</td>
<td>16.73 (2.37)</td>
</tr>
<tr>
<td>Trait BIS</td>
<td>12.68 (2.24)</td>
<td>12.50 (2.37)</td>
</tr>
</tbody>
</table>

A series of independent groups t-tests demonstrated no significant differences between the two groups on any of the 7U7D or BBS variables excepting BAS-FS, where participants in the negative false feedback group rated themselves significantly higher than those in the positive false feedback group, \( t(104) = 2.52, p = .013 \) (heteroscedasticity assumed).
Correlation analyses were conducted to assess whether relationships observed amongst the 7U7D and BBS variables were consistent across groups. Table 9.3 presents correlation coefficients for both the positive false feedback group (below the diagonal axis) and negative false feedback group (above the diagonal axis).

Table 9.3

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Coefficients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Mania-proneness</td>
<td>.32*</td>
<td>.31*</td>
<td>.36**</td>
<td>.27*</td>
<td>-.04</td>
<td></td>
</tr>
<tr>
<td>2. Depression-proneness</td>
<td>.46**</td>
<td>-.35**</td>
<td>-.22</td>
<td>-.14</td>
<td>.32**</td>
<td></td>
</tr>
<tr>
<td>3. BAS-D</td>
<td>.02</td>
<td>-.45**</td>
<td>.56***</td>
<td>.66***</td>
<td>-.08</td>
<td></td>
</tr>
<tr>
<td>4. BAS-FS</td>
<td>.22</td>
<td>-.31*</td>
<td>.64***</td>
<td>-.46***</td>
<td>-.37**</td>
<td></td>
</tr>
<tr>
<td>5. BAS-RR</td>
<td>.16</td>
<td>-.29*</td>
<td>.67***</td>
<td>.73***</td>
<td>.07</td>
<td>.07</td>
</tr>
<tr>
<td>6. Trait BIS</td>
<td>.21</td>
<td>.49***</td>
<td>-.21</td>
<td>-.05</td>
<td>-.10</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note. Correlations for the positive false feedback group (n = 50) are presented below the diagonal axis, whilst correlations for the negative false feedback group (n = 56) are presented above the diagonal axis.

Table 9.3 shows several differences in the pattern of correlations between the positive false feedback group and negative false feedback group. These differences were (i) a significant negative correlation between BAS-FS and trait BIS present only for the negative false feedback group; (ii) a significant positive correlations between mania-proneness and BAS-D, BAS-FS, and BAS-RR present only for the negative false feedback group; and (iii) significant negative correlations of depression-proneness with BAS-FS and BAS-RR present only for the positive false feedback group.

9.4.2. Examination of state mood differences based on false feedback condition. Table 9.4 describes pre-induction and post-induction mood state by mood induction group.
Table 9.4

Study 3 Mood State Means and Standard Deviations by False Feedback Group

<table>
<thead>
<tr>
<th></th>
<th>Positive false feedback group (n = 50)</th>
<th>Negative false feedback group (n = 56)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PA</td>
<td>NA</td>
</tr>
<tr>
<td>Post-induction</td>
<td>30.00 (9.77)</td>
<td>11.74 (2.76)</td>
</tr>
</tbody>
</table>

Note. Standard deviations are presented in parentheses alongside or below the mean.

A 2 (PA assessment) × 2 (False feedback group) mixed design ANOVA was used to test the effect of false feedback on PA. A significant interaction between PA assessment and false feedback group was present, $F(1, 104) = 21.01, p < .001, MSE = 11.42, \text{ partial } \eta^2 = .17, \text{ observed power } = 1.00$. Contrary to Hypothesis 3.1, this interaction suggested that within the positive false feedback group, PA remained relatively consistent from pre-induction to post-induction, whereas in the negative false feedback group PA declined from pre-induction to post-induction. Planned contrasts indicated that post-induction PA was significantly lower than pre-induction PA in the negative false feedback group, $t(55) = 5.67, p < .001$. No significant difference was found between post-induction and pre-induction PA for the positive false feedback group, $t(49) = 1.62, p = .111$. No significant difference in PA was present between the false feedback groups pre-induction, $t(104) = 0.22, p = .823$. Contrary to Hypothesis 3.3, no significant difference in PA was present between the false feedback groups post-induction, $t(104) = 1.97, p = .051$.

A 2 (NA assessment) × 2 (False feedback group) mixed design ANOVA was used to test the effect of false feedback on NA. A significant interaction between NA assessment and false feedback group was present, $F(1, 104) = 12.06, p = .001, MSE = 5.79, \text{ partial } \eta^2 = .10, \text{ observed power } = .93$. Contrary to Hypothesis 3.2, this interaction suggested that within the negative false feedback group NA remained relatively consistent pre-induction and post-induction, whereas in the positive false feedback group NA declined between pre-induction and post-induction. Planned contrasts indicated that post-induction NA was significantly lower than pre-induction NA in the positive false feedback group, $t(49) = 3.38, p = .001$. No significant
difference between post-induction and pre-induction NA was found for the negative false feedback group, $t(55) = 0.97, p = .337$. No significant difference in NA was present between the false feedback groups pre-induction, $t(104) = 0.32, p = .750$. However, supporting Hypothesis 3.4, post-induction NA was significantly lower in the positive false feedback group than in the negative false feedback group, $t(104) = 2.62, p = .010$. The lack of support for Hypotheses 3.1, 3.2, and 3.3 indicates that the false feedback mood induction did not function as anticipated in Study 3. Changes in PANAS scores were relatively weak, with the most pronounced change, a decrease in PA following negative false feedback, being unexpected. Because of these findings, the remainder of the Study 3 results should be considered being mindful that the false feedback mood induction did not operate as planned.

9.4.3. Examination of BART AMP differences based on false feedback condition. Table 9.5 describes pre-induction and post-induction BART-AMP by mood induction group.

Table 9.5

| Study 3 BART AMP Means and Standard Deviations by False Feedback Group |
|-----------------|---------|-------|--------|
|                  | M (SD)  | Actual range | Skew | Kurtosis |
| Positive false feedback group (n = 50) |
| Pre-induction BART AMP | 28.04 (12.86) | 6-73 | 1.12 | 2.23 |
| Post-induction BART AMP | 31.18 (14.97) | 8-75 | 1.03 | .99 |
| Negative false feedback group (n = 56) |
| Pre-induction BART AMP | 23.27 (12.53) | 6-61 | .99 | .60 |
| Post-induction BART AMP | 25.88 (12.29) | 7-53 | .52 | -.60 |

*Note. Although the potential range of BART AMP scores is technically 0-127, the task is probability-driven and it is highly improbable that participants would approach these extremes.*

A 2 (BART administration) × 2 (False feedback group) mixed design ANOVA was used to test the effect of false feedback on BART AMP. No significant interaction between BART assessment and false feedback group was present, $F(1, 104) = .12, p = .732, MSE = 31.83$, partial $\eta^2 < .01$, observed power = .06. However, the within-subjects main effect indicated that BART AMP was higher post-induction than pre-induction, $F(1, 104) = 13.70, p < .001, MSE = 31.83$, partial $\eta^2 < .12$, observed power = .96. Supporting Hypothesis 3.5, planned contrasts revealed that
post-induction BART AMP was significantly higher than pre-induction BART AMP for the positive false feedback group, $t(49) = 2.83, p = .007$. However, contrary to Hypothesis 3.6, an increase in BART AMP also approached significance ($p < .05$) for the negative false feedback group, $t(55) = 2.41, p = .019$. Contrary to Hypothesis 3.7, no significant difference in BART AMP was found between false feedback groups either pre-induction or post-induction, although this main effect approached the corrected significance threshold, $F(1, 104) = 4.26, p = .041, MSE = 157.32$, partial $\eta^2 < .04$, observed power = .53.

9.4.4. Analyses of covariance with the 7U7D and BBS variables entered as covariates. A series of within-groups ANCOVA were conducted, comparing (i) difference between pre-induction and post-induction PA; (ii) difference between pre-induction and post-induction NA; and (iii) difference between pre-induction and post-induction BART AMP. ANCOVA were run separately for each false feedback group and separately for each covariate in order to simplify interpretation (Tabachnick & Fidell, 2012), leading to 36 separate ANCOVA. The assumption of independence between the covariate and the experimental condition was satisfied for all of the traits except for BAS-FS. Only three of the 36 ANCOVA demonstrated a significant effect of the covariate ($p < .025$), whilst three ANCOVA approached significance ($p < .05$). The ANCOVA did not support Hypothesis 3.8 and 3.9. For clarity, only significant ANCOVA and ANCOVA approaching significance ($p < .05$) are reported in the following paragraph.

Depression-proneness, BAS-RR, and trait BIS score all significantly covaried with change in NA score in the positive false feedback group, depression-proneness $F(1, 48) = 9.11, p = .004, MSE = 7.23$, partial $\eta^2 = .16$, observed power = .84, BAS-RR $F(1, 48) = 9.25, p = .004, MSE = 7.21$, partial $\eta^2 = .16$, observed power = .84. BAS-FS and trait BIS both approached significance ($p < .05$) when entered as covariates of change in NA score in the positive false feedback group, BAS-FS $F(1, 48) = 5.22, p = .027, MSE = 7.76$, partial $\eta^2 = .10$, observed power = .61, trait BIS $F(1, 48) = 5.26, p = .026, MSE = 7.75$, partial $\eta^2 = .10$, observed power = .61. BAS-RR approached significance as a covariate of change in BART AMP for the negative false feedback group, $F(1, 54) = 4.43, p = .040, MSE = 30.92$, partial $\eta^2 = .076$, observed power = .54.
9.5. Bridging Discussion of Study 3

A brief review of hypothesis outcomes is provided in this section. Detailed discussion of the findings and limitations of Study 3 are provided in the main discussion towards the end of this document. Study 3 aimed to assess how a potential association between mania-proneness and risky decision-making as measured by BART AMP would be modulated by experimentally-induced state mood. In accordance with Hypothesis 3.4, the positive false feedback group exhibited less NA than the negative false feedback group post-induction. However, this was due to a significant post-induction decrease in NA for the positive false feedback group, rather than a significant post-induction increase in NA for the negative false feedback group. No support was found for (i) a hypothesised increase in PA for the positive false feedback group (Hypothesis 3.1); (ii) a hypothesised increase in NA for the negative feedback group (Hypothesis 3.2); and (iii) the positive false feedback group exhibiting greater PA than the negative false feedback group post-induction (Hypothesis 3.3). Interestingly, when taken together the results suggested that the false feedback mood induction operated by reducing the incongruent affect, with positive false feedback corresponding to a decrease in NA and negative false feedback corresponding to a decrease in PA. The mood induction procedure therefore appeared to have been effective, but in a manner opposite to the hypothesised mechanism of effect on state mood.

The results did not support the hypothesised effects of the false feedback mood induction on BART AMP. Although a hypothesised post-induction increase in BART AMP for the positive false feedback group was observed, supporting Hypothesis 3.5, an increase in post-induction BART AMP also approached significance for the negative group, contrary to Hypothesis 3.7. Contrary to Hypothesis 3.7, this meant that the positive false feedback group did not exhibit significantly greater post-induction BART AMP than the negative false feedback group. Hypotheses 3.8 and 3.9, concerning covariance between mania-proneness and changes in PA and BART AMP respectively, were also not supported. Exploratory analyses found that depression-proneness, BAS-RR, and trait BIS covaried with change in NA for the positive false feedback group.
10. Main Discussion

10.1. Structure of Chapter 10

The purpose of Chapter 10 is to present a discussion of the findings of the present project. This discussion commences with a review of the specific hypotheses of Study 1, Study 2, and Study 3. Following this review, the manner in which findings from the individual studies inform and address the overarching aim of the present project is considered. The overarching aim of the present project was to investigate the potential link between BAS and vulnerability to bipolar disorder in a non-clinical population. Although several specific hypotheses were supported, the majority of findings were negative, providing little support for an association between BAS and trait bipolar disorder vulnerability as operationalised here. A core innovation of the present project was that it examined BAS as both a self-reported trait and as task-based risky decision-making. However, the theoretical assumption that risky decision-making can be used as a behavioural measure of BAS was not supported in the present project, with only one significant positive correlation identified between risky decision-making and trait BAS (a correlation between GDT selections and BAS-RR in Study 2). This meant that the implementation of risky decision-making tasks may not have directly addressed the BAS theory of bipolar disorder.

After discussing the findings in the context of the overarching aim of the project, methodological limitations of the project that qualify interpretation of the results are provided for Study 1, Study 2, and Study 3. Future research suggestions attempting to provide solutions for these methodological limitations are provided as the limitations are reviewed. Broader theoretical implications for future research are then discussed. The exploratory nature and inconclusive results presented an opportunity to revisit the theoretical and methodological underpinnings of the project and to provide useful directions for advancing the literature. These theoretical implications are grouped into three streams: (i) the conceptual issues in adopting a vulnerability trait approach to bipolar disorder; (ii) issues encountered in translating the output of the neurobehavioural systems proposed by RST to a trait level of measurement; and (iii) more complex methods of understanding behavioural task
outcomes by considering within-task reactivity over the course of the task, alternate strategic approaches, and level of motivational engagement. Once these theoretical implications are discussed, specific implications of the findings of the present project are suggested and a concluding statement provided.

10.2. Review of Study 1 Hypotheses

The primary aim of Study 1 was to evaluate the relationship between trait bipolar disorder vulnerability and trait BAS using cross-sectional self-report methodology. The secondary aim of Study 1 was to assess the factor structure of the 7U7D and BBS using both EFA and CFA. EFA was used to assess the appropriate number of factors and to examine cross-loading, whilst single-factor CFA were used to confirm that each factor was unidimensional and that the items adequately represented the latent construct. Hypotheses relating to both of these aims are presented below in Table 10.1, along with an indication of whether or not they were supported by the data.
### Table 10.1

**Study 1 Hypotheses**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. The 7U7D data would fit a two-factor structure, with one factor representing mania-proneness and the other representing depression-proneness.</td>
<td>Supported</td>
</tr>
<tr>
<td>1.2. The BBS would fit a four-factor structure comprising BAS-D, BAS-FS, BAS-RR, and trait BIS.</td>
<td>Supported</td>
</tr>
<tr>
<td>1.3. The reverse-coded trait BIS items would not factor with the other trait BIS items and will hence warrant deletion.</td>
<td>Supported</td>
</tr>
<tr>
<td>1.4. A moderate-strength positive correlation would be found between mania-proneness and BAS-D.</td>
<td>Partially supported</td>
</tr>
<tr>
<td>1.5. A moderate-strength positive correlation would be found between depression-proneness and trait BIS.</td>
<td>Supported</td>
</tr>
<tr>
<td>1.6. A moderate-strength positive correlation would be found between mania-proneness and depression-proneness.</td>
<td>Supported</td>
</tr>
<tr>
<td>1.7. BAS-D, BAS-FS, and BAS-RR would exhibit a moderate-strength positive correlation with one another.</td>
<td>Supported</td>
</tr>
<tr>
<td>1.8. A moderate-strength positive correlation would be found between BAS-RR and trait BIS.</td>
<td>Supported</td>
</tr>
</tbody>
</table>

Hypothesis 1.1, predicting that the two-factor structure of the 7U7D found by Youngstrom et al. (2013) would be replicated in the Study 1 data, was supported. A two-factor solution comprising mania-proneness and depression-proneness was suggested by Kaiser’s (1960) criterion, MAP testing, and by the interpretable simple structure obtained via maximum likelihood EFA with Promax rotation. Parallel analysis suggested a three-factor solution. Generating a three-factor solution resulted in the mania-proneness factor being divided into two separate factors. The distinction between these factors was difficult to interpret based on item content, although one factor appeared to correspond primarily to affective phenomena and the other to cognitive or interpersonal phenomena. The two-factor solution was retained as a more suitable partition of underlying variance in the 7U7D. CFA demonstrated depression-proneness to constitute a good fit to the data, however deletion of mania-proneness Item 7 (“Have there been periods of several days or more when your
thinking was so clear and quick that it was much better than most other people's?" ) was required for that factor to adequately fit the data. It is unclear why Item 7 limited the fit of the mania-proneness factor in the Study 1 sample but not in that of Youngstrom et al. (2013). However, it may be that Item 7 responses were less correlated with responses to the other mania-proneness items as Item 7 may have been assessing alertness more generally.

Hypothesis 1.2, predicting that a four-factor BBS structure resembling that found by Carver and White (1994) would be replicated in the Study 1 data, was supported. However, the four-factor BBS solution was only obtained once trait BIS Item 2 and trait BIS Item 22, the only reverse-coded items in the scale, were deleted. In accordance with Hypothesis 1.3, these items were deleted because they loaded on a fifth factor that was regarded as method-logically spurious rather than usefully assessing trait-level expression of an aspect of BIS or FFFS. This deletion was also consistent with Gorsuch’s (1983) recommendation that a factor should consist of at least three items. Once the reverse-coded items were deleted, a four-factor BBS solution comprising BAS-D, BAS-FS, BAS-RR, and trait BIS was suggested by Kaiser’s criterion and by the interpretable simple structure obtained via maximum likelihood EFA with Promax rotation. MAP testing suggested a two-factor structure whilst parallel analysis suggested a seven-factor structure, however neither of these solutions resulted in interpretable simple structure. Hence, it appears that the four-factor solution originally suggested by Carver and White is the optimum factor structure for the BBS, although the reverse-coded items require removal from the scale.

Limitations of the BBS were still apparent even after removing the reverse-coded items. These limitations were consistent with previous findings (Campbell-Sils et al., 2004; Cogswell et al., 2006; Heubeck, Wilkinson, & Cologon, 1998). Item 5 (“I'm always willing to try something new if I think it will be fun.”) cross-loaded on both BAS-FS and BAS-RR, loading most strongly on BAS-RR despite being categorised as a BAS-FS item in the scale as scored (Carver & White, 1994). Item 21 (“When I go after something I use a ‘no holds barred’ approach.”) cross-loaded on all three trait BAS factors, loading most strongly upon BAS-D, as per the scale as scored. CFA data suggested that Item 19 (“I feel worried when I think I have done poorly at something important.”) should be deleted due to redundancy against Item
24 (“I worry about making mistakes.”), which was retained for being more general. Despite previously published concerns (e.g., Cogswell et al., 2006), internal consistency was acceptable and adequate fit was achieved across all four BBS factors. However, issues with the reverse-coded Item 2 and Item 22, cross-loading between trait BAS Item 5 and Item 21, and redundancy between trait BIS Item 19 and Item 24 mean that although the BBS remains the only published multidimensional measure of trait BAS, caution must still be taken when interpreting response data.

The data broadly supported the correlational hypotheses formed to address the secondary aim of Study 1. Mania-proneness was positively correlated with BAS-D (Hypothesis 1.4), depression-proneness was positively correlated with trait BIS (Hypothesis 1.5), mania-proneness and depression-proneness were positively correlated (Hypothesis 1.6), positive intercorrelation was observed between BAS-D, BAS-FS, and BAS-RR (Hypothesis 1.7), and BAS-RR was positively correlated with trait BIS (Hypothesis 1.8). However, the positive correlation between mania-proneness and BAS-D was only weak. This weakness of this finding is somewhat incongruent with the important link between bipolar disorder vulnerability or phenomenology and BAS sensitivity or dysregulation suggested by the BAS hypothesis of bipolar disorder (Alloy & Abramson, 2010; Johnson, 2005). Although BAS-D was selected as the core measure of trait BAS in the present project, BAS-FS also exhibited a similar weak positive relationship with mania-proneness, suggesting little difference between BAS-D and BAS-FS in relation to bipolar disorder vulnerability. In contrast, BAS-RR exhibited a weak negative relationship with mania-proneness. This is likely to be explainable by the positive overlap between BAS-RR and trait BIS, which although not significantly correlated with mania-proneness trended in a negative direction. This correlation between BAS-RR and trait BIS has been consistently noted (e.g., Alloy et al., 2006; Carver & White, 1994; Cogswell et al., 2006). The shared variance between BAS-RR and trait BIS is possibly due to their similar theme of emotional investment in goal-oriented outcomes, whether or not the goal in question is successfully achieved. The positive correlations of depression-proneness with BAS-D and BAS-RR and negative correlation of depression-proneness with trait BIS are consistent with views of depression as a goal-disengagement process (Bowins, 2008).
10.3. Review of Study 2 Hypotheses

The primary aim of Study 2 was to evaluate the relationship between trait bipolar disorder vulnerability and risky decision-making in the form of behavioural task responses. Risky decision-making was included in the present project as a putative behavioural manifestation of BAS. Behavioural tasks were selected that incorporated risky decision-making (BART, GDT, CS-IGT) and set-shifting (CS-IGT, WCST), which was included to explore the specificity of decision-making difficulty. The potential relationships of the 7U7D and BBS variables with the behavioural task outcomes were examined at three levels of analysis: (i) bivariate correlations; (ii) hierarchical multiple regression analyses controlling for PA and NA; and (iii) mediation modelling assessing formal statistical mediation via PA and NA. Table 10.2, below, reviews the hypotheses tested in Study 2 along with an indication of whether or not they were supported by the data.

The pattern of findings that emerged across the different hypotheses tested in Study 2 was that an association between mania-proneness and risky decision-making was not supported. Contrary to Hypotheses 2.1, 2.2, and 2.3, mania-proneness was not associated with increased risky decision-making in terms of BART AMP, GDT selections, or Block 5 CS-IGT selections. Mania-proneness was also not associated with set-shifting difficulty, corresponding with increased risky decision-making, on CS-IGT blocks following a shift in rule, providing no support for Hypothesis 2.4. Although the lack of association of mania-proneness and BAS-D with WCST total error percentage and perseverative error percentage was supported, this null prediction was formed to contrast with the CS-IGT data, and offers little meaning in the context of the unsupported Hypothesis 2.4. The expected correlation between mania-proneness and risky decision-making did not emerge when the results were examined using hierarchical multiple regression controlling for PA and NA and using mediation modelling assessing mediation via PA and NA, providing no support for Hypothesis 2.5. These results are inconsistent with the important link between bipolar disorder vulnerability or phenomenology and BAS sensitivity or dysregulation suggested by the BAS hypothesis of bipolar disorder. Based on the results of Study 2, there does not appear to be link between BAS and bipolar
disorder when examined using a vulnerability trait approach and battery of risky decision-making tasks.

Table 10.2

Study 2 Hypotheses

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. A moderate-strength positive correlation would be found between mania-proneness and BART AMP.</td>
<td>Not supported</td>
</tr>
<tr>
<td>2.2. A moderate strength negative correlation would be found between mania-proneness and GDT selections.</td>
<td>Not supported</td>
</tr>
<tr>
<td>2.3. A moderate strength negative correlation would be found between mania-proneness and Block 5 CS-IGT selections.</td>
<td>Not supported</td>
</tr>
<tr>
<td>2.4. Mania-proneness would be strongly negatively correlated with CS-IGT difference scores for Block 6 - 5, Block 8 - 7, and Block 10 - 11, but with no significant correlation present between mania-proneness and WCST error percentage (perseverative and total).</td>
<td>Partially supported; no correlation with WCST error percentages</td>
</tr>
<tr>
<td>2.5. Controlling for PA and NA using hierarchical regression would diminish the correlations of mania-proneness and BAS-D with BART AMP, GDT selections, and CS-IGT selections.</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

A noteworthy finding emergent throughout Study 2 was that BAS-D was not correlated with risky decision-making outcomes across any of the behavioural tasks. This assumption was explored as given that risky decision-making necessarily involves a reward stimulus and that BAS is sensitive to reward stimuli (Corr, 2008; Gray, 1975), it was plausible that risky decision-making can be used as a putative behavioural measure of BAS. There are two main interpretations for this finding. The first is that the lack of correlation between risky decision-making and BAS-D indicates that risky decision-making tasks are not appropriate for use as a behavioural measure of BAS. If this is the case, then it is possible that (i) risky decision-making does not by definition elicit BAS activation; (ii) any BAS activation elicited by risky decision-making is outweighed by the influence of other trait variables, or by alternative state or environmental demands; or (iii) risky decision-making tasks cannot provide ecologically valid measurement of BAS as the low-
magnitude reward stimuli involved in these tasks are insufficient to elicit meaningful BAS activation. The second interpretation is that the lack of correlation between BAS-D and risky decision-making is a multi-method issue (Campbell & Fiske, 1959; Ferketich, Figueredo, & Knapp, 1991). This interpretation suggests that a reliable correspondence between self-report questionnaire responses and the behavioural outcomes of risky decision-making tasks is difficult to establish due to differences in measurement techniques. Further elucidation of this finding remains a task for future research, with suggestions ventured below in Section 10.10.

Exploratory testing showed that the 7U7D and BBS variables exhibited very few significant correlations with risky decision-making. Depression-proneness was associated with decreased BART AMP, and this relationship was fully mediated by PA and NA, becoming non-significant when NA and PA were controlled for. This finding indicates that individuals higher in depression-proneness are more likely to be cautious and conservative in risky decision-making assessed using the BART, and that this is due to their tendency to be higher in NA and lower in PA. This is consistent with research linking depression to aversion to risk and withdrawal from goal-oriented behaviour (Bowins, 2008). Individuals higher in BAS-RR were more likely to make advantageous choices on the GDT, but only when PA and NA were controlled for. This finding may have arisen because BAS-RR is characterised as emotional responsiveness to rewarding stimuli (Carver & White, 1994), with advantageous GDT selections being more likely to result in a reward paid to the in-task monetary balance. In this way, individuals higher in BAS-RR may be more prone to having advantageous GDT selections positively reinforced and thereby repeated. Finally, trait BIS was associated with a smaller difference in risky decision-making between CS-IGT Block 10 and CS-IGT Block 9. This association between trait BIS and CS-IGT Block 10 - 9 difference score was present at a bivariate level but was no longer significant once PA and NA were controlled for. Because CS-IGT Block 10 was the penultimate block and final rule-change of the CS-IGT, with participants aware of the number of trials remaining, one interpretation of this correlation is that higher trait BIS was associated with more cautious risky decision-making in managing the set-shifting element of the CS-IGT at this late point in the task. Lastly, a salient finding of Study 2 was the lack of correlation between risky decision-making outcomes across the BART, GDT, and CS-IGT,
underscoring the impact that different task contexts can have on the measurement of risky decision-making.

10.4. Review of Study 3 Hypotheses

The primary aim of Study 3 was to experimentally monitor the potential effect of state mood on risky decision-making responses, and to test whether this effect was modulated by trait bipolar disorder vulnerability. Study 3 adopted a mixed design involving between-group and repeated measures elements. A false feedback mood induction was used to induce either positive or negative mood in separate groups of participants. Within these independent groups, participants completed a repeated measures paradigm where a neutral mood induction was administered followed by a valenced mood induction dependent on group. The secondary aim of Study 3 was to assess the validity of the false feedback mood induction with reference to changes in PA and NA and also to changes in risky decision-making, operationalised as BART AMP. The secondary aim and the hypotheses flowing from it needed to be addressed prior to the primary aim, as the secondary aim served as a manipulation check for Study 3. Table 10.3, below, reviews the hypotheses tested in Study 3 along with an indication of whether or not they were supported by the data.

Because the hypotheses ventured in Study 3 are heavily interconnected, it is helpful to review them grouped as follows: (i) Hypotheses 3.1, 3.2, 3.3, and 3.4, concerning measurement of self-reported mood state relative to the false feedback mood induction; (ii) Hypotheses 3.5, 3.6, and 3.7, concerning measurement of risky decision-making relative to the false-feedback mood induction; and (iii) Hypotheses 3.8 and 3.9, concerning a potential association between mania-proneness and responsiveness to the false feedback mood induction in terms of mood state and risky decision-making behaviour. The subsequent paragraphs follow this structure in their review of the findings of Study 3.
Table 10.3

Study 3 Hypotheses

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1. The positive false feedback group would exhibit greater post-induction PA than pre-induction PA.</td>
<td>Not supported; NA declined</td>
</tr>
<tr>
<td>3.2. The negative false feedback group would exhibit greater post-induction NA than pre-induction NA.</td>
<td>Not supported; PA declined</td>
</tr>
<tr>
<td>3.3. The positive false feedback group would exhibit greater PA post-induction than the negative false-feedback group.</td>
<td>Not supported</td>
</tr>
<tr>
<td>3.4. The negative false feedback group would exhibit greater NA post-induction than the positive false-feedback group.</td>
<td>Supported</td>
</tr>
<tr>
<td>3.5. Participants in the positive false feedback group would exhibit increased BART AMP following mood induction.</td>
<td>Supported</td>
</tr>
<tr>
<td>3.6. Participants in the negative false feedback group would exhibit decreased BART AMP following mood induction.</td>
<td>Not supported</td>
</tr>
<tr>
<td>3.7. The positive false feedback group would exhibit greater BART AMP post-induction than the negative false-feedback group.</td>
<td>Not supported</td>
</tr>
<tr>
<td>3.8. The difference between pre-induction and post-induction PA would covary based on mania-proneness.</td>
<td>Not supported</td>
</tr>
<tr>
<td>3.9. The difference between pre-induction and post-induction BART AMP would covary based on mania-proneness.</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

The first four hypotheses assessed the effectiveness of the false feedback mood induction at the level of self-reported mood state, operationalised as PA and NA. These hypotheses addressed the secondary aim of the study. No pre-existing differences in PA or NA were present between the false feedback groups when mood state was initially measured. Contrary to hypotheses, the false feedback mood induction appeared to exert an effect on mood state, but in reverse to the expected manner. It was hypothesised that positive false feedback would elicit an increase in PA (Hypothesis 3.1), whilst negative false feedback would elicit an increase in NA (Hypothesis 3.2). However, the data demonstrated that positive false feedback elicited a decrease in NA, as per Farmer et al. (2006), whilst negative false feedback elicited a decrease in PA. Although PA and NA are regarded as separate dimensions of mood (Tellegen, Watson, & Clark, 1999), these results can still be viewed as
influencing mood in a positive direction using positive false feedback and influencing mood in a negative direction with negative feedback. The decrease in NA observed in the positive false feedback group indicated that participants became calmer and more relaxed, whilst the decrease in PA observed in the negative feedback group indicated that participants became dulled and fatigued (Watson, Clark, & Tellegen, 1988). Although the false feedback mood induction was seemingly effective in influencing state mood, albeit in an incongruent manner, the false feedback groups only exhibited a significant post-induction difference in NA, with no significant difference present in post-induction PA. This could be due to modest effect size in a relatively small sample. However, due to (i) the unsupported hypotheses; (ii) the unanticipated direction of the mood induction effects; and (iii) the changes in state mood being relatively minor as measured by the PANAS, subsequent findings must be interpreted in the context of the false feedback mood induction not functioning as planned.

The second group of hypotheses assessed the effectiveness of the false feedback mood induction at the level of risky decision-making, operationalised as BART AMP. As with the first group of hypotheses, these hypotheses also addressed the secondary aim of the study. No pre-existing difference in BART AMP was present between the false feedback groups on the pre-induction administration of the BART. Supporting Hypothesis 3.5 but contrary to Hypothesis 3.6, both the positive false feedback group and negative false feedback group exhibited an increase in BART AMP from pre-induction administration to post-induction administration. No significant difference in BART AMP was present between the positive false feedback group and negative false feedback group for the post-induction administration (Hypothesis 3.7). There are three explanations that can be ventured for the mutual post-induction increase in BART AMP between false feedback groups. The first explanation is that both decline in NA and decline in PA elicit an increase in risky decision-making, which is a possibility that has yet to be explored in the literature. The second explanation is that the increase in BART AMP occurred due to an order effect of boredom and fatigue rather than due to change in mood state. Fatigue would appear to be a more likely confounding variable. A fatigued participant might become more reckless in their decision-making due to reduced effortful self-control (Vohs et al., 2014). In contrast, if a participant became bored
and disengaged from the study, decreased BART AMP might be hypothesised as for ending the experiment more quickly. As counterbalancing could not be implemented in Study 3 due to concerns regarding statistical power, an order effect of participant fatigue cannot be ruled out. Finally, the third explanation for the mutual increase in BART AMP is that it occurred due to error variance resulting from random factors not assessed or controlled within the Study 3 design.

The final pair of hypotheses concerned the potential association of mania-proneness with responsiveness to the false feedback mood induction in terms of mood state and risky decision-making behaviour. This association was not supported via ANCOVA. Based on this result, mania-proneness is unlikely to influence responsiveness to a false feedback mood induction. However, depression-proneness, BAS-RR, and trait BIS were significant covariates of change in NA for the positive false feedback group. The results of Study 2 demonstrated that these three variables all share a moderate-to-strong relationship with NA, and hence NA might be more reactive to environmental events for individuals higher in depression-proneness, BAS-RR, and trait BIS. Although depression-proneness and trait BIS are associated with NA virtually by definition, with depression and the anxiety that is an affective concomitant of BIS regarded as forms of negative emotion (Gray, 1971; Watson & Tellegen, 1985), BAS-RR is likely to be connected to NA because of its consistent moderate positive correlation with trait BIS (e.g., Carver & White, 1994), as discussed in Section 2.7.4.

10.5. Summary of Support for the Overarching Aim

As the aforementioned review of hypotheses demonstrates, few significant findings regarding the relationship between trait bipolar disorder vulnerability (operationalised as 7U7D mania-proneness), trait BAS (operationalised as BBS BAS-D), and risky decision-making (operationalised as BART, GDT, and CS-IGT responses) were obtained across the present project. When drawing inferences from the findings, it is important to address the core research question underpinning all of the hypotheses: To what extent is a link present between trait vulnerability to bipolar disorder and BAS? Taking into account the breadth of analyses conducted during this project, significant findings were relatively few, with only modest bivariate correlations between the 7U7D and BBS variables suggesting a link between bipolar
disorder vulnerability and trait BAS. Risky decision-making was not associated with trait bipolar disorder vulnerability in the expected manner, and this can be viewed either as further lack of support for an association between trait bipolar disorder vulnerability and BAS, or as an outcome of risky decision-making potentially being invalid as a behavioural measure of BAS (as discussed in Section 10.3).

In summary, the dominant finding of the present project was that trait vulnerability to bipolar disorder does not appear to be linked to trait BAS examined at a questionnaire level or to BAS putatively examined at a behavioural level in the form of risky decision-making. Having identified this null finding, it must be qualified by reviewing the limitations of the three studies that comprised the present project. In addition to these specific limitations, the null finding also presents an opportunity to review theoretical and methodological limitations within the literature as a means of generating future research implications that can help in identifying why the BAS hypothesis of bipolar disorder was unsupported.

Section 10.6 reviews the limitations of Study 1, Study 2, and Study 3 of the present project. Once this has been accomplished, theoretical and methodological implications are presented in Section 10.7, focusing on (i) the conceptual issues in adopting a vulnerability trait approach to bipolar disorder; (ii) issues encountered in translating the output of the neurobehavioural systems proposed by RST to a trait level of measurement; and (iii) more complex methods of understanding behavioural task outcomes by considering within-task reactivity over the course of the task, alternate strategic approaches, and level of motivational engagement. Once these theoretical and methodological implications are discussed, specific implications of the findings of the present project are suggested and a concluding statement provided for the thesis as a whole in Section 10.8.

10.6. Limitations of the Present Project

The findings of the present project need to be considered within the context of limitations that were present in the research design. A number of methodological limitations occurred in each of the three studies. Limitations for each study are reviewed below. Due to the shared focus on the BAS theory of bipolar disorder from a perspective of trait bipolar disorder vulnerability, trait BAS, and risky decision-making, some of the limitations presented below were applicable to more than one of
the three studies. In these incidences, limitations are reviewed in relation to the first study that they are applicable to.

**10.6.1. Limitations of Study 1.** The primary limitation of not only Study 1, but arguably the project as a whole, was that there were not enough participants who were high in trait vulnerability to bipolar disorder as assessed by the 7U7D. Because non-psychiatric samples comprised primarily of students were tested, it may be more accurate to describe the present project as assessing low to moderate trait bipolar disorder vulnerability rather than assessing the entire range of a continuous spectrum. Richer elaboration on this limitation demands consideration of (i) representative versus screened samples; (ii) differences between continuous and categorical conceptualisations of bipolar disorder; and (iii) the distinction between high vulnerability and actual disorder presence. Due to both this complexity and to the pervasiveness of this sampling limitation across studies, this limitation is fully discussed and expanded upon below in Section 10.8.

One limitation of Study 1 was incorporated into the research design by choice. This was the use of scales modified to correct for error variance in assessing the underlying construct of interest, rather than adhering to previously published forms of the scales used. This affected mania-proneness and trait BIS. The benefit of this decision was that it allowed more refined measurement of bipolar disorder vulnerability and RST traits. The detriment was that it limited comparability to previous publications that have administered the 7U7D or BBS scales as scored. Additionally, although the modified scales from Study 1 were applied to Study 2 and Study 3, technically these studies tested different samples that may not have been optimally assessed by the Study 1 factor solution. However, it should be noted that the modifications made based on the Study 1 data were minimal, with two of the three problematic BIS items being widely reported as inadequate due to their coding discrepancy. To examine the impact of this limitation, additional data analyses for all three studies were run using the scales as scored, with negligible changes to statistics and no changes to pattern of results occurring. Hence, this decision is unlikely to have confounded the results.

The recency of publication of the 7U7D may also be viewed as a limitation. Although the 7U7D has been shown to be reliable and valid, it has only been used in one study to date (Youngstrom et al., 2013), and hence is a relatively untested
measure. The 73-item GBI (Depue, Krauss, Spoont, & Arbisi, 1989) was administered in all three studies, with data for the 14-item 7U7D drawn from the relevant GBI items. This mode of 7U7D data collection may not be optimal, as it is possible that nesting the 7U7D items within the larger GBI item structure might result in some form of response bias due to priming from item content or fatigue from the length of the scale. However, it should be noted that the only published study to administer the 7U7D also nested it within the GBI, as it was composed and validated using items from previous GBI data-sets (Youngstrom et al., 2013). Additionally, additional data analysis using the GBI rather than the 7U7D revealed no changes to the overall pattern of results. A potential discrepancy between the 7U7D as a distinct battery of items and the 7U7D as extracted from the full GBI item set should be attended to by future studies making use of the scale.

Finally, a potential limitation of Study 1 was the order in which the GBI and BBS were administered. In Study 1, the BBS was administered prior to the GBI (from which the 7U7D items were later drawn), whilst in Study 2 and Study 3, participants completed the GBI followed by the BBS. Potential order effects arising from completing the GBI and BBS are unknown. However, the difference in order of administration may help to explain the discrepancy in correlations across studies. One discrepancy was with regards to the relationship between mania-proneness and BAS-FS. As hypothesised, these variables were moderately positively correlated in the Study 2 and Study 3 data. However, mania-proneness and BAS-FS were only weakly (albeit significantly) correlated in Study 1, and this was in an unexpected negative direction, as were correlations with BAS-D and BAS-RR. This may have occurred due to a priming effect, whereby completion of the GBI first in Study 2 and Study 3 primed participants to attend to extreme or distressing emotional events, as the GBI emphasises this form of emotional experience during questioning. Hence, the pattern of correlation between Study 1 and Studies 2 and 3 may not be directly comparable. This limitation can be managed in future studies either by counterbalancing to test for its presence or by maintaining a standard order of questionnaires.

10.6.2. Limitations of Study 2. Several limitations of Study 2 arose from the length and complexity of the testing protocol. Study 2 took approximately 90 minutes to complete. This may have been perceived as onerous by the participants,
which in turn may have decreased motivation and engagement, both crucial if a study examining neurobehavioural motivational systems is to be ecologically valid. Participants were required to learn the rules to four different tasks, and practice trials were not administered as this would have increased the testing duration. This meant that participants may not have commenced each task at an equal level of knowledge, especially if they did not pay sufficient attention to the instructions. Participants who completed the WCST quickly were asked to wait until all participants had completed the WCST, which meant that some participants received a brief rest period prior to administration of the BART. Finally, the trait questionnaires were administered following the four behavioural tasks, and this may have resulted in a response bias either due to fatigue or because the assessment of risky decision-making exerted a priming effect on questionnaire responses. The administration of behavioural tasks prior to the trait questionnaires in Study 2 and Study 3 provides another possible explanation for the discrepancy in trait correlations between the later studies and Study 1.

It was assumed that all participants in Study 2 were at a similar level of motivation. The experimental design attempted to elicit this using the presence of a chocolate bar as an extrinsic reward and competitiveness (induced via deception regarding scoring and comparing of participants in a group setting) as an intrinsic reward. The chocolate bar would be more motivating for participants the stronger their preference for chocolate. Additionally, although the chocolate bar was used as a reward in order to avoid the cost and ethical concerns of rewarding participants with money, it is unknown how chocolate functions as an incentive for risky decision-making tasks relative to the provision of money (White, Lejuez, & De Wit, 2008). Similarly, the competitive nature of group testing would have been more motivating for participants who were more invested in surpassing their peers at the behavioural task. Hence, the assumption of equal motivational state may be erroneous. Although group testing was intended to stimulate intrinsic motivation via an atmosphere of competition, it should be noted that participants did not complete the Study 2 protocol in a purely independent manner, and that group sizes differed across testing sessions. These factors may have impacted participation, and performance may have differed had the tasks been completed in isolation.
The four tasks were administered one after the other, without counterbalancing. This limited the level of knowledge that Study 2 could provide regarding the effects of completing risky decision-making tasks in sequence. Counterbalancing was not possible as administering the tasks in any other order would have disrupted the logic of the experiment. Although care was taken to present the tasks in an order where they would be less likely to interfere with one another, it is possible that presenting the WCST, BART, CS-IGT, and GDT in quick succession biased participant responses in comparison to individual administration of the tasks, especially as each task uses a different rule set with different probabilities of risk.

Specific limitations were present concerning the BART, with these limitations being applicable across both Study 2 and Study 3. The BART was programmed in such a way that the on-screen graphic of the balloon reached the boundary of the top of the screen after only approximately 50 pumps. Although the balloon could be inflated to a maximum of 127 pumps, the scaling relative to overall screen size resulted in a powerful visual cue that the balloon would shortly burst. This may have led to participants approaching the BART in a more cautious manner than their predisposition would normally indicate. Conservative risky decision-making on the BART is a limitation of the task more generally (Benjamin & Robbins, 2007; Lejuez, Aklin, Jones, et al., 2003). Across studies, participants tend to approach the BART in a relatively conservative manner, with pumps typically averaging substantially below the optimum number of 64 pumps (Benjamin & Robbins, 2007; Lejuez, Aklin, Jones, et al., 2003). This was true of the present project, with an average AMP of 29.95 found in Study 2. This means, at least in a nonclinical sample, that whilst higher AMP can be viewed as increased risk-taking, it can also be viewed as a more appropriate response in order to maximise the hypothetical bank balance. Lower AMP is actually a less adaptive response pattern on the BART, as AMP only begins to attract a risk of loss greater than 50% when it exceeds the optimum number of 64 (Benjamin & Robbins, 2007). This underscores the necessity of conducting research that compares participant responses to different BART protocols. A 30-trial, 64-pump BART with the optimum number of pumps set at 32 would allow more rapid administration and greater likelihood of explosions,
but could well provide data as rich as the standard administration of the BART utilised in the present project.

Specific limitations were also present concerning the GDT. Although the traditional administration of the GDT is 18 trials (Brand et al., 2004), 30 trials were administered in Study 2 as the brief duration of the task enabled more data to be gathered. Only the initial 18 trials were used for Study 2 due to an identical pattern of results between scores at 18 and 30 trials of the task. However, it is possible that the knowledge that there would be 12 more trials biased participants towards greater risk as they may have believed that they would be able to compensate for any losses by behaving more cautiously during the final trials of the task. This limitation must also be considered in the context of the GDT being highly punishing with regards to exploration of response options. This may have frustrated participants who arrived at the task following the BART and CS-IGT, both of which are more permissive of exploration. The GDT also possesses a more complex interface that any of the other tasks, providing 14 response options, which may have confused participants. Because of its complex interface and limited tolerance of response exploration, the GDT may be especially likely to benefit from the inclusion of practice trials.

A limitation of the CS-IGT occurred specific to the computer program used in the present project. Due to the constraints of modifying and testing the Inquisit program scripts for the computer tasks, the changes in rule (at the conclusion of trials 100, 140, and 180) on the CS-IGT were subtly signified by the counter at the top of the screen disappearing until the first card selection of the subsequent block. This glitch provided a visual cue that the rules governing the CS-IGT decks had shifted. Whilst not inconsistent with breaks between blocks in previous research (Turnbull et al., 2006), this may have provided too obvious a cue to participants. Future modifications of the program should ensure that changes in underlying deck rule are not flagged in any way.

10.6.3. Limitations of Study 3. The discussion of motivation as a limitation of Study 2 also applies to Study 3. However, in this case, the source of the motivation was that the sample of undergraduate students were completing the task to further their understanding of the task paradigm being used for their major assessment. This means that the motivation to engage in the BART in Study 3 should be directly proportional to the students’ motivation to engage in studying psychology
and to perform well in their first-year psychology unit. This may not have been the case for the sample as a whole, as individuals are likely to differ in their degree of motivation.

The online method of administration also provided an uncontrolled source of variance in Study 3. Because participants were free to complete the Study 3 experiments online at a time of their choosing, it is likely that participants were in more distracting environments than the computer laboratories used in Study 2 administration. It can be assumed that the majority of Study 3 participants completed the experiment at home. In addition to exposing the participant to distractions, a comfortable home environment may have meant that participants paid less attention to the false feedback mood induction, and the reward cues characteristic of the BART may have been less emotionally salient.

The primary limitations of Study 3 are the limitations of mood induction procedures more generally. The false feedback mood induction procedure did not manipulate participant mood in the expected manner. Mood induction procedures are relatively subjective, as not all participants may react the same way to the induction stimuli (Martin, 1990). Study 3 used false feedback on a behavioural task to elicit positive or negative mood. This procedure can be viewed as much a motivation induction as it is a mood induction (Chiew & Braver, 2009). The effectiveness of this mood induction should be proportional to the participant’s investment in the task; a participant who cares little for the task would be unlikely to have their mood affected by performance feedback. This meant that the level of mood induced varied across participants. Whilst this concern was anticipated, participant numbers were such that it was judged to be damaging to statistical power to exclude participants from the data analysis based on their individual mood ratings.

The mood induction protocol used in Study 3 was also complicated by the repeated measures design. There is a dearth of research into the phenomenological time-course of induced state mood. Assuming that the mood induction is effective, it remains unknown how repeated mood inductions interact. Three possibilities can be forwarded: (i) a previous mood induction might be overridden by a later mood induction; (ii) a previous mood induction might create a temporary set point of mood that is resilient to later mood inductions within the short-term interval; or (iii) the mood inductions might cancel each other out in a purely additive or subtractive
manner. This is before considering the degree of strength of the induced mood, the specific type of mood being induced, the participant’s pre-existing mood state upon entering the experiment, and any fatigue associated with the experimental protocol. Even the use of neutral baseline feedback may be a confounding factor, as feedback that is not strongly positive could conceivably elicit apathy or boredom due to a lack of emotional salience. Mood induction as a field of research will benefit from refined operational measures and an understanding of the particular mechanisms behind transient mood onset.

Finally, the design of Study 3 was limited in its ability to identify fatigue effects, because (i) counterbalancing could not be used due to lack of knowledge regarding repeated mood inductions; and (ii) a condition where both BART trials of Study 3 were preceded by neutral false feedback was not feasible as dividing the sample into three conditions would have rendered participant numbers per group too low. The inclusion of an entirely neutral condition would be a useful inclusion in future studies utilising a false feedback mood induction. Within a group receiving neutral false feedback prior to both BART trials, performance could only be said to differ as a function of the time course of the experiment, rather than as a function of induced mood.

10.7. Conceptual and Methodological Issues affecting the Present Project

The overarching finding of the present project was that mania-proneness and depression-proneness in a non-psychiatric population were unrelated to BAS and BAS-relevant behaviours, providing no support for the BAS theory of bipolar disorder. This finding, or lack thereof, was consistent across a comprehensive series of investigations. The three studies provided many opportunities for an association between BAS and bipolar disorder to emerge if present. Although it was judged highly improbable for BAS to be as important to bipolar disorder as the literature suggests without an association being revealed, the study was subject to several conceptual and methodological issues that may have obscured the predicted effects. Many of these issues represent violations of the basic assumptions underlying the project. These issues include (i) an inability of a continuous trait approach to explain BAS dysregulation in bipolar disorder; (ii) an imperfect translation of RST principles to complex, human-level functioning; (iii) inappropriate operationalisation of BAS
as a self-reported personality trait; (iv) engagement, strategic thinking, and within-task reactivity during the risky decision-making tasks. These considerations are reviewed below.

10.8. Distinguishing Trait Vulnerability to Bipolar Disorder from Continuous Degree of Bipolar Disorder

10.8.1. Failure to sample the full spectrum of 7U7D responses. A possible reason for the general lack of effect found in the present study is that the sample was too heavily weighted towards low trait vulnerability to bipolar disorder. Very few participants endorsed high mania-proneness or depression-proneness. This high positive skew of trait vulnerability to bipolar disorder is consistent with the rarity of bipolar disorder as a clinical syndrome (APA, 2013) and with the data obtained by previous studies utilising the precursor to the 7U7D, the GBI (Depue et al., 1989). It is noteworthy that previous GBI studies have often taken a case-scoring approach, and in doing so have had to screen large samples to identify a high-risk group. For example, Alloy et al. (2008) screened 20,500 participants in order to ultimately recruit only 136 high-spectrum individuals who agreed to participate in their longitudinal study. It is arguable that an approach such as this considers participants scoring low on the GBI as being a categorical non-psychiatric comparison group, rather than falling low on a continuous spectrum per se. In contrast to the high-spectrum versus low-spectrum screening design, the present project relied purely on voluntary participation, with the consistent strong positive skew in 7U7D scores apparently reflecting low trait vulnerability in the general community. From a case-scoring perspective, participants who were sampled in the present project could also be viewed categorically as not possessing bipolar vulnerability. However, this concern is inconsistent with the continuous approach to psychopathology adopted by the current project.

10.8.2. Conceptual models of psychiatric disorders. In order to explain the present findings it is necessary to consider the limitations of a continuous approach to bipolar disorder. In doing so, it is important to consider the different forms that a continuous approach to bipolar disorder might take. Clark (2005) reviewed four theoretical models of psychopathology and comorbidity that also pose implications for the relationship between psychopathology and normal functioning. Firstly, the
predisposition/vulnerability model postulates that a pre-existing condition serves as a risk factor for a later clinical disorder. This pre-existing condition may itself be a clinical disorder; however, it might also be a personality trait, as is more relevant to the current discussion. Secondly, the pathoplasty model proposes that a prior disorder influences the properties of a later disorder, such as severity, course, or treatment outcome. Encompassed within this model is the idea that personality traits can be modified by prior experience of mental disorder (e.g., an increase in neuroticism following a depressive episode). This alteration in personality might be state-based (a complication effect), returning to premorbid functioning following a remission period. However, it may also be trait-based (a scarring effect), resulting in lasting change. Both the predisposition/vulnerability and pathoplasty models share a common emphasis on temporal sequence indicating causality (Clark, 2005).

In contrast, the latter two models reviewed by Clark (2005) both focus on an underlying factor that can generate comorbid conditions or temperaments. The shared factor model proposes a common genetic diathesis underlying multiple comorbid phenomena. For example, neuroticism and depression might commonly co-occur because they share an overlapping genetic predisposition. Finally, the spectrum model proposes that psycho-pathology is continuous with normal functioning, usually in the form of a continuum ranging from non-pathological experience to severe, psychopathological conditions. In its purest form, a spectrum model would propose that any environmental interactions are already implicit in the trait predisposition, and that high levels of a psychopathological trait equate to full clinical expression of that type of psychopathology. It should be noted that the four models described by Clark are not mutually exclusive, and multiple models might describe differing aspects of an individual diagnosis. Additionally, it is noteworthy that all four models can be applied to categorical rather than continuous phenomena. Although a spectrum model might seem counterintuitive to envisage in categorical terms, an example is provided by the mood disorders of the DSM-5. The mood disorders constitute a gradated series of categorical diagnoses focusing on similar affective symptoms, and are ordinally ranked in terms of their severity, that is to say, their phenomenological distance from normal functioning.

The present project was fundamentally grounded in the assumption that at least some of the elements driving bipolar disorder can be usefully thought of as
occurring on a continuum with normal functioning. This approach informed the inclusion of non-psychiatric participants assessed via self-report trait measures. However, within this continuous approach to psychopathology, the exact form that such a continuum might take was purposefully left unspecified. Put simply, this is because at present there is insufficient evidence to determine which of the models outlined by Clark (2005) best represents bipolar disorder, and whether this is in a primarily categorical or continuous manner. Part of the difficulty in properly modelling bipolar disorder is the fact that all four models might apply. Another complexity is that, as noted by Depue (1981), bipolar disorder is likely to consist of both categorical and continuous aspects (Meehl, 1990).

Before reviewing Depue's (1981) argument for a combined categorical/qualitative and continuous/quantitative understanding of bipolar disorder, it is useful to recognise different types of categorical model (Clark, 2005; Haslam, 2002; Waldman & Lilienfeld, 2001). Practical categories occur when what exists in reality as a continuous dimension is dichotomised by the application of a cut-off point, often on the basis of contextual utility. Configural categories occur when an individual possesses heightened levels of several dimensional traits or symptoms, and this specific (and possibly uncommon) configuration lends itself to representation as a discrete type. Both of these categorical models are easily reconcilable with continuous approaches. Practical categories essentially adopt a continuous approach but acknowledge the pragmatism of investing in a cut-off, perhaps where functional impairment becomes noticeable. The underlying assumption of configural categories is that they result from a specific confluence of traits, traits that might be best modelled as separable continua. In this sense, an individual receiving a diagnosis best represented as a configural category is a multivariate outlier on a number of trait dimensions. However, pure categorical approaches are also possible. Natural categories are those that possess a specific aetiological basis that makes them qualitatively distinct from normal functioning. Natural categories are common in traditional medical disorders, but far less evidence supports natural categorical distinctions for psychiatric disorders (Clark, 2005).

The present study used the 7U7D to assess bipolar disorder on a continuous basis. The 7U7D is a modern short-form version of the earlier GBI (Depue et al., 1981). The assumption underlying the GBI was that it assessed a genetic
vulnerability to bipolar disorder. Hence, at its inception the GBI was designed to fit a predisposition/vulnerability model (Clark, 2005; Depue et al., 1981). Consistent with the prevailing psychobiological view of bipolar disorder, Depue (1981) noted that individually minuscule genetic effects could aggregate in order to generate a vulnerability continuum that differs across individuals. This is the quantitative element that formed the theoretical foundation of the GBI, and by extension, the 7U7D. However, Depue (1981) also acknowledged a qualitative element to bipolar disorder, describing this as a diathetic threshold where the combined presence or configuration of multiple genes results in a functional biological discontinuity. Thus, whilst bipolar disorder might be continuous at a genotypic level, categorical distinctions might become more relevant at the level of biological phenotype. In keeping with this notion, early GBI literature (e.g., Depue et al., 1989) applied a categorical distinction between high-risk and low-risk to this predisposition/vulnerability model; the four-point GBI response scale and case-scoring method were devised in order to capture this distinction (Depue et al., 1981).

Therefore, as per Depue (1981) and Clark (2005), bipolar disorder may be most accurately viewed as consisting of both continuous and categorical elements. At a biological level, these elements are represented by the integration of continuum arguments with genetic understanding (Kelsoe, 2003), and the search for categorical endophenotypes (Glahn, Bearden, Niendam, & Escamilla, 2004). At a phenomenological level, these elements are represented by use of continuous trait vulnerability measures (Youngstrom et al., 2013) and the categorical diagnostic entities of DSM-5 (APA, 2013). However, what is missing is a holistic perspective that combines continuous and categorical elements. Such a perspective is difficult to apply at an empirical level because the different models outlined by Clark (2005) are seldom explicitly tested, and often generate similar predictions. For example, a controversy that may have affected the present study is the lack of differentiation between 7U7D score as a predisposition/vulnerability measure versus 7U7D score as a pure spectrum measure (capturing bipolar disorder as a continuous phenomenon, as opposed to the ordinal “spectrum” of diagnoses contained in DSM-5). Although intended to measure trait vulnerability as a point of design, that does not necessarily mean that the 7U7D is capturing a vulnerability trait. The 7U7D items were initially generated by a top-down focus on clinical symptoms, rather than a bottom-up focus
on how bipolar disorder phenomenology might be expressed at the level of normal functioning. Because of this, the 7U7D might actually be functioning as a pure spectrum measure, where extreme scores are equivalent to exhibiting psychopathology (regardless of formal diagnosis), rather than signifying vulnerability to psychopathology.

The above distinction becomes important when considering the lack of support for the BAS theory of bipolar disorder found in the present project. If a pure spectrum model is an accurate representation of bipolar disorder, then the proposed relationship between trait levels of bipolar disorder and BAS should be approximately constant at all levels of the trait. Hence, the lack of clinical patients or high-scoring non-clinical participants in the present study would not constitute a limitation should a pure spectrum model be applicable. However, if a predisposition/vulnerability model is a valid means of conceptualising trait levels of bipolar disorder, then BAS dysregulation may not be a constant outcome at all levels of trait vulnerability. Instead, BAS dysregulation might best be conceptualised as a functional categorical outcome that only results when a diathetic threshold is exceeded (Depue et al., 1981). Although the present project was not designed to directly assess this hypothesis, the lack of significant findings can be explained by this argument. Although BAS dysregulation has been established prior to the onset of the full clinical bipolar disorder syndrome (Alloy et al., 2008), and hence is unlikely to be explainable as a pathoplastic consequence of bipolar disorder, it may be that BAS dysregulation is only characteristic of bipolar disorder or attenuated bipolar disorder symptoms once a certain diathetic threshold has been passed.

The distinction between the predisposition/vulnerability and spectrum models may also explain the discrepancy between the present findings and those of previous studies. Many studies informing the current project’s hypotheses used continuous measures (e.g., Alloy et al., 2006; Alloy et al., 2008), a method of assessment compatible with either a predisposition/vulnerability or spectrum model. Many of these studies also used high-risk versus low-risk designs, rather than correlational analyses that better suit continuous variables. Hence, whilst this literature may sometimes be described broadly as adopting a “spectrum” approach, participants in the high-risk groups may have in fact passed a diathetic threshold and qualitatively resemble diagnosed bipolar disorder clients. In contrast, low-risk individuals might
simply be better categorised as non-psychiatric comparisons rather than being described as low on a continuum of bipolar disorder traits. Hence, it is possible that high-spectrum samples (as assessed by the GBI or 7U7D) represent undiagnosed bipolar disorder at clinical severity, and that this phenomenon is categorically distinct from the mood variability symptoms endorsed by low-spectrum samples such as those tested in the present project.

The lack of clarity in predisposition/vulnerability versus spectrum models, and lack of explicit testing of the assumptions underlying these models, is an important complexity in examining the BAS theory of bipolar disorder. What is currently absent from the literature is empirical discrimination between the continuous approach as predisposition/vulnerability to bipolar disorder (or the underlying psychopathological dimensions of mania-proneness and depression-proneness) versus a continuous spectrum as simply being representative of bipolar disorder phenomenology at an attenuated level. There is little literature explicitly dissociating high vulnerability from the actual presence of psychopathology. One way to examine this research question would be to identify individuals who exhibit high trait vulnerability but who are resilient to developing bipolar disorder. A complementary goal would be to identify individuals who develop bipolar disorder but exhibit few personality-level signs of trait vulnerability. This remains a possibility for subsequent clinical research. At present, the primary methodological tool that has been used to examine the categorical versus continuous dilemma in psychopathology is taxometric analysis (Meehl, 1992). A review of the taxometric literature can provide further clarification on how bipolar disorder might be most accurately conceptualised.

**10.8.3. The purpose of taxometric analysis.** Taxometric analysis is a statistical methodology capable of directly testing whether a latent variable is more appropriately thought of as categorical (i.e., taxonic) or continuous (Meehl, 1992; Meehl, 1995). Taxometric analysis is currently the gold-standard methodological tool for identification of qualitative versus quantitative constructs, designed to address the limitations of previous cluster analysis algorithms (Ruscio & Ruscio, 2004b). The technique attempts to separate the potential *taxon* group (e.g., individuals diagnosed with bipolar disorder) from a *complement* group (e.g., non-psychiatric controls) by examining the distributions of a set of *indicator* variables.
A taxon is a discrete category (Meehl, 1992), which in its purest sense refers to a natural kind (e.g., a qualitative biological abnormality), although the term encompasses other categorical models, such as configural categories (Clark, 2005; Meehl, 1992).

Before proceeding, it should be reiterated that taxometric analysis empirically assesses the taxonicity of the *latent* variable (Meehl, 1992; Ruscio & Ruscio, 2004a). This is important to note as a taxonic latent variable might be overtly measured using dimensional ratings, and a dimensional latent variable might be overtly measured using dichotomous ratings (Meehl, 1995). In part because of this possible measurement discrepancy, taxometric analysis does not assume that all categorical boundaries are necessarily sharp, distinct points of discontinuity, and hence acknowledges that discrete categories may possess relatively indistinct boundaries (Meehl, 1995). It is argued that taxometric analysis findings are minimally affected by the design of the overt measures used to acquire data (Meehl, 1992; Ruscio & Ruscio, 2004b). However, as illustrated below, overt measurements and the design philosophies informing their creation may influence taxometric analysis findings more indirectly by way of content validity.

### 10.8.4. Taxometric analysis of bipolar disorder

To date, only three taxometric studies have focused specifically on bipolar disorder. Two of these studies have investigated clinical bipolar disorder, with one study finding bipolar disorder to be taxonic (Ahmed, Green, Clark, Stahl, & McFarland, 2011) and the other study finding it to be dimensional (Prisciandaro & Roberts, 2011). The third study examined trait vulnerability to bipolar disorder, finding that it was most appropriately described as dimensional (Meyer & Keller, 2003). These three studies are summarised below.

Ahmed, Green, Clark, Stahl, and McFarland (2011) examined non-institutionalised participants (*N* = 15,171) recruited in a North American epidemiological survey. Indicator items were chosen that assessed manic and depressive symptomatology as well as functional impairment, with the majority of the items rated on a binary yes-or-no response format. These items were composited into four depression groupings and three mania groupings based on item content. Family history, treatment frequency, and duration of symptoms were selected as external validity indicators. Manic and depressive symptoms were analysed
separately. Evidence across the analysis consistently supported a taxonic latent structure for both manic and depressive symptoms, with moderate taxonic overlap. Taxon grouping was strongly predictive of MDD diagnosis, and moderately predictive of lifetime bipolar disorder diagnosis. Ahmed et al. (2005) interpreted their findings as suggesting a discontinuity between mood-based psychopathology and non-pathological mood. However, the authors also acknowledged the presence of a hybrid structure incorporating dimensional severity elements within taxa. This was conjectured to arise from an issue of configural categorisation or complement members not having crossed a potential diathetic threshold (Ahmed et al., 2011).

Prisciandaro and Roberts (2011) used factor analysis, taxometric analysis, and a similar technique, information-theoretic latent distribution modelling, to examine the manic symptoms of bipolar disorder in two studies. A large sample of North American epidemiological survey participants ($N = 10,105$) completed eight binary ratings of manic episode symptoms. The same sample was used across both studies. Analyses from the first study suggested that manic symptoms loaded on a single factor and should be regarded as dimensional in nature. The second study compared the predictive power of four empirically and theoretically derived models of mania, using health service utilisation, psychiatric comorbidity, and suicidal behaviour as external validity indicators. Regression findings strongly supported the superiority of a continuous approach rather than viewing manic and non-manic as discrete taxa (Prisciandaro & Roberts, 2011).

Finally, one taxometric analysis has considered whether temperamental vulnerability to bipolar disorder is itself a latent category. Meyer and Keller (2003) administered the Hypomanic Personality Scale (Eckblad & Chapman, 1986) to two non-clinical samples ($N = 1,966$ adults and $N = 405$ adolescents) to assess whether hypomanic risk was discontinuous with normal emotional temperament. Taxometric analysis was conducted on an item-level basis, with each item rated on a binary response scale. No external validity indicators were investigated. The results for both samples supported a dimensional rather than taxonic structure to temperamental vulnerability to bipolar disorder. This suggests that temperamental vulnerability is on a continuum with normal temperament, as per Prisciandaro and Roberts (2011). However, the finding is nonetheless compatible with Depue’s (1981) notion of a
diathetic threshold, and accordingly with the finding that clinical mania occurs as a discrete taxon (Ahmed et al., 2011).

10.8.5. Taxometric analysis of unipolar depression. In contrast to the sparse taxometric literature on bipolar disorder, 20 taxometric analysis studies have been published examining unipolar depression. These studies have used a number of primary indicator variables, typically based around DSM criteria, the first or second versions of the Beck Depression Inventory (BDI), or the Minnesota Multiphasic Personality Inventory 2 (MMPI-2). Haslam and Beck (1994) examined a clinical sample of MDD patients in order to determine whether discrete subtypes of depression could be identified within a clinical population. Only an endogenous/melancholic subtype was supported as potentially taxonic, with depressive symptoms generally evidencing dimensionality (Haslam & Beck, 1994).

Ruscio and Ruscio (2000) examined two patient samples, with both samples supporting a dimensional structure. This result was replicated by Franklin, Strong, and Greene (2002) and Ruscio and Ruscio (2002) in alternate psychiatric samples. Prisciandaro and Roberts (2005) sampled individuals endorsing lifetime occurrence of depressed mood or anhedonia. Following taxometric analysis of clinical interview data, the authors also found evidence of the dimensionality of depression. Subsequent validation of this finding by testing a number of dimensional and categorical models continued to affirm a dimensional structure (Prisciandaro & Roberts, 2009).

Further studies have affirmed a dimensional structure to depression. Baldwin and Shean (2006) replicated dimensionality of depression in a university sample, and this dimensional structure was still present across different symptom sets of depression in a later undergraduate sample study (Shean & Baldwin, 2012). Gibb, Alloy, Abramson, Beevers, and Miller (2004) examined negative cognitive style as an indicator of depression vulnerability, finding that it was best described as dimensional. Cross-culturally, Slade and Andrews (2005) established that a latent dimensional structure to depression was also applicable to an Australian sample. Each of Slade and Andrews’ participants had endorsed experiencing depressed mood or anhedonia in the previous 12 months, however only 36.8% of the sample warranted clinical diagnosis. A dimensional structure has also been found in a Japanese undergraduate sample (Okumura, Sakamoto, Tomoda, & Kijima, 2009).
Holland, Schutte, Brennan, and Moos (2010) found that depression continued to possess a latent dimensional structure in late adulthood (age 55-65) when assessed via self-report items. However, the authors noted that suicidal ideation and preoccupation with death was differentiated as a discrete taxon (Holland, Schutte, Brennan, & Moos, 2010).

More recently, studies supporting a dimensional approach to depression have been criticised for their over-reliance on self-report scales, which may instead measure more general negative affectivity (Haslam, Holland, & Kuppens, 2012; Ruscio, Brown, & Meron Ruscio, 2009). Accordingly, later taxometric analysis studies have emphasised the use of clinician-rated interview data (Ruscio et al., 2009). Ruscio, Zimmerman, McGlinchey, Chelminsky, and Young (2007) found evidence of a latent taxonic structure to depression in an adult outpatient sample that underwent clinical interview. Ruscio, Brown, and Ruscio (2009) replicated this finding in a further outpatient sample. The results of these studies are important as they indicate that the interpretability of a taxometric analysis data is highly influenced by the content and construct validity of the primary indicator scales that are being analysed (Ruscio et al., 2009).

Later taxometric analyses have employed more refined statistical techniques that have influenced findings. For example, Beach and Amir (2003) adopted a symptom group approach, dividing depression into distress and somatic symptoms when examining Beck Depression Inventory responses in an undergraduate sample. In their initial publication, the authors found that distress symptoms were best described as dimensional in nature, whilst somatic symptoms were better described as taxonic. However, a follow-up study reanalysing Beach and Amir’s data set using a simulation technique to control for skew and low base rate found that depression was better described as taxonic across both symptom dimensions, with a discontinuity present at a high cut-off point of the BDI scoring distribution (Beach & Amir, 2006).

This trend of earlier dimensional findings shifting to later taxonic findings is paralleled in the adolescent depression literature. Ambrosini, Bennett, Cleland, and Haslam (2002) found indicators of melancholia to be taxonic in an adolescent patient sample. However, in a community child and adolescent sample, Hankin, Fraley, Lahey, and Waldman (2005) found depression to be dimensional after using clinical
interview responses as the primary indicator variable. The dimensional finding was consistent across individual symptoms, youth versus parent reports, gender, age, and symptom domains, such as distress symptoms versus vegetative symptoms (Hankin et al., 2005). Using more rigorous taxometric techniques, Solomon, Ruscio, Seeley, and Lewinsohn (2006) found depression to be taxonic in a community sample of high school students. The authors analysed BDI, Hamilton Rating Scale for Depression, and clinical interview data, consistently finding taxonicity even when cases of melancholic depression were excluded. Similarly, a taxonic structure to child and adolescent depression was also obtained by Richey et al. (2009).

10.8.6. Inferences drawn from the taxometric analysis literature.
Taxometric analysis has been argued to be the empirical technique most capable of determining whether latent variables are best described by a dimensional or taxonic structure (Ruscio & Ruscio, 2004). Unfortunately, as reviewed above, taxometric analysis results as pertain to mood disorders are equivocal across studies. The few taxometric studies of bipolar disorder have disagreed regarding dimensionality, whilst the predominantly dimensional findings of earlier depression studies have given way to a taxonic theme across later research. This means that there is no truly authoritative evidence as to whether bipolar disorder can be best conceptualised as dimensional or taxonic. However, inferences relevant to interpreting the present project’s findings can nonetheless be drawn from this literature.

The first inference is that different elements of the one syndrome are not necessarily accurately modelled in the same manner. Most taxometric analyses of mood disorders have been conducted separately for different elements of the disorder. For example, Ahmed et al. (2011) considered manic and depressive symptoms as separate streams within bipolar disorder, whilst Beach and Amir (2003, 2006) separated affective and somatic symptoms of unipolar depression. At a higher conceptual level, Meyer and Keller (2003) and Gibb et al. (2004) considered vulnerability indicators rather than clinical symptoms, whilst Haslam and Beck (2004) attempted to differentiate alternative aetiological models. Some research has even focused on only on one symptom set at a time, potentially overlooking important information provided by the confluence of manic and depressive symptoms (Prisciandaro & Roberts, 2011). The use of these approaches underscores the notion that not all characteristics of bipolar disorder need to be described by the
one categorical or continuous model (Clark, 2005). It may be that whilst some elements of bipolar disorder are best viewed as dimensional, BAS as relevant to bipolar disorder is categorical in nature, with the BAS theory of bipolar disorder only becoming applicable after a certain categorical threshold has been exceeded.

The second inference that can be drawn from the taxometric analysis literature is that taxometric analysis cannot generate scientific truth in isolation (Meehl, 1992). Taxometric analysis was designed to assess latent structure regardless of overt measurement format. However, as shown above, taxometric findings remain somewhat dependent on the overt measures used. This dependency is more a matter of content validity than it is an artefact of response format. Because the primary limitation of taxometric analysis is that it offers explanation within a data set through the use of bootstrapping techniques, this means that it is also limited to considering the underlying assumptions and content domain of the measure informing that data set. For example, taxometric analysis of BDI findings have been criticised for assessing general negative affectivity rather than clinical depression, whilst structured clinical interview ratings have been argued to provide superior validity (Ruscio, Brown, & Ruscio, 2009). However, a spectrum theorist might argue that general negative affectivity is merely subsyndromal depression (Clark, 2005), whilst a clinical interviewer could presuppose a categorical distinction, and hence would exclude subsyndromal symptoms. In this circumstance, the pool of data that a taxometric analysis has to draw on is constrained by the assumptions underlying the measurement techniques. For this reason, it may be more accurate to specify that the latent structure of unipolar depression is dimensional as measured by the BDI, or taxonic as measured by clinician rating, rather than to presume that the depression concept measured by one form of assessment is identical to the depression concept assessed by another. With further research, it is likely that such an argument can just as easily be ventured towards taxometric analysis of mania as well.

Due to the dependency of taxometric analysis on measurement methods, it is important to note that any best practice conceptualisation of bipolar disorder may not necessarily be absolute, but might instead be derived from pragmatic goals. Whilst taxometric analysis is useful for its empirical directness, its utility is limited by the circular logic of theoretical background informing scale content, which in turn informs taxometric analysis findings. These taxometric analysis findings are then
intended to provide empirical feedback to the initial theoretical background, closing the circle of reasoning. For this reason, before the taxometric analysis literature can develop further meaningfulness, more attention to measurement of the phenomena purported to characterise or underpin psychiatric disorders is required. Importantly, users of these measures should be made conscious of the theoretical model driving item generation and scale design, as these original assumptions influence later findings.

10.9. Models and Measures of BAS

10.9.1. Issues concerning BAS. The following section reviews conceptual and methodological issues concerning the measurement of BAS, and discusses how these issues may influence investigation of the BAS theory of bipolar disorder. Self-reported BAS sensitivity was a core variable in the present project. It was anticipated that an association between self-reported BAS and risky decision-making would be mediated by trait bipolar disorder vulnerability, reflecting the theorised role of BAS as a fundamental process in bipolar disorder (Depue & Iacono, 1989; Johnson et al., 2000). Although measures of impulsivity and sensation-seeking have not been accurate in predicting behavioural task performance (Bechara et al., 1994; Lejuez et al., 2002), it was believed that a specific BAS measure would be more effective. However, this prediction was not borne out across studies. This finding provides a useful opportunity to consider the validity of BAS measurement and the assumptions underlying BAS as a concept. The following section critically reviews alternate conceptualisations and methods of measuring trait BAS with the aim of generating pathways for future research.

10.9.2. The explanatory power of RST for human behaviour. The BBS was developed from the perspective of RST (Carver & White, 1994; Gray, 1990). The fact that a theoretical background formed the basis of BBS item generation and factor structure constitutes a strength of the scale, as best scientific practice is for tools to flow from theory (Meehl, 1990). RST is certainly a strong theoretical framework, capable of explaining a vast array of findings from the broad learning and neurology literatures (see Gray, 1975; Gray, 1987; Gray, 1990). However, many of these findings were derived from animal research rather than research on human participants (e.g., Gray, 1975). Because the BBS was derived from RST, it is subject
to the same underlying assumptions as RST. The RST assumption most usefully challenged is a fundamental one, based in evolutionary theory (Darwin, 1859). This is the assumption that the animal research findings that the RST framework was created to explain transfer to the human level of functioning, in an unmodified and wholly applicable manner (Corr, 2008).

Limitations in the assumption that animal findings translate directly to the human context are an important concern given that RST is so extensively formulated from animal studies (Corr, 2008; Gray, 1975; Shanks, Greek, & Greek, 2009). Although species used in animal research may possess neural structures analogous to those in humans, the effect of higher-order cognitive functions such as planning of complex goals, abstract reasoning, and reflective control is not taken into account by animal models (Gabora & Kaufman, 2010). Although BAS has been in part localised to the ventral striatum (Schultz, Tremblay, & Hollerman, 2003), it is also known that the frontal cortex is associated with BAS sensitivity in humans (Harmon-Jones & Allen, 1997), with the frontal cortex also being implicated in higher cognitive processes (Kolb & Whishaw, 2008). It can be argued that the role of the human cortical processes in BAS has not yet been sufficiently modelled by RST. Because of this, it may be that some animal findings do not transfer to the human level of functioning. Whilst this in itself constitutes a limitation of examining BAS in the context of human cognition, it becomes even more salient when considering the social and environmental complexity that humans navigate in pursuit of their goals.

Humans operate within a complex social world, involving numerous forms of both short-term (e.g., paying a bill) and long-term (e.g., retraining in an alternative career) goal-directed action. Because of this complexity, BAS processes should ideally be thought of in a similarly elaborate way, in terms of expression if not underlying neural mechanism (Leone et al., 2001). Systemically, human societies and interpersonal interactions are radically different in form and scale from those of other species. However, the animal research informing RST has conventionally involved relatively simple patterns of goal interaction and reward (Gray, 1975). In addition, animal motivation is often controlled, typically via enforcing a state of starvation so that food can be objectively classified as a high-priority reward stimulus (Gray, 1975). These approaches match the strong empirical behaviourist tradition of animal studies, and allow experiments to be as controlled as possible.
However, a restricted focus on more evolutionarily primitive animal interactions and behaviours may limit the cross-species generalisability of RST (Shanks et al., 2009).

Along with the increased cognitive control facilitated by the human cerebral cortex, animal research is not capable of directly modelling human goal-directed situations in terms of complexity (Shanks et al., 2009). Personality traits, past experiences, personal reward preferences, ability to consciously delay gratification, prioritising conflicting goals, and other complex functions are not capable of being modelled by animal studies in a manner that captures human experience (Shanks et al., 2009). This leap in complexity is well represented by the diversity of goals desired by humans (e.g., Carver & Johnson, 2006), whereas in contrast animal research has primarily focused on basic survival goals such as nutrition and reproduction (Gray, 1975). At present, it would appear reasonable to suggest that the closer a human’s needs are to basic subsistence (Maslow, 1943), the greater the explanatory power of RST. For this reason, a greater focus on complex human goals and interactions needs to be encouraged in studies adopting the RST framework. One method of facilitating this is to increase application of RST to a social psychology context, as at a human level RST has been more commonly used to examine psychopathology than the non-pathological range of behaviours studied by social, organisational, and relationship psychologists (e.g., Abele, 2014; Avivi, Laurenceau, & Carver, 2009; Fitzsimons & Bargh, 2003; Maslyn, Farmer, & Fedor, 1996; Sitkin, See, Miller, Lawless, & Carlton, 2011). Another method of acknowledging increased human-level complexity in RST is to attempt to reflect this complexity in trait models. The following sections discuss some of the ways in which trait measurement of BAS might be updated to accommodate complex human interactions.


Although it has been argued that the BBS is limited in that its factor structure was statistically derived (Torrubia, Ávila, Moltó, & Caseras, 2001), the BBS item content itself was derived based on the original RST framework (Gray, 1987). If the content of Carver and White’s (1994) BAS factor statistically separated into three subordinate factors, but was based upon a rationally derived content domain (see Carver & White, 1994, p.322), then this suggests that observable distinctions can be drawn within the superordinate factor that is BAS. To draw from Clark (2005), these distinctions might not necessarily represent natural categories in the sense of being
dissociable within BAS as a neurobehavioural system, but instead might represent practical categories in that they constitute useful and scientifically informative groupings of content within BAS as a trait.

In exploring what a multidimensional conceptualisation of trait BAS might look like, it is helpful to consider the ways in which trait BAS has been separated into subordinate categories by other scales. In their GWPQ, Wilson, Barrett, and Gray (1989) suggested that BAS might be separated into subordinate approach and active avoidance categories of behaviour that remain separable at a trait level. Whilst these factors were theoretically derived from animal behaviours and Wilson et al. (1989) were not able to obtain a factor solution that fit their scale design, the involvement of BAS in active avoidance processes is something that has been understudied at a trait level and has not been presented as an aspect of trait BAS in subsequent scales.

The most elaborate multidimensional model of trait BAS to date has not yet received published data to support it. Corr and Cooper’s (n. d.) RST-PQ separates BAS into four factors: (i) reward interest; (ii) drive-persistence; (iii) reward reactivity; and (iv) impulsivity (Corr & Cooper, n. d.). Reward interest refers to an initial vigilance towards the selection of appetitive opportunities in the environment, regardless of whether such opportunities are present or absent. Analogous to BAS-D, drive-persistence concerns active pursuit of goals, even when immediate reward may not be forthcoming. Similar to BAS-RR, reward-reactivity refers to excitement at mastering rewarding situations, especially as sub-goal procedures leading to an end-goal are fulfilled. Finally, impulsivity in Corr and Cooper’s BAS model is the burst of goal-oriented actions that is adaptive at the final stage of securing the reward stimulus. Although the RST-Q has yet to be validated and published, Corr and Cooper’s scale is an interesting example of thinking about how different elements of BAS might be most relevant to different stages of a goal-pursuit experience.

Alternative models of reward sensitivity may be useful for creating a multidimensional measure of trait BAS, provided that they do not contradict the RST framework. One such model has been outlined by Berridge, Robinson, and Aldridge (2009). Berridge et al. propose three main divisions of reward sensitivity. The first component, liking, refers to the immediate hedonic experience of pleasure following the attainment or achievement of a reward. The second component, wanting, refers
to the incentive motivation that promotes approach and consumption behaviour in the presence of a potential reward. Finally, learning, the third component, refers to the conditioning aspects of reward sensitivity that allow prediction of later possibilities based on previous outcomes. Berridge et al. argue that learning is dissociable from liking and wanting, although it draws information from prior experiences of both. Liking and wanting have been identified and dissociated at a neurological level, although the separability of learning has only been demonstrated behaviourally. A limitation of Berridge et al.’s three-component model of reward sensitivity is that it is based primarily in similar animal neurological and behavioural research to that which informed RST. This means that the arguments regarding the transfer of RST to human-level functioning in the previous section presently also generalise to the model of Berridge et al. However, given the decreased emphasis on liking and learning as viewed by Berridge et al. in trait models of RST (Corr, 2008), considering the link between this three-component model and RST and attempting to translate the model to a human trait level of analysis may benefit trait measurement of BAS.

Finally, a potential source of variance and factor structure not often considered in reward-based scales is the type of reward. This is important, as it is possible that a person might be more accurately described in terms of the types of reward that they tend to pursue. For example, an individual might seem low on trait reward sensitivity when socially-oriented questions are asked, but may actually be quite driven in the pursuit of financial wealth, an alternative form of reward. Johnson and Carver (2006) designed the 30-item WASSUP measure in order to assess preference for different goals and the level of motivation with which these goals are pursued. As the WASSUP was designed to be relevant to bipolar disorder, it assesses goals that are relatively improbable and that are highly grandiose or ambitious. The goal dimensions assessed are (i) popular fame; (ii) political influence; (iii) worldwide well-being; (iv) financial success; (v) “perfect” intimate relationships; (vi) “perfect” social relationships and interpersonal popularity; and (vii) creativity and fulfilment. These dimensions were largely independent, with only weak to moderate correlations observed. Whilst the WASSUP provides a preliminary typology of goals, it may be that adopting a similar approach for a wider array of goals (rather than just those that are grandiose and unlikely) will enhance
understanding of reward sensitivity and the processes that underpin it in a manner
different to scales that attempt to break reward sensitivity down into different
processes.

10.9.4. Lessons from the impulsivity literature. The conceptual and
empirical boundaries between BAS and impulsivity are presently unclear.
Impulsivity is generally viewed as an immediate response to positive reinforcement,
that is lacking in forethought (Whiteside & Lynam, 2001). Some elements of
impulsivity and BAS appear to overlap (Franken & Muris, 2006; Quilty & Oakman,
2004), with BAS-FS appearing to possess a strong impulsivity component (Smillie,
Jackson, & Dalgleish, 2006; Zelenski & Larsen, 1999). Unlike BAS, impulsivity
benefits from a stronger tradition of being conceptualised multidimensionally
(Barratt, 1959; Stanford et al., 2009; Whiteside & Lynam, 2001). Hence, examining
multidimensional measures of impulsivity might reveal ideas that can improve
measurement of trait BAS.

One example of an impulsivity-based factor structure that may inform
reconceptualisation of trait BAS is that of the Urgency Premeditation Perseverance
Sensation-Seeking Impulsive Behaviour Scale (UPPS; Whiteside & Lynam, 2001).
The UPPS separates impulsivity into four factors. Negative urgency captures the
tendency to act rashly in times of emotional distress. Lack of premeditation refers to
a lack of planning or forethought. Lack of perseverance involves the tendency to lose
focus and motivation before completing a task. Lastly, sensation-seeking is the
preference for novel and thrilling experiences. A fifth factor, positive urgency, the
tendency to act rashly in times of emotional elation, was later added to the scale
(Cyders et al., 2007). Categorical division of trait BAS in similar multifactorial terms
to the UPPS might enhance the content validity of trait BAS measures, or at the very
least, allow for greater academic consensus regarding what trait BAS is and what it
is not (e.g., Corr & Cooper, n. d.; Jackson, 2009).

One multifactorial conceptualisation of impulsivity is of particular relevance
to BAS in the context of bipolar disorder. Noting that impulsivity can at times be
more adaptive than maladaptive, Dickman (1990) created a 23-item measure of
functional impulsivity (11 items) and dysfunctional impulsivity (12 items). Factor
analysis was accomplished with principal axis factoring and an oblimin rotation,
although the scales were uncorrelated. Both scales exhibited adequate reliability.
Dickman defined functional impulsivity as a tendency to engage in rapid but more error-prone information processing when optimal, whereas dysfunctional impulsivity was defined as an inability to adopt a slower, methodical approach to problem-solving and decision-making even when such an approach was optimal. Although the UPPS family of impulsivity traits includes positive and negative urgency, these constructs reflect the emotional context in which the impulsivity is elicited; in contrast, the distinction between functional and dysfunctional impulsivity was almost purely outcome-based in the original validation study. Functional impulsivity was associated with extraverted qualities such as enthusiasm, adventurousness, and activity, whilst dysfunctional impulsivity was associated with unconscientious qualities, such as disorderliness and lack of forethought.

Dickman’s impulsivity structure (1990) is of interest in the context of BAS, as it suggests that what is essentially a single overarching phenomenon (impulsivity) can take the form of two separate constructs statistically (functional versus dysfunctional impulsivity), at least provided that this distinction has been planned during the generation of scale content (Dickman, 1990). In a similar manner, BAS may benefit from a renewed focus on distinguishing adaptive versus maladaptive outcomes. At present, the BAS factors assessed by the BBS largely measure adaptive outcomes (Carver & White, 1994). A potential explanation for the lack of strong correlations between BAS and mania-proneness in the present project is that mania concerns the maladaptive, dysfunctional expression of BAS, a tone of BAS that was not directly assessed. Indeed, if BAS dysregulation is viewed as the driving force in bipolar disorder, an extreme perspective might claim that maladaptive BAS is mania-proneness. Hence, measuring BAS from a standpoint of dysregulation might reveal a correlation between BAS and mania-proneness. Although a functional versus dysfunctional dichotomy has yet to be applied to trait measurement of BAS, addendums to the BBS have been published that attempt to measure BAS dysregulation and frustrative nonreward (Holzwarth & Meyer, 2006; Wright, Lam, & Brown, 2009).

Holzwarth and Meyer (2006) created a 13-item measure of BAS dysregulation called the BAS Dysregulation Scale (DYS), intended as an addendum to the BBS. The DYS items were formed by modifying the BBS BAS items to reflect level of state fluctuation. Lower DYS scores were said to indicate decreased
regulatory strength; in other words, low scorers on the DYS are characterised by a longer amount of time for the BAS to return to baseline trait levels following a period of state behavioural activation (for example, pursuing and a achieving a personal goal, such as a workplace promotion). DYS was argued to be distinct from BAS and BIS, with correlational results supporting this prediction (Holzwarth & Meyer, 2006). However, a hypothesised difference in mean DYS between non-clinical participants high or low in bipolar disorder failed to achieve significance, and the scale has been little used since its original publication.

Although the creation of the DYS scale provides an interesting example of how a non-clinical trait can be reframed in a manner more akin to a psychopathological vulnerability trait, at present a number of limitations hinder application of the DYS measure. Foremost amongst these are (i) the undefined difference between dysregulation and intra-individual variation (Holzwarth & Meyer, 2006); (ii) equivocally worded item content (e.g., “There are times when I do x, and times when I do not”) that could arguably be assessing a neutral level of trait BAS than dysregulation per se; and (iii) only surface consideration of affect and the state versus trait distinction (a concern elaborated upon below). If these limitations were addressed then the DYS could constitute a valuable expansion of trait BAS measurement, and its existence highlights an area of neglect in conceptualisation of BAS. The operationalisation of dysregulation as variability in the DYS prompts further thinking about the relationship between BAS and emotion, and also about how the distinction between state and trait is applicable to BAS.

10.9.5. A link between BAS and negative emotion. BAS is associated with the experience of positive affect, with this valence of emotion (or the prospect of experiencing this valence of emotion) seen as motivating individuals to approach rewarding stimuli (Corr, 2008). However, research into Carver and Scheier’s control-process model has demonstrated that BAS can also be associated with the negative emotions, especially anger in situations where approach towards a potential reward has been frustrated (Carver, 2004; Harmon-Jones, 2003). The role of BAS in negative emotional experiences is currently underrepresented in measures of trait BAS (Wright et al., 2009). Carver (2004) conducted three studies to investigate BAS-correlated experiences of sadness and anger (assessed via a small selection of simple scaling questions) across experimental situations of: (i) frustrative non-
reward in response to a false-feedback task \( (N = 66) \), (ii) anger provocation by reaction to a vignette \( (N = 466) \), and (iii) anger experienced in response to real news of a terrorist attack \( (N = 96) \). Study 1 found BAS-FS to be more strongly related than BIS to sadness and frustration, Study 2 demonstrated that BAS-RR predicted angry responses whereas BIS predicted responses of nervousness, and Study 3 regression analysis revealed BIS to uniquely predict fear and BAS-D to be the strongest predictor of anger (although BIS and BAS-RR had also been positively correlated with anger at a bivariate level). In short, Carver (2004) found clear support for the idea that negative emotions can arise as an outcome of BAS and are not solely modulated by BIS.

A link between BAS and externalised anger and BIS and internalised anger has been shown using trait questionnaires. Cooper, Gomez, and Buck (2008) administered the BBS along with several indices of anger to a sample of Australian undergraduate students \( (N = 100) \). BAS-D and BIS were both positively correlated with trait anger and angry arousal, whilst BIS was associated with inward expression of anger and BAS-D was associated with internal and external control over anger. BAS-FS positively predicted both direct and indirect aggression, a finding anticipated by its connotations of unplanned behaviour. In contract, BAS-RR positively predicted non-aggression. The authors concluded that BIS was broadly associated with internalised anger, whilst BAS was broadly associated with externalised anger, and noted the correspondence between this pattern and Carver’s (2004) notion of self-defensive versus predatory anger respectively (Cooper, Gomez, & Buck, 2008).

Wright, Lam, and Brown (2009) developed an addendum to the BBS to assess BAS-modulated anger: the frustrative non-reward responsiveness (FNR) subscale. FNR was designed to measure a propensity to experience diminished approach motivation following signals of non-reward; based on Carver’s (2004) reasoning, it was believed that lower signals of non-reward might be associated with an affective reaction of anger (in tandem with an aggressive surge in motivation), whilst higher signals would be reacted to with sadness (as a form of helpless disengagement). Principal axis factoring \( (N = 308) \) supported the separability of the five-item FNR subscale (and also identified the problematic BIS items consistently observed in previous studies), and adequate internal consistency and test-retest
reliability was also established. Subsequent validation ($N = 82$) demonstrated an intuitive positive correlation between FNR and apathy, however no association with performance on a treasure-seeking non-reward task was found. The FNR has been administered in one other study, where it did not differentiate between euthymic bipolar disorder patients and a non-psychiatric comparison group ($n = 40$ per group), although time taken to recover from frustration was positively correlated with number of mood episodes experienced (Wright, Lam, & Brown, 2008). As with BAS-DYS, BAS-FNR has not been adopted by the wider BBS literature.

The link between BAS and anger (Carver & Harmon-Jones, 2009) is potentially important to mood induction procedures as well as questionnaire structures. As a negative emotion, anger should be easier to induce in participants than the positive emotions associated with BAS, with a bias towards negative emotional stimuli and reactions being consistently identified across a wide range of psychological research (e.g., Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rozen & Royzman, 2001; Taylor, 1991). Anger has robust evidence placing it as a BAS-relevant emotional response (Carver, 2004; Carver & Harmon-Jones, 2009), with known neurological underpinnings (Harmon-Jones, Gable, & Peterson, 2010), and effective experimental techniques are available for inducing anger (e.g., Carver, 2004). Although the present thesis adopted Watson and Tellegen’s (1985) two-factor model of mood, focusing on positively-valenced and negatively-valenced mood more generally, a focus on specific emotions, especially anger, would be useful for enabling greater mood induction efficacy and more specific neurological conceptualisation of BAS responsiveness. For example, a fruitful avenue for future research could be pursued by reframing the design of Study 3 of the present project to examine whether individuals high in trait vulnerability to bipolar disorder are more susceptible both to induced anger and to greater risky decision-making whilst in a state of induced anger. A study design making use of anger in this way would be likely to improve the power of the mood induction technique over the false feedback methodology used in Study 3 (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Carver, 2004; Farmer et al., 2006).

Further acknowledging the link between BAS and negative emotion in trait measurement remains a challenge for future research. Although the FNR subscale is an interesting complement to the BBS and represents a useful starting point, further
study is necessary to differentiate FNR from trait BIS. Although FNR and trait BIS were clearly not mutually redundant when the subscale was initially validated \((r = .36)\), both FNR and trait BIS were characterised by a similar pattern of correlations with other measures (Wright, Lam, & Brown, 2009). One possibility is that frustrative non-reward is a construct that is difficult to capture as a distinct trait but that possesses stronger utility when viewed as a state, at the level of discrete non-reward experiences. The concept of self-report measurement of BAS as a state, rather than trait, variable, is explored more fully below.

10.9.6. The state-trait distinction in BAS measurement. All of the aforementioned self-report approaches to BAS or BAS-relevant constructs have one unifying feature: They all seek to capture BAS at a trait level of measurement. However, the animal research that BAS was developed to explain took place in isolated experimental contexts (Gray, 1971; Gray, 1975) that are more appropriately seen as occurring on a situational, or transient state, basis. This is a view that has been presented by Corr and Cooper (n. d.), who described trait expression of RST as being an aggregate of numerous state-level experiences. This constitutes a bottom-up view of trait BAS expression, where state underpins trait. The opposing top-down argument would be to suggest that an underlying trait informs state reactions, although elements of both top-down and bottom-up processes might be present. The definition, boundaries, and conceptualisation of the trait-versus-state distinction in personality research remain an area of central importance (Geiser et al., 2014). Nonetheless, a self-report state-level means of assessing the three RST constructs would be useful in bridging the gap between trait description and prediction of more specific behaviour, as well as the monitoring of behavioural reactions. To date, only one state measure of BAS has been published. In a recent study, Hervas and Vazquez (2013) adopted the novel approach of modifying the BBS (Spanish-language version) into a form reflective of state rather than trait sensitivity in order to examine the effect that a sad mood state (both naturally emergent and experimentally induced) exerts on immediate motivational sensitivity. After modifying the BBS content using phrasing such as “in this moment” or “right now”, and adding two additional items (to BAS-D and BAS-FS respectively), the authors used PCA and CFA to determine suitable factor structure; a two-factor BAS versus BIS model was judged as best fit, with both factors exhibiting adequate reliability (state BAS
Cronbach’s $\alpha = .89$, state BIS Cronbach’s $\alpha = .87$). Across four studies, Hervas and Vazquez found that although state BIS did not decrease in response to the experience of sad mood, state BAS consistently decreased. 

Although their initial experience-sampling study used naturally-emerging sad mood, which meant that intervals between baseline and sad mood testing were variable, Hervas and Vazquez (2013) also demonstrated the same effect using two laboratory-administered mood induction procedures. The authors also found that anxious attachment was associated with a greater decrease in state BAS following induction, and that state BAS and change in state BAS post-induction were predictive of depressive symptoms seven weeks later. Unfortunately, this latter finding blurs the distinction between state and trait, as consistency of depressive symptoms and state BAS across a period of seven weeks might be more indicative of an ongoing trait disposition. The issue of whether the purported state BAS measure was in actuality measuring trait BAS was compounded by a notable oversight in validation: the absence of comparison between the modified state BBS and the original trait BBS. Ultimately, this lack of investigation of the state-trait measurement boundary limits the inferences that can be drawn from Hervas and Vazquez’s study. Nonetheless, Hervas and Vasquez’s state BBS represents an interesting direction in the BAS measurement literature.

10.9.7. Inferences drawn from the expanded BAS measurement literature. The idea of a reward-sensitive or approach-oriented system that can be measured as a personality trait is more complex than it might seem at face value. The present study made use of the BBS, the most cited measure of trait BAS. However, future trait measures of BAS are likely to benefit from broadening the range of BAS characteristics that they assess. It will be helpful to consider the ways in which BAS-relevant content can be defined, and the optimal manner in which to subcategorise this content. This can be accomplished by thinking about how differing processes relate to different aspects of the human goal-pursuit experience (Corr & Cooper, n. d.), and could benefit by drawing on the more complex content breakdowns of the impulsivity literature (Whiteside & Lynam, 2001). The types of goal that attract and motivate human beings will need to be reflected within item content, if not informing the structure of the factors themselves (Johnson & Carver, 2006). At present, trait BAS is viewed on a continuum where higher BAS indicates greater reward
motivation, whilst lower BAS indicates a relative lack of reward motivation. However, the possibility that reward motivation can be expressed in two directions, adaptive and maladaptive, should also be taken into account (Dickman, 1990; Holzwarth & Meyer, 2006). More complex issues, such as the role of BAS in negative emotion (Carver, 2004; Harmon-Jones, 2003) and the distinction between state and trait BAS (Hervas & Vasquez, 2013) must also be investigated. Acknowledgement of the complexity of trait BAS in self-report questionnaire design will allow for improved research utility.

10.10. New Directions for Investigation of Risky Decision-Making

10.10.1. Dynamic reactivity, strategic typology, and motivational engagement in risky decision-making tasks. The previous sections have discussed issues in the measurement of trait bipolar disorder vulnerability and of trait BAS, considering conceptual and methodological issues in two of the three core constructs of the present project. This section focuses on the third measurement area, the use of behavioural tasks to assess risky decision-making. Unlike self-report trait measures, behavioural tasks represent specific situational contexts where a phenomenon of interest can be exhibited and quantified. This specificity means that it is not always apparent what behavioural tasks are measuring, and even tasks that are similar at face value might present important differences in task context and design. For example, the BART, IGT, and GDT assess risky decision-making by exposing the participant to different response situations, and no correlation was found between standard metrics of BART, IGT, and GDT decision-making in Study 2 of the present project. Additionally, the assumption that risky decision-making would function as a behavioural manifestation of BAS and that this would be evidenced by correlations with trait BAS was not supported. In the present project, risky decision-making did not function as a measure of BAS that was correlated with trait BAS.

The immediate explanation for the overall lack of correlation between risky decision-making and any of the trait BAS variables is that BAS processes do not inform risky decision-making. However, as there are compelling theoretical reasons why risky decision-making should involve BAS, as well as BIS and FFFS (see Section 3.2.2), it is useful to consider alternative explanations for why a consistent correlation between risky decision-making and the BBS variables was not observed
in the present project. One explanation for this lack of correlation is that self-report trait measures, as opposed to self-report state measures, are not sufficiently sensitive to risky decision-making task responses. Another explanation is that the surrounding task environment was not sufficiently motivating, in terms of the process of mastering the task or the potential rewards for completing the task. Considerations such as this suggest that is necessary to think about participant responses on a situational rather than general level, and to be mindful of the specific context of each task. The following sections discuss how research designs utilising behavioural tasks can be supported by (i) serial analysis; (ii) state measurement; (iii) motivational engagement practices from video games; (iv) analysis of emotion regulation; and (v) collection of qualitative feedback on task strategy.

10.10.2. Serial analysis of behavioural responses. Reducing data collected over the course of a behavioural task obscures trial-by-trial responses that might be important in characterising the participant. The problem of acknowledging that responses to and outcomes of previous trials during a behavioural task are likely to influence responses to later trials is one that has been considered for decades (e.g., Lashley, 1951). The process of accounting for this level of cross-trial reactivity in generating statistical findings is known as serial analysis (Gökaydin, Navarro, Ma-Wyatt, & Perfors, 2016; Lashley, 1951).

There is no universal standardised method for conducting serial analysis. However, an intuitive method is to track the probability of a response given a previous response or outcome, or a range of previous responses or outcomes over a set interval (Gökaydin et al., 2016). For example, if a participant were to choose a high-risk option and receive an aversive consequence, it might increase the likelihood of a low-risk consequence being selected during subsequent trials (Holmes et al., 2009). Serial analysis is relatively easy to apply to simple tasks, such as a two-alternative forced choice paradigm, where there are only two options or outcomes that can be selected per trial. Gökaydin, Navarro, Ma-Wyatt, and Perfors (2016) have also been able to model responses to a three-alternative forced choice paradigm.

Serial analysis has only been infrequently applied to risky decision-making tasks, perhaps because of their complex manipulation of probability and risk. A study conducted by Holmes et al. (2009) serves as a useful example of how a simple
form of serial analysis has been applied to risky decision-making. Holmes et al. (2009) conducted the only serial analysis of the BART to date by using MANOVA to compare AMP for trials preceded by an explosion to AMP for trials that were not. This technique yielded interesting findings concerning caution that would be obscured by simply analysing mean AMP (Holmes et al., 2009), as Holmes et al. (2009) were able to observe that individuals with bipolar disorder and a history of alcohol abuse were less likely than others to adjust their responses in reaction to an explosion. This methodology and finding provides an example of the feasibility of applying serial analysis to behavioural tasks, and demonstrates the richer level of inference that serial analysis allows.

Serial analysis presents a useful opportunity for risky decision-making research, but there are challenges that need to be met before serial analysis can be applied more widely. Risky decision-making tasks are an order of magnitude more complex than the forced choice tasks that have been modelled using serial analysis (Gökaydin et al., in press), because they involve a greater number of parameters, provide a greater amount of feedback to the participant, and feature probabilistic stimuli and outcomes, rather than the programmed sequences that might occur in less complex forced-choice tasks. Additionally, whereas simpler tasks might be scored by reaction time or number of errors, risky decision-making tasks are commonly scored with reference to the number of advantageous choices made. A method of reducing some of the complexity of risky decision-making tasks is to program them so that all participants receive identical stimuli and outcomes; for example, instead of a BART balloon exploding based on a probability algorithm, a number of pumps might be set for each trial (Gabriel & Williamson, 2010). This method ensures that all participants encounter the same risky decision-making events within a task, and hence might be particularly appropriate for serial analysis (Gabriel & Williamson, 2010).

One limitation of applying serial analysis to risky decision-making tasks is acknowledging that losses can be viewed in terms of magnitude. The MANOVA technique used by Holmes et al. (2009) assumes a binary perspective of consequence: the outcome of the preceding trial is either a win or a loss. Although this might seem appropriate when the only detrimental outcome possible is an explosion, it does not account for the number of pumps that could be made before the explosion occurred. It is reasonable to assume that participants would be less
likely to adjust their responding in reaction to an explosion that occurred after many pumps versus an explosion that occurred early in the trial. For the same reason, it is difficult to apply MANOVA serial analysis to tasks such as the GDT and IGT that involve variable degrees of loss occurring. One way of acknowledging magnitude of loss might be to categorise trials differently based on the degree of loss that preceded them.

Another challenge in applying serial analysis is the degree of consciousness that participants have regarding how to adjust their response pattern. Following a trial ending in an explosion with a conservative amount of pumps on the BART is an intuitive adjustment for a participant with explicit knowledge of the rules governing the task (Holmes et al., 2009). For a task with an implicit rule set, such as the IGT, it might be much harder for a participant to adjust their response pattern in terms of high-risk versus low-risk decisions (Buelow & Suhr, 2008). A loss incurred on a low-risk deck might be reacted to by selecting a high-risk deck, with the participant yet to learn the escalation of risk. Accordingly, there are risky decision-making contexts that serial analysis may be inappropriate for, or where it may only be used in tandem with some method of rating participants’ level of task knowledge.

10.10.3. State effects during behavioural tasks. A related difficulty to serial analysis of behaviour is serial recording state effects throughout a behavioural task. Reconsider the above example from Holmes et al. (2009): A participant incurs a loss on the BART following an explosion, and decreases pumps on subsequent trials in order to minimise the chance of such an explosion reoccurring. Whilst this example is phrased in behavioural terms, in psychological terms it could be said that the participant’s level of state BIS activation has been heightened by the loss/explosion, as this event as emphasised potential loss. Correspondingly, state BAS might (i) remain the same; (ii) increase to compensate for the setback, a response of determination and possibly anger (Harmon-Jones, Gable, & Price, 2013); or (iii) it might diminish in a response of helplessness (state BAS deactivation). At present, no viable technique exists for assessing state across participation in a behavioural task with only minimal task interruption. In the absence of this methodology, research questions regarding state changes and impact on risky decision-making tasks cannot be answered.
The central difficulty in implementing state measurement is the issue of doing so in a way that does not disrupt the behavioural task. It would be undesirable for the state measurement itself to become a confounding variable, priming, disrupting, or otherwise influencing participant responses. The main method for measuring state in personality psychology is to use lexical or verbal self-report question that specify a briefer time period than do trait questionnaires. The PANAS (Watson, Clark, & Tellegen, 1988) is an exemplar of this approach. A second form of assessment would be to record physiological reactions (for example, EEG, galvanic skin responses, facial muscle activity, etc.) and infer state from those (Lang Greenwald, Bradley, & Hamm, 1993). However, both of these techniques are problematic. Self-report state is likely to interrupt task performance, and although this has yet to be empirically tested, it is conceivable that repeated administrations of a state inventory within a small time period might compromise validity. In contrast, electrophysiological means of recording affective state are limited by their specificity of time and interpretation, although they retain utility for broad states of affective arousal (Feldman-Barrett, 2006).

An alternative solution to the problem of state effects is to mathematically infer their presence by controlling for measurement invariance, with the underlying consistency across a set of responses over time seen as representative of a latent trait (Geiser, Keller, & Lockhart, 2013; Geiser et al., 2014). Mathematical inference of state has been termed latent state-trait modelling (LST; Steyer, Ferring, & Schmitt, 1992). Applying LST analysis to a risky decision-making task provides a putative measure of state that is not visible to the participant during performance of the task. As with electrophysiology, LST may not identify specific varieties of state (e.g., sadness, frustration, elation, etc.) as capably as questionnaire measures. However, if self-report or even qualitative reports are integrated with an LST approach and electrophysiology, a rich assessment of state fluctuations over time and their relationship to task performance might be obtainable. It is possible that with further research on highly standardised tasks, random or pseudo-random state variance extraneous to the task context can be separated from variance in behavioural responses that occur as dynamic reactions to task demands (Gilden, 2001).

10.10.4. Enhancing engagement through game design principles. For risky decision-making tasks to provide analogous data to real-life risky decision-
making situations, participants must be adequately motivated and engaged with the
task. If they are not, it is unlikely that BAS activation would occur. As motivation
and emotion are intimately linked (Carver, 2004; Izard et al., 2002; Lang, 2010), in
eliciting motivation it is likely that a task would also be eliciting an emotional
reaction or investment in the task. A fundamental challenge for risky decision-
making paradigms is to elicit motivational or emotional connectivity and reactivity
within the participant in order for experimental results to be ecologically valid.

Several obstacles to participant motivation present themselves in behavioural
task paradigms. The first is simply that the participant may not be experiencing high
levels of intrinsic reward from participation. Whilst the initial commitment to
participate might be accompanied by feelings of altruistic reward, actual
participation is unlikely to present the participant with individually relevant and
salient reward cues. The second limitation is that levels of extrinsic reward are
necessarily constrained for financial and ethical reasons. If participants had the
possibility of acquiring a large sum of money on a behavioural task, then they might
be more likely to experience genuine motivation and the complementary emotional
reactions that underpin RST (Carver & Harmon-Jones, 2009; Corr, 2008). A third
obstacle is that many psychological research studies utilise undergraduate samples
that may not be participating entirely of their own free will. The majority of
participants in the present project were undergraduate students participating either
(a) in completion of a course hurdle requirement (a portion of the Study 1 sample
and the bulk of the Study 2 sample); or (b) to gain insight into a protocol that was
providing the results of their major assignment (the Study 3 sample). This
participatory coercion means that extraneous considerations, such as completing the
tasks in as little time as possible, may prevail over engaging with the task stimuli as
meaningful and exercising decisions analogous to those that would be made in real
life.

Experimental measures that do not rely on participants making emotionally-
informed decisions might be more resilient to limitations of participant apathy.
However, the above limitations are arguably critical for a theory as fundamentally
linked to motivation and affect as RST. What modifications can be made to
ameliorate this? The animal learning tasks that informed RST often manipulated
basic drives such as hunger and thirst to ensure motivated responding (Gray, 1975).
Such paradigms are more ethically and pragmatically problematic in human research. The present project made use of two methods of maximising motivation: (i) provision of intrinsic reward (the competitive setting); and (ii) provision of extrinsic reward (the chocolate bar). However, these incentives are not direct properties of the behavioural tasks, but are limited to occurring as part of the context surrounding the behavioural tasks. A worthwhile step in the task-based literature will be to design a risky decision-making task with production values and reward schedules that are both scientifically useful and that are also attractive to participants.

Risky decision-making tasks resemble games (gambling, board games, tabletop games, video games) in their incorporation of decision and consequence, but they are designed by psychological researchers, not game designers. The BART and GDT, and to a lesser extent, the IGT, both make use of real-world metaphors (balloons, dice, and playing cards), however it is unlikely that many people would spend substantial time engaging in these tasks outside of psychological studies. In contrast, computer and video games are a large-scale industry that consumers regularly spend large amounts of their money and time on. These consumers do not constitute a minority demographic; rather, electronic games have been successful in attracting audiences across demographics. To design a risky decision-making task that can elicit motivation intrinsic to participation, it will be beneficial for psychological researchers to learn from the motivational routines used in successful video games. The benchmark for tasks that elicit motivational engagement should be that participants demonstrably want to play them. While this can be said of electronic games, it is questionable whether it could be said of risky decision-making tasks.

Creating risky decision-making tasks that participants are more invested by drawing from electronic game production is a useful direction for addressing motivational deficits in current behavioural task paradigms. Commercial electronic games utilise a number of design principles to attract and maintain their audiences, and many of these principles involve concepts that have been investigated in psychological research (Desurvire & Wiberg, 2008; Pinelle, Wong, & Stach, 2008; Deterding, O'Hara, Sicart, Dixon, & Nacke, 2011). The reward schedules utilised in electronic game design take many forms: (i) mastery from developing skill in controlling and navigating through the gameplay mechanics; (ii) unlocking new characters, achievements, or areas; (iii) achieving high scores or other metrics that
signify outperformance of other players; (iv) satisfaction of curiosity in allowing a story to unfold; (v) accumulating vast amounts of in-game items; or (vi) simply progressing through the game and being exposed to novel gameplay mechanics or new design aesthetics as subsequent content is unlocked. If these principles could be incorporated into a risky decision-making task, then whilst some level of control might need to be sacrificed for the sake of greater complexity, such a task would provide a more true-to-reality measure of risky decision-making.

10.10.5. The use of emotion regulation to mask expression of a latent trait. Another important state phenomenon to consider when assessing risky decision-making is the ability of participants to regulate their emotional responses (Edge, Miller, et al., 2013; Gross, 1998). Emotion regulation is a broad term referring to processes and strategies for influencing (i) what emotions are experienced; (ii) the time at which emotions are experienced; and (iii) how these emotions are experienced within the individual and expressed to others (Gross & Feldman Barrett, 2011). Research has demonstrated that individuals are able to regulate their emotions (Ochsner & Gross, 2005), and this has been shown to occur on both a conscious (Gross & Levenson, 1993) and unconscious basis (Williams, Bargh, Nocera, & Gray, 2009). It is not unreasonable to assume that trait vulnerability to bipolar disorder and RST traits are also consciously and unconsciously regulated, especially given the strong links between both of these trait models and emotionality (Carver, 2004; Cassidy et al., 1998; Corr, 2008; Malhi et al., 2013).

Supporting the above contention, Edge et al. (2013) recently found that individuals with bipolar disorder are more likely to consciously avoid rewarding activities and to dampen their experiences of positive emotion as a mania-control strategy. This result echoes previous findings that individuals with bipolar disorder are more likely to spontaneously suppress their emotions following mood induction (Gruber, Harvey, & Gross, 2012). These findings were from clinical samples, where a regulatory effect is arguably more easily observable due to the extreme nature of symptoms. However, an implication of these findings is that individuals who are high in any trait that has maladaptive consequences when uninhibited will naturally have more experience regulating said trait. Because of this, “true” latent levels of bipolar disorder vulnerability or reward sensitivity may not be readily measured in
behavioural tasks because individuals with higher levels of the trait will be better able to down-regulate their responses. For example, a participant who is higher on mania-proneness might indeed feel a stronger impulse towards risky decision-making, but based on a history of experiential learning may also have habituated to this impulse and be better able to control it. This self-regulatory control could be so strongly and frequently reinforced and trained over time that it has become an automatic process.

A standardised measure of regulatory capacity or inhibitory control might be required to bridge the explanatory gap between behavioural task responses and trait measurement in future research. This could feasibly take the form of a questionnaire measure or a brief behavioural task. However, a challenge of attempting to measure regulatory capacity and its effect on behavioural expression of trait variables is that responses to any such measure might also be down-regulated. At present, experience in regulating and inhibiting emotional responses may need to be accepted as a limitation when linking trait to behaviour.

10.10.6. Valuing qualitative exploration of participant experience. The other significant outcome flowing from maximising participant engagement in behavioural tasks is that it will entail a greater focus on participant experience of behavioural tasks. One approach to designing a task that motivates participants would be to assess what motivates participants by asking them directly using qualitative methods. Qualitative research designs have seldom been applied to the behavioural task literature. However, direct information about the participants’ experience of the task can strengthen validity and provide a greater richness of information. This information can be considered in the context of the theory informing task creation, and may suggest modifications to the task to match theory and decrease measurement error.

An important example of the utility of qualitative feedback is in the area of participant strategy. Strategy is an important consideration in behavioural tasks, but is something that may not be reflected in task outcome metrics. For example, a participant who pumps BART balloons rapidly and at random might obtain similar AMP and response latency to a participant who after the first few trials carefully decides that they will pump each balloon exactly 55 times. A participant might decide that they will engage in riskier decision-making earlier in the task to help
them to estimate the task parameters, whereas another participant might attempt to
be conservative earlier in the task to build up their hypothetical bank balance, and
then having accomplished this allow themselves riskier choices later in the task.
These potentially important differences in strategy were obscured in the present
project. Qualitative feedback provides a feasible method for differentiating these
participants, and it is also worth noting that the formation and maintenance of a
response strategy signals some degree of task engagement.

Although behavioural tasks attempt to control the strategies available to
participants so that they are directly inferable from the response data, designing more
engaging tasks that more closely resemble real-world situations might mean
compromising this level of experimental control. This is because the more complex a
task becomes, the more variability is to be expected in participant perceptions of and
responses to the task. In future, the incorporation of qualitative assessment into
behavioural task designs could allow group comparisons on the level of strategic
typology. For example, participants who adhere to a set number of pumps across
BART balloons might be compared participants who endorse pumping the balloon at
random. Information regarding strategic response patterns another level of data that
could bridge the divide between specific behavioural responses and general trait
predispositions.

10.10.7. Revisiting measurement of risky decision-making. In the present
project, risky decision-making on each task was examined as an aggregate metric
derived from a range of trials. However, future research may benefit from examining
risky decision-making in a more complex manner. By applying serial analysis and
acknowledging state effects, risky decision-making moves to a finer perspective that
views decision-making as a set of within-task actions and reactions occurring over
time. By reimagining behavioural tasks to elicit greater participant engagement, risky
decision-making in experimental contexts can more closely approximate real-world
risky decision-making. Finally, by considering how automatic regulation of emotions
might impact risky decision-making and seeking qualitative feedback from
participants regarding how they have progressed through a behavioural task, risky
decision-making can be conceptualised on an individual level that emphasises the
different decision-making approaches and strategies that individuals adopt.
10.11. Implications and Conclusion

The present project investigated the BAS theory of bipolar disorder from a vulnerability trait approach, examining trait bipolar disorder vulnerability in non-psychiatric participants. BAS was examined as a trait derived from a self-report questionnaire, and through risky decision-making as a behavioural manifestation of BAS. Results across three studies were largely non-significant, suggesting that trait bipolar disorder vulnerability was not strongly associated with trait BAS, nor predictive of risky decision-making or cognitive inflexibility when pursuing a reward. These findings were consistent across multiple measures of trait BAS (BAS-D, BAS-FS, and BAS-RR) and multiple behavioural tasks (the BART, GDT, and CS-IGT), and are contrary to previous research that has implicated BAS in bipolar disorder (Alloy & Abramson, 2010; Johnson, Fulford, & Carver, 2012).

One implication of the present findings is that BAS may only be elevated in individuals at categorically high risk for bipolar disorder, and hence trait BAS is not a useful continuous indicator of bipolar disorder risk. Similarly, the findings suggested that elevated risky decision-making is not an indicator of vulnerability to bipolar disorder, and a second implication is that risky decision-making tasks do not provide strong behavioural indicators of BAS when administered as standard in research settings. Although one theoretical explanation for the findings of the present project is that BAS activity is only elevated in bipolar disorder once pathology exceeds a certain diathetic threshold (Depue et al., 1981), the present studies were not designed to test this inference, and hence its investigation must remain a goal for future research. In conclusion, the present project did not find compelling evidence that trait bipolar disorder vulnerability was associated with trait BAS or risky decision-making in a non-psychiatric sample.
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Appendix 1: The General Behaviour Inventory (Depue, Krauss, Spoont, & Arbisi, 1989)
General Behavior Inventory

The following items contain questions about feelings and behaviours. Please use the rating scale below to describe how often you feel/do what is described in the statement.

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>1.</td>
<td>Have there been periods in your life when it was almost impossible to</td>
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<td>make even small decisions, even though this may not be generally true of</td>
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<td>2.</td>
<td>Have you found your enjoyment in being with people changes -- from times</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<td>when you enjoy them immensely and want to be with them all the time, to</td>
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<td>times when you don't want to see them at all?</td>
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<td>3.</td>
<td>Have you become sad, depressed, or irritable for several days or more</td>
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<td></td>
<td>without really understanding why?</td>
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<td>4.</td>
<td>Have you experienced periods of several days or more when, although you</td>
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<td></td>
<td>were feeling unusually happy and intensely energetic (clearly more than</td>
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<td></td>
<td>your usual self), you also were physically restless, unable to sit still,</td>
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<td>and had to keep moving or jumping from one activity to another?</td>
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<td>5.</td>
<td>Have there been periods of several days or more when you felt you</td>
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<td></td>
<td>needed more sleep, even though you slept longer at night or napped more</td>
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<td></td>
<td>during the day (not including times of exercise, physical illness, or</td>
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<td></td>
<td>heavy work schedules)?</td>
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<td>6.</td>
<td>Have people said that you looked sad or lonely?</td>
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<td>7.</td>
<td>Have there been periods of several days or more when you were almost</td>
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<td></td>
<td>constantly active such that others told you they couldn't keep up with</td>
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<td></td>
<td>you or that you wore them out?</td>
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<td>8.</td>
<td>Have there been periods of several days or more when you could not</td>
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<td></td>
<td>keep your attention on any one thing for more than a few seconds and</td>
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<td></td>
<td>your mind jumped rapidly from one thought to another or to things around</td>
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<td></td>
<td>you?</td>
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<td>9.</td>
<td>Have there been periods lasting several days or more when you lost</td>
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<td></td>
<td>almost all interest in people close to you and spent long times by</td>
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<td></td>
<td>yourself?</td>
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<td>10.</td>
<td>Have you had periods of several days or more when food seemed rather</td>
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<td></td>
<td>flavourless and you didn't enjoy eating at all?</td>
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<td>11.</td>
<td>Have there been periods of several days or more when your friends or</td>
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<tr>
<td></td>
<td>family told you that you seemed unusually happy or high, clearly</td>
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<td>Item</td>
<td>Question</td>
<td>never or hardly ever</td>
<td>sometimes</td>
<td>often</td>
<td>very often or almost constantly</td>
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<td>12.</td>
<td>Have there been times when your memory or concentration seemed especially poor and you found it difficult, for example, to read or follow a TV program, even though you tried?</td>
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<td>13.</td>
<td>Have there been periods of time when you lost almost all interest in the things that you usually like to do (such as hobbies, school, work, entertainment)?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>14.</td>
<td>Have you had periods of sadness and depression when almost everything gets on your nerves and makes you irritable or angry (other than related to the menstrual cycle)?</td>
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<td>2</td>
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<tr>
<td>15.</td>
<td>Have there been times of several days or more when you did not feel the need for sleep and were able to stay awake and alert for much longer than usual because you were full of energy?</td>
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<td>2</td>
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<tr>
<td>16.</td>
<td>Have you had long periods in which you felt you couldn't enjoy life as easily as other people?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>17.</td>
<td>Have you had periods of several days or more when you wanted to be with people so much of the time that they asked you to leave them alone for awhile?</td>
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<td>2</td>
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<tr>
<td>18.</td>
<td>Have there been times of several days or more when you were so tired and worn out that it was very difficult or even impossible to do your normal everyday activities (not including times of intense exercise, physical illness, or heavy work schedules)?</td>
<td>1</td>
<td>2</td>
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<td>19.</td>
<td>Has your mood or energy shifted rapidly back and forth from happy to sad or high to low?</td>
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<td>2</td>
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<td>20.</td>
<td>Have there been periods lasting several days or more when you spent much of your time brooding about unpleasant things that have happened?</td>
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<td>2</td>
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<td>21.</td>
<td>Have there been times when you felt that you were physically cut off from other people or from yourself, or felt as if you were in a dream, or felt that the world looked different or had changed in some way?</td>
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<td>2</td>
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<tr>
<td>22.</td>
<td>Have you had periods of extreme happiness and intense energy lasting several days or more when you also felt much more anxious or tense (jittery, nervous, uptight) than usual (other than related to the menstrual cycle)?</td>
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<td>23.</td>
<td>Have there been times of several days or more when you were so sad that it was quite painful or you felt that you couldn't stand it?</td>
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<td>24.</td>
<td>Have you found that your enjoyment in eating</td>
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<td></td>
<td>different from your usual self or from a typical good mood?</td>
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<tr>
<td>Item</td>
<td>Description</td>
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<td>25.</td>
<td>Have there been times of several days or more when you wake up much too early in the morning and have problems getting back to sleep?</td>
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<td>2</td>
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<tr>
<td>26.</td>
<td>Have you had periods when you were to down that you found it hard to start talking or that talking took too much energy?</td>
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<tr>
<td>27.</td>
<td>Have there been times of several days or more when, although you were feeling unusually happy and intensely energetic, you also had to struggle very hard to control inner feelings of rage or an urge to smash or destroy things?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>28.</td>
<td>Have there been times other than when you were physically ill that you found it hard to start talking or that talking took too much energy?</td>
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<td>2</td>
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<td>29.</td>
<td>Have you experienced periods of several days or more when you were feeling down and depressed, and you also were physically restless, unable to sit still, and had to keep moving or jumping from one activity to another?</td>
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<td>2</td>
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<td>30.</td>
<td>Have there been times lasting several days or more when you felt you must have lots of excitement, and you actually did a lot of new or different things?</td>
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<td>2</td>
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<tr>
<td>31.</td>
<td>Have you had periods of extreme happiness and intense energy (clearly more than your usual self) when, for several days or more, it took you over an hour to get to sleep at night?</td>
<td>1</td>
<td>2</td>
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<td>32.</td>
<td>Have there been times when you looked back over your life and could see only failures or hardships?</td>
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<td>2</td>
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<td>33.</td>
<td>Have you experienced times of several days or more when you felt as if you were moving in slow motion?</td>
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<td>34.</td>
<td>Have there been long periods in your life when you felt sad, depressed, or irritable most of the time?</td>
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<td>35.</td>
<td>Has it seemed that you experience both pleasurable and painful emotions more intensely than other people?</td>
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<tr>
<td>36.</td>
<td>Have there been periods of several days or more when you felt guilty and thought you deserved to be punished for something you had or had not</td>
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<tr>
<td>Item</td>
<td>Question</td>
<td>Never or hardly ever</td>
<td>Sometimes</td>
<td>Often</td>
<td>Very often or almost constantly</td>
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<td>37.</td>
<td>Have you had times of several days or more when you woke up frequently or had trouble staying asleep during the middle of the night?</td>
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<td>2</td>
<td>3</td>
<td>4</td>
</tr>
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<td>38.</td>
<td>Have you had periods of extreme happiness and high energy lasting several days or more when what you saw, heard, smelled, tasted, or touched seemed vivid or intense?</td>
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<td>2</td>
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<tr>
<td>39.</td>
<td>Have there been times when you were feeling low and depressed, and you also had to smuggle very hard to control inner feelings of rage or an urge to smash or destroy things?</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>40.</td>
<td>Have you found that your feelings or energy are generally up or down, but rarely in the middle?</td>
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<td>4</td>
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<td>41.</td>
<td>Have you had periods of several days or more when it was difficult or almost impossible to think and your mind felt sluggish, stagnant, or &quot;dead&quot;?</td>
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<td>2</td>
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<td>4</td>
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<td>42.</td>
<td>Have there been times when you had a strong urge to do something mischievous, destructive, risky, or shocking?</td>
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<td>43.</td>
<td>Have there been periods of several days or more when your thinking was so clear and quick that it was much better than most other people's?</td>
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<td>44.</td>
<td>Have there been times when you exploded at others and afterwards felt bad about yourself?</td>
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<td>45.</td>
<td>Have there been times of several days or more when you were so down that nothing (not even friends or good news) could cheer you up?</td>
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<td>2</td>
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<td>4</td>
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<td>46.</td>
<td>Have there been times of a couple days or more when you felt that you were a very important person or that your abilities or talents were better than most other people's?</td>
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<td>2</td>
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<td>4</td>
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<td>47.</td>
<td>Have them been times when you have hated yourself or felt that you were stupid, ugly, unlovable, or useless?</td>
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<td>4</td>
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<td>48.</td>
<td>Have you found that your thinking changes greatly -- that there are periods of several days or more when you think better than most people, and other periods when your mind doesn't work well at all?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>49.</td>
<td>Have there been times of a day or more when you had no feelings or emotions and seemed cut off from other people?</td>
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<td>4</td>
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<td>50.</td>
<td>Have you had sad and depressed periods lasting several days or more when you also felt much more anxious or tense (jittery, nervous, uptight) than usual (other than related to the menstrual cycle)?</td>
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<td>2</td>
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<td>51.</td>
<td>Have there been times when you have done excessively spontaneous, sexual, impulsive,</td>
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<tr>
<td>Item</td>
<td>Question</td>
<td>never or hardly ever</td>
<td>sometimes</td>
<td>often</td>
<td>very often or almost constantly</td>
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<td>52.</td>
<td>Have you had periods of sadness and depression when, for several days or more, it took you over an hour to get to sleep at night, even though you were very tired?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>53.</td>
<td>Have you had periods lasting several days or more when you felt depressed or irritable, and then other periods of several days or more when you felt extremely high, elated, and overflowing with energy?</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>54.</td>
<td>Have there been periods when, although you were feeling unusually happy and intensely energetic, almost everything got on your nerves and made you irritable or angry (other than related to the menstrual cycle)?</td>
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<td>2</td>
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<td>4</td>
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<td>55.</td>
<td>Have there been times when upsetting or bad thoughts kept going through your mind and you couldn't stop them?</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>56.</td>
<td>Have there been times of several days or more when you really got down on yourself and felt worthless?</td>
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<td>2</td>
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<td>4</td>
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<td>57.</td>
<td>Have there been times when you had blank spells in which your activities were interrupted, and you did not know what was going on around you?</td>
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<tr>
<td>58.</td>
<td>Have you had sad and depressed periods of several days or more, interrupted by periods lasting between an hour to a day when you felt extremely happy and intensely energetic?</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<td>59.</td>
<td>Have there been periods of several days or more when you were slowed down and couldn't move as quickly as usual?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>60.</td>
<td>Have you experienced weight changes (increases, decreases, or both) of five (5) pounds or more in short periods of time (three weeks or less), not including changes due to physical illness, menstruation, exercise, or dieting?</td>
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<td>2</td>
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<td>61.</td>
<td>Have there been periods of a couple days or more when sexual feelings and thoughts were almost constant, and you couldn't think about anything else?</td>
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<td>4</td>
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<tr>
<td>62.</td>
<td>Have you had periods when it seemed that the future was hopeless and things could not improve?</td>
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<td>4</td>
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<tr>
<td>63.</td>
<td>Have there been periods lasting several days or more when you were so down in the dumps that you thought you might never snap out of it?</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>64.</td>
<td>Have you had times when your thoughts and ideas came so fast that you couldn't get them all out, or they came so quickly that others</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>1 = never or hardly ever</td>
<td>2 = sometimes</td>
<td>3 = often</td>
<td>4 = very often or almost constantly</td>
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<tr>
<td>65.</td>
<td>Have there been times of several days or more when you felt very down and depressed during the early part of the day, but then less so during the evening?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>66.</td>
<td>Have there been times when you began many new activities with lots of enthusiasm and then found yourself quickly losing interest in them?</td>
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<td>2</td>
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<td>67.</td>
<td>Have you found that your mood consistently follows the seasons, where you have long periods of depression during the winter, but mostly happy periods during the summer?</td>
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<td>2</td>
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<tr>
<td>68.</td>
<td>Have you had long periods when you were down and depressed, interrupted by brief periods when your mood was normal or slightly happy?</td>
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<td>2</td>
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<tr>
<td>69.</td>
<td>Have there been times of several days or more when you have struggled to control an urge to cry, have had frequent crying spells, or found yourself crying without really understanding why (other than related to the menstrual cycle)?</td>
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<td>2</td>
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<tr>
<td>70.</td>
<td>Have there been times of several days or more when almost all sexual interest was lost?</td>
<td>1</td>
<td>2</td>
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<td>4</td>
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<tr>
<td>71.</td>
<td>Have you found yourself at times feeling fearful or suspicious of your environment or people around you?</td>
<td>1</td>
<td>2</td>
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<td>4</td>
</tr>
<tr>
<td>72.</td>
<td>Have there been periods of time when you felt a persistent sense of gloom?</td>
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<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>73.</td>
<td>Have there been times when you have felt that you would be better off dead?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix 2: The BIS/BAS Scales (Carver & White, 1994)
The BIS/BAS Scales

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses.

Choose from the following four response options:

1 = very true for me
2 = somewhat true for me
3 = somewhat false for me
4 = very false for me

1. A person's family is the most important thing in life.
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
3. I go out of my way to get things I want.
4. When I'm doing well at something I love to keep at it.
5. I'm always willing to try something new if I think it will be fun.
6. How I dress is important to me.
7. When I get something I want, I feel excited and energized.
8. Criticism or scolding hurts me quite a bit.
9. When I want something I usually go all-out to get it.
10. I will often do things for no other reason than that they might be fun.
11. It's hard for me to find the time to do things such as get a haircut.
12. If I see a chance to get something I want I move on it right away.
13. I feel pretty worried or upset when I think or know somebody is angry at me.
14. When I see an opportunity for something I like I get excited right away.
15. I often act on the spur of the moment.
16. If I think something unpleasant is going to happen I usually get pretty "worked up."
17. I often wonder why people act the way they do.
18. When good things happen to me, it affects me strongly.
19. I feel worried when I think I have done poorly at something important.
20. I crave excitement and new sensations.
21. When I go after something I use a "no holds barred" approach.
22. I have very few fears compared to my friends.
23. It would excite me to win a contest.
24. I worry about making mistakes.
Appendix 3: The Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988)
The PANAS

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer. Indicate to what extent you feel this way right now, that is, at the present moment.

Use the following scale to record your answers:

1 = very slightly or not at all
2 = a little
3 = moderately
4 = quite a bit
5 = extremely

_ __ __ __ __
Interested Irritable

_ __ __ __
Distressed Alert

_ __ __
Excited Ashamed

_ __
Upset Inspired

_ __
Strong Nervous

_ __
Guilty Determined

_ __
Scared Attentive

_ __
Hostile Jittery

_ __
Enthusiastic Active

_ __
Proud Afraid
Appendix 4: Ethics Proposal, Participant Information and Consent Form, and Ethics Approval for Study 1

*Note.* The project referred to in this application as Stage 1 was conducted and provided the data for Study 1 of the present project. The project referred to as Stage 2 was a planned project that was discontinued following a transfer of program and broadening of the scope of the project.
Declaration of Adherence to Ethical Standards: Study 1

In submitting this thesis as a requirement for the Doctor of Philosophy (Clinical Psychology) program at Swinburne University of Technology, I declare that:

1. Ethical standards were upheld in the conducting of this research;
2. All conditions pertaining to ethics clearance were properly met;

and

3. All final reports to the Swinburne University Human Research Ethics Committee have been submitted.

Signed:

James Collett
29/04/2016
Dear Dr Murray, Mr Collett and Dr Ciorciari,

**SUHREC Project 2010/051 The relationship between goal-oriented motivation and mood variability: Implications for bipolar disorder**

Dr Greg Murray FLSS Mr James Collett Dr Joseph Ciorciari FSI
Approved duration: 31/05/10 To 01/03/13 [Adjusted]

I refer to the ethical review of the above project protocol undertaken by Swinburne’s Human Research Ethics Committee (SUHREC). Your responses to the review, as emailed on 31 May 2010 with attachments, were put to and approved by a SUHREC delegate.

I am pleased to advise that, as submitted to date, the project has approval to proceed in line with standard on-going ethics clearance conditions here outlined.

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the National Statement on Ethical Conduct in Human Research and with respect to secure data use, retention and disposal.

- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator/ supervisor requires timely notification and SUHREC endorsement.

- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/ clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants and any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.

- At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project.

- A duly authorised external or internal audit of the project may be undertaken at any time.

Please contact me if you have any queries about the ethical review process, citing the SUHREC project number. Copies of clearance emails should be retained as part of project record-keeping.

Best wishes for the project.

Yours sincerely

Ann Gaeth
for Keith Wilkins
Secretary, SUHREC
HUMAN RESEARCH ETHICS COMMITTEE
APPLICATION FOR ETHICS APPROVAL
of a
RESEARCH PROTOCOL

11.1. SECTION A: GENERAL INFORMATION

[Note: This application form should not be used for research involving clinical trials or ionising radiation. See below.**]

<table>
<thead>
<tr>
<th>PROJECT FULL TITLE</th>
<th>The Relationship between Goal-Oriented Motivation and Mood Variability: Implications for Bipolar Disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHORT TITLE</td>
<td></td>
</tr>
<tr>
<td>(If applicable)</td>
<td></td>
</tr>
<tr>
<td>APPLICANT DETAILS</td>
<td></td>
</tr>
</tbody>
</table>
| RESPONSIBLE SWINBURNE FIRST INVESTIGATOR / SUPERVISOR | Name & Title/Position: Dr. Greg Murray, Associate Professor  
Tel No(s): 9214 8300  
Email: GWMurray@groupwise.swin.edu.au  
Fax: N/A  
Faculty / School / Centre / Institute: Faculty of Life & Social Sciences  
Swinburne Status: ☑ Swinburne Staff Member □ Adjunct Staff Member  
Address for correspondence: PO Box 218 John St., Hawthorn, 3122. |

- Please complete as clearly as possible. (For Honours, higher degree and)  
- Main Student Investigator(s): James Collett  
  Email: jcollett616@gmail.com  
  Tel No(s): 04 1712 4032  
  Student ID Number: 4162293  
  Fax: N/A  
  Degree Being Undertaken: Doctorate of Psychology (Clinical Psychology) |

- List below the names of other Chief/Associate Investigators and Research Assistants (including those with access to identifiable data).  
(Add (copy/paste) cells as required for additional investigators/assistants. Append Student lists for class projects.)

| Name & Title: Dr. Joseph Ciorciari, Senior Lecturer  
Institutional Address: Brain Sciences Institute, 400 Burwood Rd., Hawthorn, 3122.  
Tel No(s): 9214 8363  
Email: JCIorciari@groupwise.swin.edu.au |

<table>
<thead>
<tr>
<th>Proposed Period During Which Human Research Activity Requiring Ethics Approval is Needed:</th>
<th>From 01 03 2010 to 01 12 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dd m yyyy dd m yyyy</td>
</tr>
</tbody>
</table>
[Double-click on YES/NO 'check box' to select box, then enter Default Value as Checked ☑ or leaving as Not Checked ☐ ]

<table>
<thead>
<tr>
<th>TYPE OF ACTIVITY (Select as many boxes as applicable)</th>
<th>☑ Research by Staff Member</th>
<th>☑ Contract Research (Attach copy of contract)</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ Supervised Postgraduate Research</td>
<td>☑ Supervised Undergraduate Research</td>
<td></td>
</tr>
<tr>
<td>☑ Supervised Class Projects:</td>
<td>No of students involved:</td>
<td></td>
</tr>
<tr>
<td>Subject Code &amp; Short Title:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**11.1.1. Broad Category of Research**

Select one category box which best fits the application:

- ☐ Social/Cultural/Humanities
- ☐ Business/Management
- ☐ Education/Training/Program Evaluation
- ☑ Psychological/Brain/Neuro-sciences
- ☐ Health/Safety
- ☐ Engineering/Science/Technology
- ☐ Other (please specify) ……………………………………………………

[** For research involving Clinical Trials or Ionising Radiation, please contact the Research Ethics Officer.]

**Official Use Only:**

- ☑ Higher Risk/Impact
- ☑ Minimal Risk/Low Impact Research Only
- ☑ SUHREC
- ☑ SHESC (HBS - A / B)
- ☑ SHESC (SBT - A / B)
- ☑ Other
- ☑ Notification Only

**11.1.2. Human Research Risk/Review Classification** (Nb Checking to be consistent with published risk criteria.*

To enable a determination as to whether prima facie your research activity is Minimal Risk and/or Low Impact, please clarify by selecting [X] any one or more boxes below as to whether your research activity involves:

[Double-click on YES /NO 'check box' to select X by entering in Default Value as Checked ☑ or leaving as Not Checked ☐ ]

- ☑ Vulnerable participants, children or those dependent on care*
- ☑ Indigenous Peoples* or Special Cultural/Ethnic groups
- ☑ Externally funded research requiring HREC-level clearance*
- ☑ Multi-centre/Other sites requiring HREC-level approval*
- ☐ Research conducted overseas
- ☑ Conflicts of interest or dual researcher-professional roles
- ☑ Data access/use without an individual’s prior consent*
- ☑ Data access/use subject to statutory guidelines &/or reporting*
- ☐ Identification of participant individuals/groups in research outcomes without full consent or there is unclear consent for this*
- ☐ Sensitive information/issues vis-à-vis context/impact (legal*, regulatory compliance*, commercial, professional, cultural, etc)
- ☐ Personally intrusive/confronting or quite inconvenient/embarrassing questioning or other activity
- ☑ Physically confining/invasive techniques or significant physical contact/stimulation (TMS*, X-ray*, CT scan*, MRI*, clothing change, etc)
- ☑ Working in hazardous environments (asbestos dust*, infectious disease*, war or civil strife*, etc)
- ☑ Handling hazardous substances (eg, asbestos*, radioactive material*, explosives*, etc) or equipment
Stage Two of the experiment consists of a repeated measures design in which participants undergo a positive mood induction during one trial and a neutral mood induction during the other. Stage Two will be a single-blind procedure in that the participant will not be informed of the purpose of the mood induction procedure or which condition they are currently participating in. This will be done to ensure that awareness of mood does not attenuate the mood induction affect. The participant will be fully debriefed as to the nature of the research project upon completion of the Stage Two procedure.

All participants completing Stage Two of the experiment will be provided with $10.00 as compensation for volunteering their time. In addition, to ensure that those participating are motivated to perform well on the computer task, participants will have the opportunity to receive a monetary prize based on the hypothetical ‘bank balance’ score that they achieve during completion of the BART computer task (see below). The participant with the highest score (measured in successful button presses during the computer task) will receive a prize of $50.00. The participants with the second and third highest scores will receive lesser prizes of $30.00 and $20.00 respectively.

This incentive strategy is necessary so that participants are adequately motivated to achieve the goal of obtaining the highest score possible, as the experimental situation is supposed to be analogous to goal-striving behaviour in the real world. Participants will be informed that they possess a fair and equal chance of obtaining the reward when compared to other participants. Participants will not be provided with a point of reference to compare their performance to that of others, and hence the performance-based financial incentive should not cause any distress. Performance on the BART is influenced both by random chance (with scoring probability following a pre-determined algorithm, outlined below) and by the participant's personal decision-making ability (with the task rewarding an optimal balance between caution and risk); hence the incentive will not be purely lottery-based.
11.1.3. A1  WHY IS THE PROJECT TO BE UNDERTAKEN
This project is being undertaken as a course requirement for the completion of the Doctor of Psychology (Clinical Psychology) postgraduate degree. The project also has scientific aims, the background and rationale of which are summarised below.

Bipolar disorder (BD) is an affective disorder characterised by recurrent alternations between states of depression and mania (American Psychiatric Association, 2000). The designation ‘bipolar’ implies that depression and mania are best viewed as opposite extremes of the same continuum. However, there are growing calls for mania and depression to be viewed as distinct emotional dimensions (Murray, Goldstone, & Cunningham, 2007). Recent factor-analytic research supports the theory that BD is best viewed as two distinct and yet highly correlated factors corresponding to the dual states of mania and depression (Bullock & Murray, 2009). The high incidence of mixed states, where BD patients experience the symptoms of mania and depression simultaneously (Goodwin & Jamieson, 2007), also suggests that mania and depression are separable, as theoretically it becomes much harder to explain their co-occurrence if they are placed at opposite poles of a single dimension. Although mania and depression are of undoubted importance to BD phenomenology, a third important factor is also present: the affective dysregulation itself. If manic and depressive states represent the extreme poles of two separate (albeit correlated) dimensions, then a third variable influencing the fluctuation of mood could prove important in explaining the mechanism for change.

Gray's Reinforcement Sensitivity Theory (RST) proposed two neurobehavioural motivational systems: a Behavioural Activation System (BAS), and a Behavioural Inhibition System (BIS; Gray, 1972). BAS is a goal-oriented, appetitive motivational system that is responsive to potential rewards and also stimuli associated with the active avoidance or cessation of punishment (Heubeck, Wilkinson, & Cologon, 1998). BIS is a threat-oriented, aversive motivational system that is responsive to punishment and frustrative non-reward, and promotes actions such as ceasing behaviours that are not readily reinforced (Heubeck, Wilkinson, & Cologon, 1998).

Although it is difficult to separate trait and state effects in BD, theorists have suggested that BAS hypersensitivity may explain the fluctuations in mood that individuals with BD experience (Alloy et al., 2008). BAS hypersensitivity theory postulates that individuals with BD undergo excessive BAS activation in response to goal-salient events, inducing a manic state. Conversely, individuals with BD that undergo excessive BAS deactivation are likely to experience a depressive state (Alloy et al., 2008). Support for BAS hypersensitivity or dysregulation has been shown on a consistent basis (for a review, see Alloy, Abramson, Urošević, Bender, & Wagner, 2009). In addition, similarities between BAS and mood phenomenology have been found in electroencephalographic research, and it would appear that similar neurotransmitter systems propagate both goal-oriented motivation and the excessive affective states characteristic of BD (Carver, Johnson, & Joorman, 2008), providing biological evidence for an association between BAS and BD, further strengthening the hypothesis that the two phenomena are related.

Based on the evidence presented above, the proposed study will investigate the relationship between BD and motivational orientation. A key feature of the design is that it does NOT exclusively sample individuals diagnosed with BD. Rather, non-clinical participants will be recruited and rated on a validated quantitative self-report measure of vulnerability to BD (i.e., trait bipolarity).

The study’s primary outcome variable is the tendency to seek rewards (reward sensitivity), as measured on a computerised behavioural task (the BART; see below). A mood induction procedure (the IAPS; see below) will also be used to manipulate mood state effects. The overarching hypotheses of the study are that, compared with people low on trait bipolarity, people with elevated vulnerability to BD will demonstrate i) higher levels of reward sensitivity on the BART task, and ii) greater increases in reward sensitivity when exposed to a positive mood manipulation. Beyond the computerised behavioural task, reward sensitivity as a trait will also be investigated through a self-report questionnaire measure.
Summarise in sufficient detail why the project is being undertaken. If references are quoted, full citations should be given. Include the educational and/or scientific aims of the project. (boxes will expand for your text)

References:

11.1.4. A2 WHAT - BRIEF DESCRIPTION OF PROJECT
In plain English

The project possesses a two-stage design. Stage One is a large-sample screening study in which self-report questionnaire data will be collected. Stage Two will involve the administration of the mood induction and computerised behavioural task with a small subset of Stage One participants.

The Stage One questionnaire battery will be administered online using Opinio software. The General Behaviour Inventory (GBI; Depue et al., 1989), Australian Personality Inventory (API; Murray et al., 2009), and BIS/BAS Scales (Carver & White, 1994) will be included in the questionnaire battery (these questionnaires are described below). A sample of convenience will be recruited by online advertisement of the project and psychology students at Swinburne will be recruited via the Research Experience Program (REP) and advertisement prior to lectures.
Stage Two participants will be recruited from the larger Stage One sample. After completing the Stage One questionnaire, participants will be invited to provide their email address if they are interested in participating in Stage Two. Stage Two will be a repeated measures design involving two conditions – a neutral mood induction versus a positive mood induction. Mood induction will be accomplished using the International Affective Picture System (IAPS; Lang, 1995; see below). The participants will not be informed of the mood condition that they are currently completing, nor will they be informed of the purpose of the IAPS slideshow. This is because cueing the participant toward the source of their mood risks attenuating the mood induction effect, as explicit awareness of the intended mood state may cause the participant to readjust their mood in a compensatory manner (Schwarz, 1990).

After viewing the IAPS, participants will complete the Positive Affect and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) as a mood manipulation check (and to permit statistical control of mood as a mediator of reward sensitivity effects). Participants will then complete the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), a risk-taking task commonly used as a behavioural measure of BIS/BAS processes. Finally, the PANAS will be completed a second time after completing the BART, in order to establish how performance on the BART may have affected mood state.

References: See the Procedures section below.

11.1.5. A3 HOW - PROCEDURES

Please detail clearly and sufficiently the proposed research/statistical method(s), procedures and instruments to be used in the project, including all screening and research ‘procedures’ to which the participants will be subjected, and asterisk those which may have adverse consequences. Please include as appendices all screening instruments, questionnaires, interview protocols etc (at least in draft form if not finalised).

During Stage One participants will complete three scales in an online questionnaire (hard copies of the scales are appended to this application):

i) The GBI, a measure of trait bipolarity with subscales including mania, depression, and biphasic symptoms (Depue et al., 1989).
ii) The API, a measure of the Five-Factor Model of Personality, assessing Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness (Murray et al., 2009).
iii) The BIS/BAS Scales, a measure of sensitivity to rewarding and threatening stimuli and situations (Carver & White, 1994). The BAS factor is broken down into three subscales – Drive, Fun Seeking, and Reward Responsiveness.

As outlined above, a subset of Stage One participants will be recruited into Stage Two. Due to the repeated measures design, participants will participate in two conditions in Stage Two: a positive mood induction and a neutral mood induction (via the IAPS). The order that the Stage Two conditions are administered in will be counterbalanced across participants to avoid order effects. The second trial will take place approximately 24 hours after the first trial (i.e. the Stage Two procedure will be completed on two consecutive days). This will be done to control for individual fatigue/time-of-day effects. A margin of error of up to one hour on the second trial will be provided in the interests of participant convenience.
Participants will complete a further three tasks in Stage Two:

i) The IAPS, a slideshow of pictures selected to elicit either positive or neutral affect (Lang, 1995). The IAPS picture set will be administered to prime a neutral mood in one trial and a positive mood in the other trial. Participants simply observe the pictures as they are presented on the computer monitor. IAPS pictures designed to elicit negative affect exist but will not be utilised in the present study. The IAPS has been used in literally hundreds of studies in Australia and elsewhere, and no ill effects have been reported (e.g., see Kemp et al., 2002, and Kemp et al., 2004, both studies completed at Swinburne University of Technology).

ii) The BART involves a computer simulation representing a balloon being inflated with a pump that the participant controls. Each time that the participant inflates the balloon, a set monetary reward of one (virtual) cent is deposited into a temporary reserve (the hypothetical bank balance). However, the balloon is capable of popping due to overinflation. The probability of overinflation increases with each pump. Initially, the balloon has a 1 in 128 chance of popping, however this continues to decrease to 1/127, 1/126, and so forth until on the 128th pump there is a 1/1 probability of the balloon exploding. Using this algorithm sets the average breaking point for the balloon at 64 pumps – hence, although the probability of success per trial is randomly computer-generated, across trials the BART rewards the participant’s ability to maintain a balance between caution and excessive risk-taking. The participant can choose to abandon the trial at any time, retaining their money and proceeding to the next trial. As the number of pumps progresses, the amount that the participant has to lose increases whilst the value of the potential reward relative to what they have already accumulated decreases (Lejuez et al., 2002). Ten trials of the BART will be completed in each of the two BART administrations. Participants will be instructed that their goal is to accrue as much money in their hypothetical bank balance as possible.

iii) The PANAS will be administered prior to and following BART administration to assess mood state in the form of Positive Affect and Negative Affect (Watson, Clark, & Tellegen, 1988). Positive affect refers to a pleasant state of high energy and full concentration, with low scores suggesting sadness and lethargy. Negative affect refers to an unpleasant state encompassing generally aversive moods, with low scores indicating a calm state. Participants will rate the degree that they are experiencing each item at the present moment.

A question asking the participants to reveal the occurrence and valence (positive or negative) of any significant life events in the previous 24 hours will also be included with the PANAS mood state measure as extreme life events might exert a confounding effect on mood. Participants will not be asked to disclose the exact nature of these significant life events (e.g. via an open question).

Further demographic questions focusing on motivation, optimism, and overconfidence have also been added to the PANAS in order to check for the presence of positive cognitive distortions (such as the illusion of control over chance events) that are observable in clinical mania.

After completing each condition of the Stage Two procedure, participants will be provided with a voucher to the value of $10.00 as reimbursement ($5.00 per condition) for
donation of their time. They will also be informed that the score that they have obtained on the BART will enter them into a chance to receive a further financial reward of either $20.00, $30.00, or $50.00. Participants will be aware that they will be receiving reimbursement and that there is the possibility of receiving a monetary prize based on their BART performance before they complete the BART. Participants will be fully debriefed as to the nature of the research project upon completion of the Stage Two procedure.

Once Stage Two data collection has ceased, total BART scores will be obtained, and the five participants with the highest scores will be contacted via email to inform that they have won the monetary prize. The participant with the highest score (measured in successful button presses during the computer task) will receive a prize of $50.00. The two participants with the next highest scores will receive lesser prizes of $30.00 and $20.00. Following this (and before merging the Stage Two data with the Stage One data), participant data will be de-identified and an anonymous code number used to link data across stages.

Stage One can be completed by the participants anywhere that they are able to access the internet. The Stage Two procedure will be administered on computer in a quiet room with the experimenter present at all times. Informed consent sheets, copies of the questionnaires, and the protocol instructions for the IAPS and BART are appended to this document.

References:
If you feel that it is necessary to include further material, please append.

11.1.6. A4 DESCRIBE ANY RISK THAT MAY ARISE TO THE PARTICIPANT / DONOR?
Risk to participants (and to researchers) can be real but does not need to be physical. Risk includes such as self esteem, regret, embarrassment, civil or criminal liability, disease, physical harm, loss of employment or professional standing, etc. Please consider such possibilities carefully. Some research activities may put the participant at risk through what is being done or simply through their participation.

Please describe the risk you perceive and the protective measures to be taken.

No foreseeable risk to the participants is associated with this project. Neither the task nor the questionnaires are likely to elicit distress, and the mood induction procedure is only being used to generate positive affect.

11.1.7. A5 DESCRIBE ANY RISK THAT MAY ARISE TO THE RESEARCHER / ADMINISTRATOR?
Some research activities may put the researcher at risk through what is being done or simply through their participation.

Please describe the risk you perceive and the protective measures to be taken.

This project holds no risks for the researcher.

11.1.8. A6 WHAT BENEFITS ARE ANTICIPATED FROM THE PROJECT
Ethical principles would require that benefits flowed from the activities - but please avoid grandiose claims.

(a) To the Participant (what and how so)
Participants from Swinburne University will benefit from an increased understanding of psychological research. External participants will gain an understanding of how psychometric and behavioural research designs operate. The provision of a financial incentive for participation in the behavioural task will ensure that the benefits to the participant outweigh the incurred loss of time.

(b) More generally (to society, profession, knowledge, understanding, etc, and how so.)

Expanding the present knowledge base regarding bipolar vulnerability and the mechanism for mood lability in bipolar disorder will ultimately allow for more accurately focused preventative therapies and screening/monitoring of at-risk cases.

11.1.9. A7 POTENTIAL PROBLEMS
From time to time in the course of a research project important information, such as an individual found to be at risk, or entirely unforeseen events may come to pass. What procedures are in place to handle unexpected or particularly significant personal or other information that may come to light through the project, eg, unknown medical/psychiatric condition, a particularly distressed participant, civil or criminal liability, etc.

Whilst such an event is judged to be unlikely, should a participant be distressed they will be conferred with and directed to either the student counselling service, Swinburne Psychology Clinic, or LifeLine.

11.1.10. A8 PROFESSIONAL/ETHICAL ABILITY & TRAINING
(Researchers/Students/Assistants)
NS 1.15 Research must be conducted or supervised only by persons or teams with experience, qualifications and competence appropriate to the research … using (appropriate) facilities … (and with appropriate skills and resources for dealing with any contingencies…

(a) Sufficiently detail what investigators/assistants will do in this project and their expertise/competence to do so.

The investigator will be required to set up the online questionnaire battery and administer the Stage Two protocol on a laptop computer. The role of investigator will also involve contacting those Stage One participants that have expressed interest in Stage Two participation, and to ensure that anonymity of the linked Stage One and Stage Two data is maintained. The investigator’s previous training in communication, research, and ethical considerations has adequately prepared him to carry out these tasks.

(b) Sufficiently detail any further training/qualifications required for investigators/assistants to carry out the project.

No further training is necessary to facilitate completion of this research project.

11.1.11. A9 FUTURE USE OF DATA

Will any of these data be used by yourself, your students or others for any purpose other than for this project as described in the protocol? If so please describe.

The data collected in the course of the present research project will only be used for the present research project.

11.1.12. A10 EXTERNAL INVOLVEMENT

Is a body external to Swinburne involved in initiation or support of the project?

☐ Yes Name of body/organisation. ..................................................................

If an external body is associated with the project you must provide the HREC with detail of the arrangements, including details of any funding or other resources being provided. A copy of relevant pages from the contractual arrangements should be attached.

☐ No

11.1.13. A11 EXTERNAL APPROVALS

Projects involving other organisations or entities may require approval from other institutions or their ethics committees, etc. for such things as access to prospective participants, contact lists, data, facilities, etc. A copy of such approvals may be required to be provided to the HREC at the time of application or be made available as soon as possible. In which case, the project may not commence, until such evidence is provided.

Please indicate, as appropriate, if formal clearance/permission has been obtained or sought:

Institutional Yes ☐ Documentation Attached ☐ or to follow ☐

Next of Kin (for special groups) Yes ☐ Documentation Attached ☐ or to follow ☐

(estimate when likely to be obtained)

N/A

☐ No (please explain)

N/A


Is there any relationship or association between the sponsor and any of the researchers listed in Section A of this form, for example are any of the researchers directors, officers, employees, shareholders or promoters of the sponsor or do they receive any personal benefits from the sponsor under any other contracts or arrangements?

☒ No

☐ Yes (please explain the relationship(s), including how a vested or a conflict of interest situation does not arise.)
11.2. SECTION B: ETHICAL ISSUES OVERVIEW

11.2.1. ETHICAL ISSUES

[Double-click on YES/NO 'check box' to select box, then enter Default Value as Checked ☑️ or leaving as Not Checked ☐️ ]

(a) Non-/Limited Disclosure or Deception: Is any detail in relation to research purposes, methods or questions being withheld from participants? Or will deception of any kind be involved? Or any covert/undeclared observation? (Refer National Statement Chap 17)

(b) Does the data collection process involve access to confidential personal data (including access to data provided for a purpose other that this particular research project) without the prior consent of subjects?

(c) Will participants have pictures taken of them, e.g., photographs, video recordings? If "YES", please explain how you intend to retain confidentiality and ultimately dispose of the material.

(d) If interviews are to be conducted, will they be record by electronic device? If "YES", please explain how you intend to retain confidentiality and ultimately dispose of the material.

(e) Will participants be asked to perform any acts or make statements which might compromise them, diminish self esteem or cause them embarrassment or regret (minimal, moderate or significant)?

(f) Might any aspect of your study reasonably be expected to place the participant at risk of criminal or civil liability (not just immediately or directly)?

(g) Might any aspect of your study reasonably be expected to place the participant at risk of damage to their professional/social/cultural/financial standing or employability?

(h) Will the research involve access to data banks subject to privacy legislation?* (NOTE: Annual reporting to Government may be required on this item. For info: please contact the Research Ethics Officer.)

(i) Will participants come into contact with any equipment which uses an electrical supply in any form e.g., audiometer, biofeedback, electrical stimulation, magnetic stimulation, etc.? If "YES", please outline below what safety precautions will be followed.

(j) Will any treatment be used with potentially unpleasant or harmful side effects?

(k) Does the research involve any stimuli, tasks, investigations or procedures which may be experienced by participants as stressful, noxious, aversive or unpleasant during or after the research procedures?

(l) Will the research involve the use of placebo control conditions or the withholding/substitution of treatment, programs or services (health, educational, commercial, other)?

(m) Will any samples of body fluid or body tissue be required specifically for the research which would not be required in the case of ordinary treatment?

(n) Will participants be fingerprinted or DNA "fingerprinted"?

(o) Are there in your opinion any other ethical issues involved in the research?

NOTE: If the answer to any of the above questions is "yes", please explain and justify below in sufficient clear detail. (The box below will expand to fit your response.)
11.3. SECTION C: PARTICIPANT DETAILS

11.3.1. C1 PARTICIPANT DETAILS

The composition of the participant group may, in some circumstances, distort and invalidate an outcome, and risks may arise through the composition of the participant group.

How many individual participants will be involved? (Number/number ranges for which approval is sought)

- Males: 130-170
- Females: 130-170
- Total participants: 260-340

Over what range of ages?

From 15 To (Oldest): 70

If there is a gender or age imbalance in the number of participants please explain why.

A gender-balanced sample is desirable for this project, however it is not integral to the design and participants will not be screened on the basis of gender.

Note that Stage Two of the project will consist of a subset of volunteers from the Stage One sample. The Stage Two sample is projected to constitute from 50 to a maximum of 100 participants.

11.3.2. C2 RECRUITMENT

How will participants be recruited/selected?

Please outline the process in sufficient detail how this is to occur.

Note: Where participants are obtained from or through schools, hospitals, prisons or other institutions, appropriate institutional or other authority will probably be needed. If soliciting for participants by advertisement or poster please attach proposed copies or text.

(See also Project Information Consent Statements and Signed Consent Forms info at the end of this application form.)

Stage One participants will be recruited in three ways:

i) As part of Swinburne University's REP for first-year psychology students.
ii) By recruitment drives held prior to second- or third-year psychology lectures.
iii) By advertisement to email contacts, social networking sites, community message-boards, and acquaintances of the experimenters.

On the final page of the Stage One questionnaire, participants will have the option of expressing interest in Stage Two participation by leaving their email address. They will later be contacted via email with the Stage Two information sheet attached, and given the option of participating in Stage Two. Completion of the Stage One questionnaire battery is a prerequisite of Stage Two participation.

11.3.3. C3 PRE-EXISTING CONDITIONS

In some situations an underlying medical or other significant condition of a participant may result in an otherwise relatively innocuous situation causing excessive stress and exacerbate the condition. Researchers must, therefore, be alert to such situations and be able to address the resulting issues.
Do participants have any medical or other significant condition of which you are aware, eg. diabetes, asthma, depression, epilepsy? What steps are in place to handle any resulting problems (you may need to correlate with A3, A4 and A7 of this form)?

If an unexpected psychological or physiological problem were to occur during the study, the university counselling and medical clinic information supplied on the consent form can be referred to. The investigator (a probationary psychologist completing supervised postgraduate training in clinical psychology) will be physically present during Stage Two administration in the unlikely event that help needs to be summoned.

11.3.4. C4 DISCLOSURE AND INFORMED CONSENT
How will participants be informed about the project in order to give valid consent:

☑️ Consent Information Statement(s)/Letter(s) and Signed Consent Form(s) will be used. A copy must be attached to your application. A guide to consent instruments is given at the end of this form.

☑️ Consent Information Statement(s)/Letter(s) and consent implied by return of anonymous questionnaire

☐ Verbal advice (Please explain how and why)

☐ Other (Please explain how and why)

Consent to participate in Stage One will be implied by return of the questionnaire. Participants will be informed of the project goals and their ethical rights in an introduction to the questionnaire.

Consent to participate in Stage Two will be recorded using a signed consent form. The participants will be provided with an information sheet outlining the procedure and goals of the project and reminding them of their ethical rights. This sheet will also be emailed to them for their consideration before consenting to participate in Stage Two.

Copies of appropriate consent instruments must be attached to your application. Please consult the Guide to Human Research Informed Consent Instruments in carefully preparing informed consent instruments.

11.3.5. C5 COMPENSATION
Consent to participate must be freely given and not induced through the level of reward, perceived reward, or power relationships

Provide details of any financial or other reward or inducement is being offered to subjects for participation. Indicate the source of the funds.

Stage One participation will not be compensated for, except in the form of REP time credit for those participants who are first-year Psychology students at Swinburne University.

Stage Two participants will be provided with a voucher for their inconvenience and time expense. Due to the repeated measures design, participants are required to complete two conditions within the Stage Two procedure. Participants will be informed that they will receive a fixed sum of $5.00, in the form of a credit voucher, for completing each condition of Stage Two, leading to a total of $10.00 reimbursement (provided following administration of both conditions of Stage Two).

However, to increase the effectiveness of the BART as a reward task (by eliciting goal-oriented motivation; a scientific requirement crucial to the study), Stage Two participants will also be informed that they will be able to receive a monetary prize should they receive one of the highest scores. The participant with the highest score (measured in successful button presses during the computer task) will receive a prize of $50.00, the
participant with the second highest score will receive a lesser prize of $30.00, and the participant with the third highest score will receive $20.00. All participants will be fully aware of that they stand a fair and equal chance of receiving the reward, and that the reward will be tied to task performance. The financial incentive will be drawn from the research funding of James Collett.

11.3.6. C6 RELATIONSHIP TO INVESTIGATOR(S)
Free consent may be difficult to ensure if the participant is dependent upon the investigator for employment, assessments etc.

Some relationships cause special ethical issues to arise
Are participants linked with the investigator through some particular relationship - eg. employees ultimately responsible to or superiors of the investigator, students of investigator, family members, friends etc.

Participants enrolled in psychology at Swinburne University may come into contact with the investigators as all three are teaching staff. Any participants who are taught or assessed by the investigators will be informed that their acceptance or refusal to participate in the project will in no way impact their assessment as a student in their course.

11.3.7. C7 INVOLVEMENT OF SPECIAL GROUPS
Particular issues of consent may arise where special groups of participants are to be involved. There may be, for example, a need to obtain informed consent from persons other than the direct participant. Examples of such special groups include special cultural groups - eg. indigenous Australians; children and young persons (Guidelines section 4.2); groups with special circumstances - eg. persons with an intellectual or mental impairment (Guidelines s. 5)

Please identify and describe the nature of the groups and procedures used to obtain permission.

Note. Persons proposing research projects involving Indigenous Australians should consult with the relevant University manager of indigenous programs prior to finalising definition of the project.

No special groups are participating in this research project.

11.3.8. C8 PRIVACY
The University is subject to the Victorian Information Privacy and Health Records Acts as well as the Commonwealth Privacy Act and, in particular, the Information/Health/National Privacy principles (IPPs/HPPs/NPPs) set out therein and is required to report annually on projects which relate to or utilise particular records.

Does the research involves access to data which was collected by an organisation for its own purposes (ie. not specifically collected for this project) such as student records, other data banks, human pathology or diagnostic specimens provided by an institution/s?
If yes, please indicate source/s.

No external data is being utilised in this project.

11.3.9. C9 LOCATION OF STUDY
Please indicate where the research will be carried out. If the research will not be on University premises permission of owner / occupier may be required. If so, please indicate what authority or permission may be required and how will be obtained. NB: Where required, please attach to this application evidence of authority obtained or provide the Secretary, HREC as soon as practicable.

The online questionnaire can be completed anywhere that the participant has access to a computer with an internet connection. The Stage Two protocol will be completed on a laptop computer located in a small, quiet room booked in one of the buildings located at Swinburne University's Hawthorn campus.
11.4. SECTION D: DATA & PUBLICATION ARRANGEMENTS (Nb Section D Revised Aug 2007)

PLEASE CONSIDER CAREFULLY YOUR RESPONSES TO THIS SECTION. YOU NEED TO BE CLEAR AS TO WHAT IS OCCURRING WITH RESPECT TO DATA COLLECTION, RETENTION and DISPOSAL.

(In your responses, you should demonstrate familiarity with National Statement requirements for confidentiality, relevant Privacy Principles and Swinburne’s Policy on the Conduct of Research, eg, Sect 4, see URL: http://www.swinburne.edu.au/corporate/registrar/ppd/docs/PolicyontheConductofResearch.pdf).

11.4.1. D1 DATA COLLECTION/RECORDING (Nb Section D1 Revised Aug 2007)

Please note that, with any information or data collected/retained, if any individual can reasonably be identified, the information can be deemed “personal information” or “health information” under National/Health/Information Privacy Principles (NPPs/HPPs/IPPs).

(a) How or in what form will data be collected/recorded? (eg, notes; verbatim, audio and/or video recordings; transcriptions of recordings; recorded or signed consents; etc)

Stage One information will be collected via computer and stored electronically. Stage Two task performance information will also be collected via computer and stored as electronically, whilst the mood state questionnaires will be kept securely in a locked filing cabinet and later transferred to the Stage Two computer data file.

(b) As regards any individual, in relation to any data collection or retention, you need to acknowledge either or both of the following:

[Double-click on ‘check box’ to select X by entering in Default Value as Checked ☒ or leaving as Not Checked ☐]

☒ An Individual can be identified OR is Potentially Identifiable / Re-Identifiable

(An individual can be identified at some point or by the very nature of the data collected/retained: at time of an interview, by signed consent form, identified or labelled voice or image recording, pen-and-paper questionnaire, on-line survey instruments, etc. Whilst data may not have (explicit) identifiers, an individual’s identify can still reasonably be worked out.

Or data may have (explicit) identifiers removed and replaced by codes that permit matching of an individual with the data collected/retained, in which case it is possible to identify or re-identify the person to whom the data relates.)

☐ An Individual is Non- or Un-identifiable

(Data collected/retained anonymously and with no reasonable possibility of being identified.)

Your acknowledgement may require further explanation or clarification; if so, please include in the following box.

Participants expressing interest in Stage Two participation at the close of the Stage One questionnaire will be identifiable by their email address. This email address will be used to invite the Stage One participant to participate in Stage Two. If the participant declines to participate their email will be immediately removed from their recorded Stage One data.

Upon commencing Stage Two participation, participants will be randomly assigned a unique code number that only they and the researchers will be able to identify as their own. The consent form will not include this code number. This identification code will then be used to label and match the Stage One and Stage Two data.

Once data collection is completed for the BART, total scores will be obtained and the monetary incentive prizes distributed. Following this, there will be no further need for the participants’ identifying details, and as such any documentation linking personal
information to code number will be destroyed, restoring anonymity. Only group data will be presented and no individuals will be identified if the results of this study are published in a scientific journal.

11.4.2. D2 DATA SECURITY (Nb Section D2 Revised Aug 2007)
Please note that “data must be held for sufficient time to allow reference. For data that is published this may be for as long as interest and discussion persists following publication. It is recommended that the minimum period for retention is at least 5 years from the date of publication but for specific types of research, such as clinical research, 15 years (or more) may be more appropriate.” (Sect 4.3 of Swinburne’s Policy on the Conduct of Research)

Please indicate how data (all types of data, including, eg, signed consent forms) will be securely retained (eg, electronic form in password-protected disk drive, locked filing cabinet, etc) and where? With more than one type of data, will the types be separately stored?
In your explanation, you will need to make clear how due confidentiality and/or anonymity will be maintained.

(a) During the study

Personal details (i.e., email address, assigned code number) necessary for linking Stage One and Stage Two data will be stored on a password-protected data file on the Swinburne main drive. This document will be deleted once data collection has been completed, restoring confidentiality. Stage One and Stage Two data will be stored in a password-protected data file on the main hard-drive at Swinburne University. Stage Two consent forms will be stored in a locked filing cabinet at Swinburne University.

(b) Following completion of study

All information related to the study will be stored securely on a password protected data file on the Swinburne main drive. Data will be held for a minimum of 7 years post publication.

11.4.3. D3 PUBLICATION/OUTPUT (Nb Section D3 Revised Aug 2007)
Please explain in sufficient detail:
(a) What, if any, publication (conference, news media, academic journal, other journal, etc) is envisaged following on or in relation to this project, both in terms of data proper and/or analysis of data?
(b) Will participants be informed about any envisaged research publication/outcome? (This information is normally to be included in the information given prior to obtaining informed consent.)
(c) Would any participants be able to be identified through the publication of data proper or research findings? If so, explain why this is necessary.

(a) Publication may occur in one or more international refereed journals in which no identification of individuals will be possible.
(b) Participants will be informed of this during the informed consent process.
(c) Participants would be completely unidentifiable through the publication of data or research findings.

11.4.4. D4 INDIGENOUS ISSUES
Storage arrangements for data relating to research into Indigenous matters must be determined in compliance with the Policy on the Conduct of Research after consultation with the communities involved.
What consultation has taken place and what arrangements have been made.

N/A

11.4.5. D5 OTHER ISSUES (Nb Section D5 Revised Aug 2007)
Are there any other issue relating to data collection, retention, use or disclosure which the ethics committee should be made aware of and, if so, please explain how you are to deal with this. (Eg, Research outcomes unduly impacting on any individual or group not directly participating, etc.)

N/A

11.5. SECTION E: SUBSTANCES & CLINICAL ISSUES
☒ No matters in this section are applicable to the study or

11.5.1. E1 ADMINISTRATION OF SUBSTANCES/AGENTS
Name of substance(s) 
Dosage per administration 
Frequency of administration 
Total amounts to be administered 
Anticipated effects:

NOTE: If the research involves administration of foreign substances or invasive procedures, please attach a statement accepting responsibility for those procedures by a medical or paramedical practitioner with Indemnity insurance.
☐ STATEMENT ATTACHED

11.5.2. E2 BODY FLUIDS OR TISSUE
What fluids or tissue? How will be samples be obtained?

Frequency and volume 
How are samples to be stored?
How will samples be disposed of?
Who will take the samples?
What are their qualifications for doing so?
Do participants carry, as far as you know, the Hepatitis B or HIV virus? If so how will the risks be handled

Do participants carry, as far as you know, any other contagious diseases or viruses? If so how will the risks be handled

### 11.6. SECTION F Declarations for Signature

1. With respect to this project, I / We, the undersigned Investigator(s)/Assistant(s) agree:
   - To undertake human research activity or handle data confidentially in accordance with Swinburne requirements, including any standard or special ethics clearance conditions, under the proper direction of the responsible Swinburne manager and/or principal Swinburne (or other) researcher/supervisor.

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All listed applicants must sign. The Chief Investigator/Supervisor is also responsible for personnel subsequently joining the project. Expand this table or duplicate this page as required. NB This information is subject to Swinburne or external audit.

### Please note that

**PROJECTS MUST NOT COMMENCE WITHOUT PRIOR WRITTEN APPROVAL from the Human Research Ethics Committee (SUHREC) or its appropriate Subcommittee (SHESC)**

2. Declaration of Compliance by Chief Investigator(s)/Student Supervisor(s).
I declare that the above project has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice, including any standard or special conditions for on-going ethics clearance. I further declare that all listed and subsequently appointed researchers or assistants involved in this project will be made aware of the conditions of ethics approval as communicated to me, including approved documentation and procedures.

Signature & Date:

..........................................................
3. Endorsement of Head of Academic Unit (or Delegate) or Above.
I declare that this project: has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice; and has research merit, adequate resourcing and appropriate leadership/supervision.

Signature & Date:

Name of Signatory & Position:

(Please note:  This endorsement must be given by an authorised official who is not also a chief or co-investigator of the project and who is not also the supervisor of a student investigator with an interest in the project.)
Stage One Informed Consent

The Relationship between Goal-Oriented Motivation and Mood Variability
- Stage One -

Investigators: Assoc. Prof. Greg Murray, Dr. Joseph Ciorciari, Mr. James Collett

Thank you for your interest in participating in this study. The aim of this project is to investigate the ways in which sensitivity to rewarding stimuli and sensitivity to threatening stimuli are associated with personality traits such as mood variability. Participation will involve completing three questionnaires and should take approximately 30 minutes.

Your participation in this study is completely voluntary. Your initial agreement of participation in this study does not stop you from discontinuing participation and you are free to withdraw at any time. Choosing whether or not to participate in the project will not have any impact on the way your academic outcomes are graded in your course. Clicking the “Submit” button at the conclusion of this questionnaire will be seen as implying your consent to participate in the study.

At completion, this questionnaire provides an option to leave your email address if you would like to participate in a follow-up Stage Two experiment. The Stage Two experiment will involve observing a series of pictures and then completing a computer task on two occasions, a process taking approximately 30 minutes per administration. Stage Two participants will be provided with a small compensation for their time.

Note that your email address will render your results potentially identifiable; however rest assured that anonymity will be maintained by the allocation of a unique code number that will allow your questionnaire data and behavioural task data to be matched. Once Stage Two data collection is complete any documentation linking identifying information to code number will no longer be necessary and will be destroyed.

The results of this investigation will be presented in a Doctoral thesis as an assessment requirement in the completion of the student investigator’s Doctorate of Psychology (Clinical Psychology). Only group data will be presented and no individuals will be identified if the results of this study are published in a scientific journal.

This study conforms to the principles set out in the Swinburne University of Technology Policy on Research Ethics and the NHMRC guidelines as specified in the National Statement on Ethical Conduct on Research Involving Humans. Retain this information sheet for your own records.
If you have any psychological or physiological concerns during the course of this study, which for any reason you do not want to reveal to the primary investigator or SUHREC, then the following are the contact details for the Swinburne University Counselling and Medical Clinics (note that these services are free for all Swinburne students):

### Hawthorn Counselling Service
36 Wakefield Street (corner Wakefield & John Streets)
Service hours are usually 9am - 5pm weekdays
Phone: 9214 8025
Fax: 9214 5993

### Hawthorn Medical Service
McLeod Lane (Between John and William Streets, Hawthorn)
Health Service Building
Room: SH102
Ph: 9214 8483
Fax: 9818 7548

### Lilydale Counselling Service
Student Centre Reception
Phone: 9215 7101
Fax: 9215 7070

### Lilydale Medical Service
Room LD108
Ph: 9215 7106
Fax: 9215 7070

If you would like further information on this research project, please contact:
James Collett, Doctoral Candidate & Provisional Psychologist, BA309, Swinburne University Hawthorn, jcollett@swin.edu.au.

If there are any questions, concerns or complaints involving this study please contact:
Dr. Greg Murray, Swinburne University of Technology, PO Box 218, Hawthorn, Victoria 3122, Tel (03) 9214 8300 or email gwm@swin.edu.au.

This project has been approved by or on behalf of Swinburne’s Human Research Ethics Committee (SUHREC) in line with the *National Statement on Ethical Conduct in Research Involving Humans*. If you have any concerns or complaints about the conduct of this project you can contact:
Research Ethics Officer, Office of Research & Graduate Studies (H68), Swinburne University of Technology, PO Box 218, Hawthorn VIC 3122. Tel (03) 9214 5218 or resethics@swin.edu.au.
Appendix 5: Ethics Proposal, Participant Information and Consent Form, and Ethics Approval for Study 2
In submitting this thesis as a requirement for the Doctor of Philosophy (Clinical Psychology) program at Swinburne University of Technology, I declare that:

1. Ethical standards were upheld in the conducting of this research;
2. All conditions pertaining to ethics clearance were properly met; and
3. All final reports to the Swinburne University Human Research Ethics Committee have been submitted.

Signed:

James Collett
29/04/2016
SUHREC Project 2012/286 Ethics Clearance  
Sheila Hamilton-Brown  

Wednesday, 9 January 2013 10:02 AM  
To: Professor Greg Murray/Mr James Collett; FLSS  

Dear Greg and James  

SUHREC Project 2012/286 The Effect of Trait Mood Variability on Risk-Taking and Cognitive Flexibility  
Professor Greg Murray, Mr James Collett, Dr Conrad Perry; FLSS  
Approved Duration: 09/01/2013 To 01/04/2014 [Adjusted]  

I refer to the ethical review of the above project protocol by Swinburne's Human Research Ethics Committee (SUHREC). The responses to the review, as emailed on 6 January 2013 with attachments including revised appendices, were put to a SUHREC delegate for approval.  

I am pleased to advise that, as submitted to date, the project may proceed in line with standard on-going ethics clearance conditions here outlined.  

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the National Statement on Ethical Conduct in Human Research and with respect to secure data use, retention and disposal.  

- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator/supervisor requires timely notification and SUHREC endorsement.  

- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants and any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.  

- At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project.  

- A duly authorised external or internal audit of the project may be undertaken at any time.  

Please contact the Research Ethics Office if you have any queries about on-going ethics clearance, citing the SUHREC project number. Copies of clearance emails should be retained as part of project record-keeping.  

Best wishes for the project.  

Yours sincerely,  

Sheila  
for Keith Wilkins  
Secretary, SUHREC
11.7. SECTION A: GENERAL INFORMATION

[Nb This application form should not be used for research involving clinical trials or ionising radiation. See below.**]

**PROJECT FULL TITLE**
The Effect of Trait Mood Variability on Risk-Taking and Cognitive Flexibility

**SHORT TITLE**
(If applicable)

**APPLICANT DETAILS**

**RESPONSIBLE SWINBURNE FIRST INVESTIGATOR / SUPERVISOR**
(Where project is part of student research degrees or dissertations, Senior Swinburne Supervisor must still be listed as the first investigator)

Name & Title/Position: Professor Greg Murray
Tel No(s): 9214 8300
Email: GWM@swin.edu.au
Fax: N/A

Faculty / School / Centre / Institute: Faculty of Life & Social Sciences
Swinburne Status: ☑ Swinburne Staff Member ☐ Adjunct Staff Member
Address for correspondence: PO Box 218 John St., Hawthorn, 3122.

**List below the names of other Chief/Associate Investigators and Research Assistants (including those with access to identifiable data). (Add (copy/paste) cells as required for additional investigators/assistants. Append Student lists for class projects.)**

**Main Student Investigator(s): James Collett**
Email: jcollett@swin.edu.au
Tel No(s): 04 1712 4032
Student ID Number: 4162293
Fax: N/A
Degree Being Undertaken: Doctor of Philosophy (Clinical Psychology)

**Please complete as clearly as possible. (For Honours, higher degree and**

**Proposed Period During Which Human Research Activity Requiring Ethics Approval is Needed:**

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### 11.7.1. Broad Category of Research
Select one category box which best fits the application:

- ☐ Social/Cultural/Humanities
- ☐ Business/Management
- ☐ Education/Training/Program Evaluation
- ☑ Psychological/Brain/Neuro-sciences
- ☐ Health/Safety
- ☐ Other (please specify) .................................................................

[** For research involving Clinical Trials or Ionising Radiation, please contact the Research Ethics Officer.]

### 11.7.2. Human Research Risk/Review Classification
(Nb Checking to be consistent with published risk criteria.)

To enable a determination as to whether prima facie your research activity is Minimal Risk and/or Low Impact, please clarify by selecting [X] any one or more boxes below as to whether your research activity involves:

[Double-click on YES/NO 'check box' to select X by entering in Default Value as Checked ☑ or leaving as Not Checked ☐]

- ☐ Vulnerable participants, children or those dependent on care*
- ☐ Indigenous Peoples* or Special Cultural/Ethnic groups
- ☐ Externally funded research requiring HREC-level clearance*
- ☐ Multi-centre/Other sites requiring HREC-level approval*
- ☐ Research conducted overseas
- ☐ Conflicts of interest or dual researcher-professional roles
- ☐ Data access/use without an individual’s prior consent*
- ☐ Data access/use subject to statutory guidelines &/or reporting*
- ☐ Identification of participant individuals/groups in research outcomes without full consent or there is unclear consent for this*
- ☐ Sensitive information/issues vis-à-vis context/impact (legal*, regulatory compliance*, commercial, professional, cultural, etc)
- ☐ Personally intrusive/confronting or quite inconvenient/embarrassing questioning or other activity
- ☐ Physically confining/invasive techniques or significant physical contact/stimulation (TMS*, X-ray*, CT scan*, MRI*, clothing change, etc)
- ☐ Working in hazardous environments (asbestos dust*, infectious disease*, war or civil strife*, etc)
- ☐ Handling hazardous substances (eg, asbestos*, radioactive material*, explosives*, etc) or equipment
- ☐ Administration of medical/herbal substances*/treatments*
- ☐ Administration of other (non-medical) substances/treatments
All participants (REP and non-REP) will receive a chocolate bar (monetary value < $2.50) after completing the experiment. This is not compensation for time and effort; this is an integral feature of the reward-motivation design. Participants will be given the misinformation that the chocolate bar will only be awarded to them should they score within the top 20% of the sample on the combination of the three reward-based cognitive tasks (the CGT, BART, and IGT). This minor deception is necessary so that participants are adequately motivated to achieve the goal of obtaining the highest score possible (with reward sensitivity being the core variable of the project), as the experimental situation is supposed to be analogous to goal-striving behaviour in the real world. It also allows reward motivation to be stimulated with a low-cost, immediate reward that can be granted equally to all participants.

Participants will be fully debriefed as to the nature of the minor deception following their participation in the experiment. Participants will not be provided with a point of reference to compare their performance to that of others. Performance on the cognitive tasks is influenced both by random factors (with scoring probability following pre-determined statistical algorithms) and by the participant’s personal decision-making approach (with the tasks rewarding an optimal balance between caution and risk). Note that although the reward-based tasks are scored in “monetary” terms (i.e., a decimal system of hypothetical dollars and cents analogous to real-world currency), participants will be fully informed prior to the task that they will not be rewarded with money for their performance on the reward-based tasks.

Compensation procedures for this study differ depending on whether the participant is recruited through Swinburne University of Technology’s Research Experience Program for first-year psychology students (REP) or from other students and the general public (non-REP). Due to the length (60-90 minutes) and limited flexibility (with participants being required to attend testing sessions on campus) inherent to the data collection protocol, non-REP participants completing the experiment will be provided with $10.00 as compensation for volunteering their time, whilst REP participants will receive 90 minutes REP credit.
This study is being undertaken as a course requirement for the completion of the Doctor of Philosophy (Clinical Psychology) postgraduate degree. The study will also make a novel contribution to psychological science by adopting an integrated approach to investigating cognitive and affective features of the *trait of mood variability*. It is important to note that, although this personality trait is associated at its clinical extreme with bipolar disorder (Depue, Krauss, Spoont, & Arbisi, 1989), and the study’s findings will have implications for pathological mood states, the present study uses a normal population sample and will not recruit participants at the clinical extreme of the trait. Similarly, although the study’s specific hypotheses derive from literature investigating clinically significant bipolar disorder, the present study aims to extend these findings back into the normal population by investigating correlates of the normal range trait of mood variability. The background and rationale of the study’s scientific aims are summarised below. This study outline overlaps with a second study also being conducted for the student researcher’s Doctor of Philosophy (Clinical Psychology), namely, *Trait Mood Variability and Susceptibility to Behavioural Change following Mood Induction.*

Bipolar disorder is an affective disorder characterised by extreme fluctuations in mood; at clinical levels, these mood states are termed mania and depression (American Psychiatric Association, 2000). However, many researchers now view mood variability as an important affective phenomenon that is also present in the non-psychiatric population and characteristic of normal mood (Depue, Krauss, Spoont, & Arbisi, 1989; Murray, Goldstone, & Cunningham, 2007). This *trait mood variability* has been successfully and meaningfully examined in non-clinical participants, although the reasons behind such mood variability and its relationships with other personality traits remain poorly understood (Carver & Johnson, 2009; Depue, Krauss, Spoont, & Arbisi, 1989).

A promising candidate variable potentially influencing trait mood variability (in terms of both mood fluctuation and the experience of depressed or elevated moods) is sensitivity to reward (Alloy et al., 2008), commonly studied within the conceptual framework of reinforcement sensitivity theory (RST; Gray, 1972). Gray’s (1972) RST proposes two main neurobehavioural motivational systems: a Behavioural Activation System (BAS), and a Behavioural Inhibition System (BIS). BAS is a goal-oriented, appetitive motivational system that is responsive to potential rewards and also stimuli associated with the active avoidance or cessation of punishment (Heubeck, Wilkinson, & Cologon, 1998). BIS is a threat-oriented, aversive motivational system that is responsive to punishment and frustrative non-reward, and promotes actions such as ceasing behaviours that are not readily reinforced (Heubeck, Wilkinson, & Cologon, 1998).

Although it is difficult to separate trait and state (i.e., transient or temporary) effects when examining trait mood variability, at the trait’s clinical extremes theorists have suggested that BAS hypersensitivity may explain the intense and excessive fluctuations in mood that individuals with bipolar disorder experience (Alloy et al., 2008). BAS hypersensitivity theory postulates that individuals with bipolar disorder undergo excessive BAS activation (e.g., drive for reward) in response to goal-salient events, inducing a manic state. Conversely, individuals with bipolar disorder who undergo excessive BAS deactivation (e.g., frustrated attempts to obtain a reward) are likely to experience a depressive state (Alloy et al., 2008). Support for BAS hypersensitivity/dysregulation in bipolar disorder has been shown on a consistent basis and is consistent with the clinical phenomenology of bipolar disorder (for a review, see Alloy, Abramson, Urošević, Bender, & Wagner, 2009). In addition, similarities between BAS and mood phenomenology have been found in electro-encephalographic research, and it would appear that similar neurotransmitter systems propagate both goal-oriented motivation and the excessive affective states characteristic of bipolar disorder (Carver, Johnson, & Joorman, 2008), providing biological evidence for an association between BAS and trait mood variability, and further strengthening the hypothesis that the two phenomena are related.
In a real-world context, settings that involve BAS and BIS processes are situations with an element of risk, where the potential for gain (BAS-driven) needs to be balanced by the potential for loss (BIS-driven). A number of cognitive tasks, including the Balloon Analogue Risk Task (BART), the Cambridge Gamble Task (CGT), and the Iowa Gambling Task (IGT), have been used to examine risky decision-making. Interestingly, cognitive risk-taking tasks do not correlate strongly with conceptually related traits, such as impulsiveness and sensation seeking, underscoring the importance of adopting a multimethod approach to investigating risk-taking (Lejuez et al., 2003; Linke et al., 2012; Upton, Bishara, Ahn, & Stout, 2011). Although a bias towards riskier decision-making has been shown to be present in bipolar disorder (Adida et al., 2011), these findings remain equivocal (e.g., Holmes at al., 2009), and risky decision-making in bipolar disorder has yet to be studied in the context of (a) a continuous trait model of bipolar disorder that focuses on trait mood variability, and (b) the overarching theoretical background provided by RST and the BAS hypersensitivity hypothesis.

In addition to elevated risk-taking (Adida et al., 2011), task-based research has also begun to suggest the presence of learning deficiencies in bipolar disorder, suggesting that this variable may also correlate with the trait of mood variability. In particular, difficulty adjusting decision-making strategy following response feedback is an important feature of people with pathological levels of mood variability (Holmes et al., 2009). Holmes et al. (2009) used the BART to examine risk-taking in a sample of individuals diagnosed with bipolar disorder, who either did or did not have a past history of alcohol abuse. A group of healthy control participants was also recruited. Holmes et al. (2009) found that the bipolar disorder group with a history of alcohol dependence popped significantly more balloons than the other groups. BART performance was not found to differ as a function of mood state, and was not consistently associated with trait impulsiveness. However, the researchers also examined learning effects between BART trials, finding that whilst the control group and the bipolar disorder group without a history of alcohol dependence would pump the BART balloon less during a trial that had been preceded by a popped balloon, the bipolar disorder group with a history of alcohol dependence tended to enact a similar number of pumps regardless of whether the previous balloon had popped or not. This finding complements previous findings regarding impaired response modification in bipolar disorder (Johnson et al., 2011), with Holmes et al. (2009) suggesting that the failure of the bipolar disorder group with a comorbid history of alcohol dependence to learn from negative feedback may be due to an impaired perception of risk that can eventuate in the repetition of unrewarded risky behaviour.

Despite the ease with which the findings of Holmes et al. (2009) can be integrated with what is already known about bipolar disorder phenomenology, there is a notable scarcity of research using reward-laden tasks to examine learning and cognitive flexibility in bipolar disorder and its associated traits. Although impairments in cognitive flexibility (or set-shifting – the ability to “shift” perceptual set in terms of adapting to a change in rules) have been demonstrated in bipolar disorder (Quraishi & Frangou, 2002), this has usually been in the context of clinical groups, where the level of cognitive impairment is arguably non-specific and occurs across a range of psychiatric disorders (Quraishi & Frangou, 2002). However, the BAS hypersensitivity hypothesis suggests that bipolar disorder may be more specifically characterised by impairment in reward-based decision-making (i.e., risk-taking) and set shifting (i.e., the ability to adjust strategy in response to feedback), with the affective drive for reward interfering with more rational learning processes. By extension, trait mood variability may also be associated with set-shifting inflexibility; clarifying whether this occurs in non-reward and reward-based settings is a goal of the proposed study.

Based on the evidence presented above, the proposed study will investigate the relationship between trait mood variability and reward-oriented motivation and learning using self-report questionnaires and four computerised cognitive tasks. A key feature of the design is that it does not sample individuals diagnosed with bipolar disorder. Rather, non-clinical participants will be recruited and rated on a validated quantitative self-report measure of trait mood variability. As noted above, the findings of the study will nonetheless have implications for how we think about the extreme mood variability in diagnosable bipolar disorder, and the specific research questions derive in part from earlier investigations into bipolar disorder. The overarching logic of the study was to test for predicted correlations between a validated measure of trait mood variability (the predictor variable) and features of cognition in the context of reward cues (dependent variables). Four specific questions were set:
<table>
<thead>
<tr>
<th>Rationale</th>
<th>Dependent variable</th>
<th>1. Does mood variability as a trait correlate with more risky reward-based decision-making?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating a correspondingly greater risk of incurring loss. It is hypothesised that higher risk-taking will be associated with high trait mood variability, and that individuals high in trait mood variability will be less reactive to losses on the BART (i.e. exhibit relatively small reductions in responding after a series of losses).</td>
<td>Adjusted average button presses on the Balloon Analogue Risk Task (BART). This provides a measure of risky decision-making, as a greater number of button presses creates a correspondingly greater risk of incurring loss.</td>
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<tr>
<td>Risk-taking is a prominent phenomenon observed in clinical bipolar disorder and is a primary context where reward-based pursuit can take place. The Balloon Analogue Risk Task (BART) will be used to compare risk-taking propensity, and also to gauge whether individuals at differing levels of trait mood variability will adjust their decision-making strategy to become more cautious following the occurrence of losses.</td>
<td>Risk-taking propensity</td>
<td></td>
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<tr>
<td>It is hypothesised that higher risk-taking will be associated with high trait mood variability, and that individuals high in trait mood variability will be less reactive to losses on the BART (i.e. exhibit relatively small reductions in responding after a series of losses).</td>
<td>(Note: This research aim will also be replicated in the accompanying study <strong>Trait Mood Variability and Susceptibility to Behavioural Change following Mood Induction</strong>).</td>
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<tr>
<td>The CGT from the Cambridge Neuropsychological Test Automated Battery (CANTAB) will be used to discriminate risky decision-making from impulsive responding (by altering the order in which risk options are presented; see below).</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
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<tr>
<td>It is hypothesised that the cognitive impairment that accompanies full clinical affective and psychotic disorders will not be evident within the non-psychiatric population, and that any set-shifting impairment measured on the WCST will be less pronounced than that measured on the IGT.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>2. Is the hypothesised association between mood variability and risky decision-making mediated by impulsivity?</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
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<tr>
<td>Although risk-taking and impulsivity are similar in terms of their reliance on positive reinforcement processes, impulsivity tends to connote short-term reward processes that are lacking in premeditation, planning, and perseverance, a salient contrast when compared to the on-going inflexible pursuit of rewarding stimuli that characterises bipolar disorder phenomenology (Alloy et al., 2009; Goodwin &amp; Jamison, 2007).</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>The CGT from the Cambridge Neuropsychological Test Automated Battery (CANTAB) will be used to discriminate risky decision-making from impulsive responding (by altering the order in which risk options are presented; see below).</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
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<tr>
<td>It is expected that trait mood variability will be correlated with risky decision-making and that this relationship will not simply be due to impulsive responding.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>It is expected that participants high in trait mood variability will exhibit higher risky decision-making on the IGT, and also that they will experience greater difficulty adjusting their strategy following alteration of the pattern of high-risk/low-risk card decks.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>It is hypothesised that the cognitive impairment that accompanies full clinical affective and psychotic disorders will not be evident within the non-psychiatric population, and that any set-shifting impairment measured on the WCST will be less pronounced than that measured on the IGT.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>3. Does mood variability as a trait correlate with cognitive flexibility as assessed on a reward-based set-shifting task?</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
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<tr>
<td>Set-shifting, the ability to adapt responses to changing rules or conditions (i.e., to shift perceptual set) is seen as an important indicator of cognitive flexibility; for example, an individual with poor set-shifting abilities may have difficulty adjusting their strategy or approach to a task. Set-shifting ability will be operationalized as scores on the Iowa Gambling Task (IGT; also known as the Bechara Gambling Task).</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
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<tr>
<td>A modified form of the IGT, an alternative risk-taking task to the BART with a greater emphasis on learned associations, will be used to examine differences in cognitive flexibility in the context of rewards.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
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<tr>
<td>It is expected that participants high in trait mood variability will exhibit higher risky decision-making on the IGT, and also that they will experience greater difficulty adjusting their strategy following alteration of the pattern of high-risk/low-risk card decks.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>4. Does mood variability as a trait correlate with cognitive flexibility as assessed on a set-shifting task in the absence of reward cues?</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>Set-shifting ability as measured in scores on the Wisconsin Card-Sorting Task (WCST).</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>Clinical bipolar disorder is associated with a general level of cognitive impairment (Quraishi &amp; Frangou, 2002); however such impairment is by no means exclusive to bipolar disorder, but characterises other mental disorders, such as schizophrenia (Quraishi &amp; Frangou, 2002), as well. It is unknown whether non-clinical trait mood variability is associated with set-shifting inflexibility. In terms of clarifying this issue, it is of theoretical importance to administer a non-reward-laden learning task in order to discern whether (a) high trait mood variability is associated with less flexible set-shifting ability in general, and (b) whether reward-laden learning tasks (see above) result in a more severe cognitive deficit than non-reward-laden learning tasks.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
<tr>
<td>The WCST will be used to examine this. It is hypothesised that the cognitive impairment that tends to accompany full clinical affective and psychotic disorders will not be evident within the non-psychiatric population, and that any set-shifting impairment measured on the WCST will be less pronounced than that measured on the IGT.</td>
<td>Cambridge Gamble Task (CGT) score and frequency of high risk responses.</td>
<td></td>
</tr>
</tbody>
</table>
References:


The study protocol follows a five-stage within-subjects repeated measures design (refer to Figure 1) in which participants complete an initial battery of self-report measures followed by a series of four cognitive tasks. A measure of state mood will be administered prior to and following the cognitive task battery in order to check for confounding state mood effects. To maximise motivation towards task performance, participants will be told that should they score within the top 20% of the sample on the combination of the three reward-based cognitive tasks (the CGT, BART, and IGT) they will receive a chocolate bar (as noted above and below, some deception is involved, in that all participants will in fact receive the chocolate bar). Participant completion of the testing procedure is projected to take approximately 60 to 90 minutes. A sample of convenience will be recruited by online advertisement and psychology students at Swinburne will be recruited via the Research Experience Program (REP) and advertisement prior to lectures.

Self-report questionnaires. The questionnaire battery will be administered online using the Opinio software. The General Behaviour Inventory (GBI; Depue et al., 1989) and BIS/BAS Scales (Carver & White, 1994) will be included in the questionnaire battery (described below in the following section). Prior to (in order to establish baseline mood) and following completion of cognitive task battery, participants will complete the Positive Affect and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) to permit statistical control of participants’ state mood as a potential mediator of reward sensitivity effects.

The cognitive tasks. Following completion of the questionnaire battery, participants will complete a series of four cognitive tasks that relate to cognitive flexibility and reward responsiveness. The order in which the participants will complete these tasks will be counterbalanced in order to check for practice, order, and fatigue effects. However, the order in which the tasks are presented here reflects the most logical sequence of investigation.
Figure 1. Flowchart describing the stages of the protocol and the purpose of each stage.

1. Participants will complete a computerised version of the Wisconsin Card-Sorting Task (WCST; Grant & Berg, 1948) in order to assess the ability to shift perceptual "set" in the face of changing task demands but in the absence of reward-laden stimuli (e.g., high score, money earned, or positive feedback). Set-shifting is a common indicator of learning and cognitive flexibility. The WCST has been selected in order to measure set-shifting learning whilst minimising reward as much as possible; although it provides participants with positive/negative feedback by way of training them in the rules of the
task, it does not provide a running score tally, use hypothetical financial units, or ask that
the participant balances the degree of reward versus loss during the task.

2. Participants will complete the Cambridge Gamble Task (CGT, Rogers et al., 1999) in
order to assess risk taking. For the present purposes, a major strength of the CGT is
that it is designed to control for lower level impulsive responding (i.e., always choosing
early options, regardless of whether they constitute a greater or lesser risk) and hence
serves as a purer measure of driven risky decision-making. In contrast to the Balloon
Analogue Risk Task (below), the CGT also has the advantage of using a less complex
probability algorithm thereby simplifying the statistical modelling of decision-making.

3. Participants will then complete the Balloon Analogue Risk Task (BART; Lejuez et al.,
2002), a risk taking task commonly used as a behavioural measure of BIS/BAS
processes. Although the BART assesses the same construct as the CGT, it has been
designed to more closely reflect real-life escalation of risk, using a dynamic algorithm
that means that as the participant's score becomes higher, the probability of loss also
increases (with the participant limited in their ability to individually control the amount of
score that they could lose). The balloon metaphor central to the BART also makes the
nature of the task immediately recognisable to most participants, circumventing the
confounding speed-of-learning effects that characterise the Iowa Gambling Task.

4. Finally, participants will complete an adaptation of the Iowa Gambling Task (IGT;
Bechara, Damasio, Damasio, & Anderson, 1994) that has been modified for the present
study to emphasise the learning component and to allow for the measurement of reward-
based set-shifting. The modified IGT will function in the same manner as a standard IGT
in terms of allowing risky decision-making and speed of learning to be gauged. However,
the risk pattern of the decks will be altered during the tasks, creating a need for
participants to adapt their choice of deck accordingly.

Following completion of the four cognitive tasks, participants will complete the PANAS for
a second time.

References: See the Procedures section below.

11.7.5. A3 HOW - PROCEDURES
Please detail clearly and sufficiently the proposed research/statistical method(s), procedures and
instruments to be used in the project, including all screening and research 'procedures' to which the
participants will be subjected, and asterisk those which may have adverse consequences.
Please include as appendices all screening instruments, questionnaires, interview protocols etc (at
least in draft form if not finalised).

The Trait Questionnaire Battery. Participants will complete two scales in an online
questionnaire (hard copies of the scales are appended to this application):

i) The General Behaviour Inventory, a 73-item measure of trait mood variability with
subcales assessing mania (elevated mood), depression (depressed mood), and
biphasic symptoms (lability of mood; Depue, Krauss, Spoont, & Arbisi, 1989).
ii) The BIS/BAS Scales, a 24-item measure of sensitivity to rewarding and threatening
stimuli and situations (Carver & White, 1994). The BAS factor is broken down into three
subcales – Drive, Fun Seeking, and Reward Responsiveness. Although the BIS factor
was originally viewed as holistic, more recent studies have separated BIS into two
factors, BIS (reflective of anxiety) and Fight-Flight-Freezing System (FFFS; reflective of
fear), consistent with modern revisions of RST (e.g., Beck, Smits, Claes, Vandereycken, & Bijttebier, 2009).

Assessment of Mood State. The Positive Affect and Negative Affect Schedule is a 20-item measure assessing (a) Positive Affect, a pleasant state of high energy and full concentration, with low scores suggesting sadness and lethargy, and (b) negative affect, an unpleasant state encompassing generally aversive moods, with low scores indicating a state of calm (Watson, Clark, & Tellegen, 1988). Participants will rate the degree that they are experiencing each item at the present moment. In addition, a simple visual scale where participants rate their overall mood from 0 (extremely negative) to 10 (extremely positive) will also be included with the PANAS.

Beyond the PANAS, a number of Likert-type self-report items were also developed for this project to measure motivation, optimism, and overconfidence (factors of conceptual importance to both trait mood variability and reward sensitivity). The PANAS and additional questions are appended to this ethics application.

The Wisconsin Card-Sorting Task (WCST; Grant & Berg, 1948). The WCST is administered via computer. Individuals are asked to sort a variety of cards (presented on the computer screen) by either the shape, colour, or number of the symbol(s) pictured on the card. However, the initial card-sorting rules (e.g., grouping cards of a similar colour) reverse in subsequent trials, forcing the participant to inhibit their previous learning and adapt to the change in situation (shifting their perceptual set). The WCST is an established neuropsychological test, a variant of which (Owen, Roberts, Polkey, Sahakian, & Robbins, 1991) is included as a subtest of the Cambridge Neuropsychological Test Automated Battery (CANTAB), a gold-standard test battery used in neuropsychological assessment and research.

The Cambridge Gamble Task (CGT; Rogers et al., 1999). The CGT is administered via computer and features an on-screen display where 10 coloured boxes are presented. These boxes are either coloured red or blue (with proportions differing across different trials). The participant must guess what colour of box a yellow token is hidden under, and has the option of betting a portion of their current score upon this outcome. The participant's betting options (either 95, 75, 50, 25, or 5% of their total points) is initially presented to them in ascending order and later in descending order, allowing impulsivity (selection of earlier options) to be disentangled from risky decision-making (selection of a higher proportion of the total score). A version of the CGT is included as a subtest of the CANTAB.

The Balloon Analogue Risk Task (BART; Lejuez et al., 2002). The BART involves a computer simulation representing a balloon being inflated with a pump that the participant controls. Each time that the participant inflates the balloon, a set monetary reward of one (virtual) cent is deposited into a temporary reserve (the hypothetical bank balance). However, the balloon is capable of popping due to overinflation. The probability of overinflation increases with each pump. Initially, the balloon has a 1 in 128 chance of popping, however this continues to decrease to 1/127, 1/126, and so forth until on the 128th pump there is a 1/1 probability of the balloon exploding. Using this algorithm sets the average breaking point for the balloon at 64 pumps – hence, although the probability of success per individual trial is randomly computer-generated, across trials the BART rewards the participant's ability to maintain a balance between caution and excessive
risk-taking. The participant can choose to abandon the trial at any time, retaining their score and proceeding to the next trial. As the number of pumps progresses, the amount that the participant has to lose increases whilst the value of the potential reward relative to what they have already accumulated decreases. Participants will be instructed that their goal is to accrue as much money in their hypothetical bank balance as possible.

The Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994). Administered via computer, the IGT requires that the participant choose from four decks of cards (labelled A, B, C, and D) represented on-screen. Each card choice results in an amount of hypothetical money (the participant's score) gained, but occasionally will also result in the loss (or penalty) of an amount of money. Deck A provides high gains but a high frequency of low-magnitude penalties. Deck B provides high gains but a low frequency of high-magnitude penalties. Deck C provides modest gains and a high frequency of lower magnitude penalties, whilst Deck D provides modest gains and a low frequency of higher magnitude penalties; however, these penalties are lower than those incurred in Decks A and B. The IGT probability algorithm is set so that if a participant consistently chooses from Decks C and D then their modest yet consistent gains will outweigh the amount of money that they are being penalised. Hence, Decks C and D represent low risk options whereas Decks A and B represent high risk options (Adida et al., 2008). The IGT has been criticised as a pure risk-taking measure due to the fact that the participant needs to learn the differing pattern of risk between Decks A and B and Decks C and D (Upton, Bishara, Ahn, & Stout, 2011); however, for the purposes of the present study this means that the IGT can be easily modified to create a reward-laden set-shifting task. This will be accomplished by altering the frequency, magnitude, and overall risk level of different decks during different blocks of the task.

The results will be analysed using regression and analysis of variance techniques.

References:
Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L.,


If you feel that it is necessary to include further material, please append.

11.7.6. A4  DESCRIBE ANY RISK THAT MAY ARISE TO THE PARTICIPANT / DONOR?

Risk to participants (and to researchers) can be real but does not need to be physical. Risk includes such as self esteem, regret, embarrassment, civil or criminal liability, disease, physical harm, loss of employment or professional standing, etc. Please consider such possibilities carefully.

Some research activities may put the participant at risk through what is being done or simply through their participation.

Please describe the risk you perceive and the protective measures to be taken.

The study is not associated with any foreseeable risks to participants. Neither the tasks nor the questionnaires are believed to be likely to elicit distress.

11.7.7. A5  DESCRIBE ANY RISK THAT MAY ARISE TO THE RESEARCHER / ADMINISTRATOR?

Some research activities may put the researcher at risk through what is being done or simply through their participation.

Please describe the risk you perceive and the protective measures to be taken.

This project holds no risks for the researcher.

11.7.8. A6  WHAT BENEFITS ARE ANTICIPATED FROM THE PROJECT

Ethical principles would require that benefits flowed from the activities - but please avoid grandiose claims.

(a) To the Participant (what and how so)

Participants will benefit from an increased understanding of psychological research, and through their participation will gain an understanding of how psychometric and behavioural research designs operate. The provision of a financial incentive/REP credit for participation in the experiment will ensure that the participant is compensated for the time spent on the study.

(b) More generally (to society, profession, knowledge, understanding, etc, and how so.)

Expanding the present knowledge base regarding trait mood variability (and the vulnerability to bipolar disorder) and the mechanism for mood lability in bipolar disorder will ultimately allow for more accurately focused preventative therapies and
screening/monitoring of at-risk cases.

11.7.9. A7 POTENTIAL PROBLEMS
From time to time in the course of a research project important information, such as an individual found to be at risk, or entirely unforeseen events may come to pass. What procedures are in place to handle unexpected or particularly significant personal or other information that may come to light through the project, eg, unknown medical/psychiatric condition, a particularly distressed participant, civil or criminal liability, etc.

Whilst such an event is judged to be unlikely, should a participant become distressed in the process of participating (before, during, or after) they will be directed to either the student counselling service, Swinburne Psychology Clinic, or LifeLine as appropriate.

11.7.10. A8 PROFESSIONAL/ETHICAL ABILITY & TRAINING
(Researchers/Students/Assistants)
NS 1.15 Research must be conducted or supervised only by persons or teams with experience, qualifications and competence appropriate to the research … using (appropriate) facilities … (and with appropriate skills and resources for dealing with any contingencies…

(a) Sufficiently detail what investigators/assistants will do in this project and their expertise/competence to do so.

The investigator will be required to set up the online questionnaire battery and administer the protocol on a computer. The role of the investigator will also involve ensuring that the anonymity, confidentiality, and integrity of the stored data is maintained. The investigator’s previous training in communication, research, and ethical considerations has adequately prepared him to carry out these tasks.

(b) Sufficiently detail any further training/qualifications required for investigators/assistants to carry out the project.

No further training is necessary to facilitate completion of this research project.

11.7.11. A9 FUTURE USE OF DATA
Will any of these data be used by yourself, your students or others for any purpose other than for this project as described in the protocol? If so please describe.

The data collected in the course of the present study will only be used directly for the present thesis project, and scientific publications arising from the thesis project.

11.7.12. A10 EXTERNAL INVOLVEMENT
Is a body external to Swinburne involved in initiation or support of the project?

☐ Yes Name of body/organisation. ..........................................................

If an external body is associated with the project you must provide the HREC with detail of the arrangements, including details of any funding or other resources being provided. A copy of relevant pages from the contractual arrangements should be attached.

☐ No

11.7.13. A11 EXTERNAL APPROVALS
Projects involving other organisations or entities may require approval from other institutions or their ethics committees, etc. for such things as access to prospective participants, contact lists, data, facilities, etc. A copy of such approvals may be required to be provided to the HREC at the time of application or be made available as soon as possible. In which case, the project may not commence, until such evidence is provided.

Please indicate, as appropriate, if formal clearance/permission has been obtained or sought:

Institutional Yes ☐ Documentation Attached ☐ or to follow ☐

Next of Kin (for special groups) Yes ☐ Documentation Attached ☐ or to follow ☐

(estimate when likely to be obtained)
N/A

☐ No (please explain)

N/A

11.7.14. A12 RESEARCHER / SPONSOR RELATIONSHIP

Is there any relationship or association between the sponsor and any of the researchers listed in Section A of this form, for example are any of the researchers directors, officers, employees, shareholders or promoters of the sponsor or do they receive any personal benefits from the sponsor under any other contracts or arrangements?

☒ No

☐ Yes (please explain the relationship(s), including how a vested or a conflict of interest situation does not arise.)

11.8. SECTION B: ETHICAL ISSUES OVERVIEW

11.8.1. B ETHICAL ISSUES

[Double-click on YES/NO 'check box' to select box, then enter Default Value as Checked ☒ or leaving as Not Checked ☐ ]

(a) Non-/Limited Disclosure or Deception: Is any detail in relation to research purposes, methods or questions being withheld from participants? Or will deception of any kind be involved? Or any covert/undeclared observation? (Refer National Statement Chap 17)

(b) Does the data collection process involve access to confidential personal data (including access to data provided for a purpose other that this particular research project) without the prior consent of subjects?

(c) Will participants have pictures taken of them, e.g., photographs, video recordings?

If "YES", please explain how you intend to retain confidentiality and ultimately dispose of the material.

(d) If interviews are to be conducted, will they be recorded by electronic device?

If "Yes", please explain how you intend to retain confidentiality and ultimately dispose of the material.

(e) Will participants be asked to perform any acts or make statements which might compromise them, diminish self esteem or cause them embarrassment or regret (minimal, moderate or significant)?

(f) Might any aspect of your study reasonably be expected to place the participant at risk of criminal or civil liability (not just immediately or directly)?

(g) Might any aspect of your study reasonably be expected to place the participant at risk of damage to their professional/social/cultural/financial standing or employability?

(h) Will the research involve access to data banks subject to privacy legislation?* (NOTE: Annual reporting to Government may be required on this item. For info: please contact the Research Ethics Officer.)

(i) Will participants come into contact with any equipment which uses an electrical supply in any form e.g., audiometer, biofeedback, electrical stimulation, magnetic stimulation, etc.? If "YES", please outline below what safety precautions will be followed.

(j) Will any treatment be used with potentially unpleasant or harmful side effects?
Does the research involve any stimuli, tasks, investigations or procedures which may
be experienced by participants as stressful, noxious, aversive or unpleasant during
or after the research procedures? □ ☒

Will the research involve the use of placebo control conditions or the
withholding/substitution of treatment, programs or services (health, educational, 
commercial, other)? □ ☒

Will any samples of body fluid or body tissue be required specifically for the research
which would not be required in the case of ordinary treatment? □ ☒

Will participants be fingerprinted or DNA "fingerprinted"? □ ☒

Are there in your opinion any other ethical issues involved in the research? □ ☒

NOTE: If the answer to any of the above questions is "yes", please explain and justify
below in sufficient clear detail. (The box below will expand to fit your response.)

The deception and temporary (duration of the experiment) non-disclosure is necessary to allow
provision of a low-cost yet gratifying reward (a central design feature of the project) whilst also allowing
all participants to receive the same level of reward equally, regardless of task performance (which is
affected by randomised probabilistic variables outside the participant’s direct control).

Attach further documents if appropriate

11.9. SECTION C: PARTICIPANT DETAILS

11.9.1. C1 PARTICIPANT DETAILS

The composition of the participant group may, in some circumstances, distort and invalidate
an outcome, and risks may arise through the composition of the participant group.

How many individual participants will be involved? (Number/number ranges for which
approval is sought)

Males: 50-75  Females: 50-75  Total participants 100-150

Over what range of ages?

From (youngest): 18  To (Oldest): 70

If there is a gender or age imbalance in the number of participants please explain why.

A gender-balanced sample is desirable for this project, however it is not integral to the
design and participants will not be screened or excluded on the basis of gender.

11.9.2. C2 RECRUITMENT

How will participants be recruited/selected?

Please outline the process in sufficient detail how this is to occur.

Note: Where participants are obtained from or through schools, hospitals, prisons or other
institutions, appropriate institutional or other authority will probably be needed. If soliciting for
participants by advertisement or poster please attach proposed copies or text.
(See also Project Information Consent Statements and Signed Consent Forms info at the end
of this application form.)

Participants will be recruited in two ways:

i) REP Participants: As part of Swinburne University’s REP for first-year psychology
students.

ii) Non-REP Participants: By advertisement to second-, third-, and fourth-year
psychology students (at Swinburne University of Technology Hawthorn), email contacts,
social networking sites, community message-boards, and acquaintances of the
experimenters.

Note that REP volunteers will be compensated for their time with 90 minutes REP credit,
whilst non-REP participants will receive a voucher for $10. These compensation values were judged by the investigators to be comparable. Data from REP and Non-REP participant groups will be compared before hypothesis testing to assess whether or not it is appropriate to collapse the groups into a single sample.

11.9.3. C3 PRE-EXISTING CONDITIONS

In some situations an underlying medical or other significant condition of a participant may result in an otherwise relatively innocuous situation causing excessive stress and exacerbate the condition. Researchers must, therefore, be alert to such situations and be able to address the resulting issues.

Do participants have any medical or other significant condition of which you are aware, eg. diabetes, asthma, depression, epilepsy? What steps are in place to handle any resulting problems (you may need to correlate with A3, A4 and A7 of this form)?

In the unlikely event of an unexpected psychological or physiological problem occurring during the study, the university counselling and medical clinic information supplied on the consent form can be referred to. The investigator (a probationary psychologist completing supervised postgraduate training in clinical psychology) will be physically present during administration of the experiment in the unlikely event that help needs to be summoned.

11.9.4. C4 DISCLOSURE AND INFORMED CONSENT

How will participants be informed about the project in order to give valid consent:

- Consent Information Statement(s)/Letter(s) and Signed Consent Form(s) will be used. *A copy must be attached to your application. A guide to consent instruments is given at the end of this form.*

- Consent Information Statement(s)/Letter(s) and consent implied by return of anonymous questionnaire

- Verbal advice (Please explain how and why)

- Other (Please explain how and why)

Participants will be provided with an information statement (appended to this ethics application) outlining the procedure and goals of the project and reminding them of their ethical rights prior to commencing the experiment.

This information sheet will also be emailed to potential participants for their consideration before consenting to participate in the experiment.

Consent to participate in the experiment will be implied by submission of the questionnaire and task data during the testing sessions. Participants will be informed that their participation is entirely voluntary and that they have the right to withdraw at any time.

Copies of appropriate consent instruments must be attached to your application. Please consult the Guide to Human Research Informed Consent Instruments in carefully preparing informed consent instruments.

11.9.5. C5 COMPENSATION

Consent to participate must be freely given and not induced through the level of reward, perceived reward, or power relationships

Provide details of any financial or other reward or inducement is being offered to subjects for participation. Indicate the source of the funds.
**Compensation:** Compensation for participation in the project will differ between REP and Non-REP participants. REP participants will receive 90 minutes REP credit and Non-REP participants will receive a $10 voucher in order to ensure that participants are sufficiently compensated for their inconvenience and time expense. As the project is a task-based experiment held on campus, rather than a solely online or questionnaire-based study, this compensation is warranted due to the additional effort participation requires. Note that this compensation is conceptually separate from the reward stimulus (chocolate bar) that will also be granted to participants, and that participants will be fully informed with regard to the separability of adequate compensation and the obtainable reward. REP and Non-REP participant groups will be compared following the study to test whether the discrepancy in compensation has not inadvertently created a confounding variable.

**Reward:** To increase the effectiveness of the CGT, BART, and IGT as tasks that elicit goal-oriented motivation (a scientific requirement crucial to the study), participants will also be informed that they will receive a chocolate bar should their aggregated task results place them in the top 20% of scores. In reality all participants will receive the chocolate bar and will then be fully debriefed regarding the nature of and need for this minor deception.

### 11.9.6. C6 RELATIONSHIP TO INVESTIGATOR(S)

Free consent may be difficult to ensure if the participant is dependent upon the investigator for employment, assessments etc.

*Some relationships cause special ethical issues to arise*

Are participants linked with the investigator through some particular relationship - eg. employees ultimately responsible to or superiors of the investigator, students of investigator, family members, friends etc.

Participants enrolled in psychology at Swinburne University may come into contact with the investigators outside of the project, as all three investigators are teaching staff. Participants will be informed that their acceptance or refusal to participate in the project will in no way impact their assessment as a student in their course.

### 11.9.7. C7 INVOLVEMENT OF SPECIAL GROUPS

Particular issues of consent may arise where special groups of participants are to be involved. There may be, for example, a need to obtain informed consent from persons other than the direct participant. Examples of such special groups include special cultural groups - eg. indigenous Australians; children and young persons (Guidelines section 4.2); groups with special circumstances - eg. persons with an intellectual or mental impairment (Guidelines s. 5)

Please identify and describe the nature of the groups and procedures used to obtain permission.

*Note. Persons proposing research projects involving Indigenous Australians should consult with the relevant University manager of indigenous programs prior to finalising definition of the project.*

No special groups are participating in this research project.

### 11.9.8. C8 PRIVACY

The University is subject to the Victorian Information Privacy and Health Records Acts as well as the Commonwealth Privacy Act and, in particular, the Information/Health/National Privacy principles (IPPs/HPPs/NPPs) set out therein and is required to report annually on projects which relate to or utilise particular records.

Does the research involves access to data which was collected by an organisation for its own purposes (ie. not specifically collected for this project) such as student records, other data banks,
human pathology or diagnostic specimens provided by an institution/s?
If yes, please indicate source/s.

No external data is being utilised in this project.

11.9.9. C9 LOCATION OF STUDY
Please indicate where the research will be carried out. If the research will not be on University premises permission of owner / occupier may be required. If so, please indicate what authority or permission may be required and how will be obtained. NB: Where required, please attach to this application evidence of authority obtained or provide the Secretary, HREC as soon as practicable.
The study will be completed in a computer laboratory located at the Hawthorn campus of Swinburne University of Technology.

11.10. SECTION D: DATA & PUBLICATION ARRANGEMENTS (Nb Section D Revised Aug 2007)
PLEASE CONSIDER CAREFULLY YOUR RESPONSES TO THIS SECTION. YOU NEED TO BE CLEAR AS TO WHAT IS OCCURRING WITH RESPECT TO DATA COLLECTION, RETENTION and DISPOSAL.
(In your responses, you should demonstrate familiarity with National Statement requirements for confidentiality, relevant Privacy Principles and Swinburne’s Policy on the Conduct of Research, eg, Sect 4, see URL: http://www.swinburne.edu.au/corporate/registrar/ppd/docs/PolicyontheConductofResearch.pdf).

11.10.1. D1 DATA COLLECTION/RECORDING (Nb Section D1 Revised Aug 2007)
Please note that, with any information or data collected/retained, if any individual can reasonably be identified, the information can be deemed “personal information” or “health information” under National/Health/Information Privacy Principles (NPPs/HPPs/IPPs).
(a) How or in what form will data be collected/recorded?
(eg, notes; verbatim, audio and/or video recordings; transcriptions of recordings; recorded or signed consents; etc)

Data from the experiment will be collected via computer and stored electronically in a password-protected form. An informed consent statement will be presented to the participant prior to the commencement of the experiment. Consent to participate will be implied by submission of the data following completion of the experiment.

(c) As regards any individual, in relation to any data collection or retention, you need to acknowledge either or both of the following:
[Double-click on 'check box' to select X by entering in Default Value as Checked ☑ or leaving as Not Checked ☐]

☐ An Individual can be identified OR is Potentially Identifiable / Re-Identifiable
(An individual can be identified at some point or by the very nature of the data collected/retained: at time of an interview, by signed consent form, identified or labelled voice or image recording, pen-and-paper questionnaire, on-line survey instruments, etc.
Whilst data may not have (explicit) identifiers, an individual’s identify can still reasonably be worked out.
Or data may have (explicit) identifiers removed and replaced by codes that permit matching of an individual with the data collected/retained, in which case it is possible to identify or re-identify the person to whom the data relates.)

☒ An Individual is Non- or Un-identifiable
(Data collected/retained anonymously and with no reasonable possibility of being identified.)

Your acknowledgement may require further explanation or clarification; if so, please include in the following box.

Although the experimenter will be present in the computer laboratory in which participants are completing the experiment, participants will not be reasonably able to be
identified following completion of the experiment, nor will the participant’s data be able to be matched to their identity.

11.10.2. D2 DATA SECURITY (Nb Section D2 Revised Aug 2007)
Please note that “data must be held for sufficient time to allow reference. For data that is published this may be for as long as interest and discussion persists following publication. It is recommended that the minimum period for retention is at least 5 years from the date of publication but for specific types of research, such as clinical research, 15 years (or more) may be more appropriate.” (Sect 4.3 of Swinburne’s Policy on the Conduct of Research)

Please indicate how data (all types of data, including, eg, signed consent forms) will be securely retained (eg, electronic form in password-protected disk drive, locked filing cabinet, etc) and where? With more than one type of data, will the types be separately stored? In your explanation, you will need to make clear how due confidentiality and/or anonymity will be maintained.

(a) During the study
Data will be stored in a password-protected data file on the main hard-drive at Swinburne University of Technology.

(b) Following completion of study
All information related to the study will be stored securely on a password protected data file on the Swinburne main drive. Data will be held for a minimum of 7 years post publication.

11.10.3. D3 PUBLICATION/OUTPUT (Nb Section D3 Revised Aug 2007)
Please explain in sufficient detail:
(a) What, if any, publication (conference, news media, academic journal, other journal, etc) is envisaged following on or in relation to this project, both in terms of data proper and/or analysis of data?
(b) Will participants be informed about any envisaged research publication/outcome? (This information is normally to be included in the information given prior to obtaining informed consent.)
(c) Would any participants be able to be identified through the publication of data proper or research findings? If so, explain why this is necessary.

(a) Publication may occur in one or more international refereed journals in which no identification of individuals will be possible.
(b) Participants will be informed of this during the informed consent process.
(c) Participants would be completely unidentifiable through the publication of data or research findings.

11.10.4. D4 INDIGENOUS ISSUES
Storage arrangements for data relating to research into Indigenous matters must be determined in compliance with the Policy on the Conduct of Research after consultation with the communities involved.
What consultation has taken place and what arrangements have been made.

N/A
11.10.5. D5  OTHER ISSUES (Nb Section D5 Revised Aug 2007)
Are there any other issue relating to data collection, retention, use or disclosure which the ethics committee should be made aware of and, if so, please explain how you are to deal with this.
(Eg, Research outcomes unduly impacting on any individual or group not directly participating, etc.)
N/A

11.11. SECTION E:  SUBSTANCES & CLINICAL ISSUES
☒  No matters in this section are applicable to the study  or

11.11.1. E1  ADMINISTRATION OF SUBSTANCES/AGENTS

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Anticipated effects:

NOTE: If the research involves administration of foreign substances or invasive procedures, please attach a statement accepting responsibility for those procedures by a medical or paramedical practitioner with Indemnity insurance.
☐  STATEMENT ATTACHED

11.11.2. E2  BODY FLUIDS OR TISSUE

What fluids or tissue? How will be samples be obtained?

Frequency and volume

How are samples to be stored?

How will samples be disposed of?

Who will take the samples?

What are their qualifications for doing so?

Do participants carry, as far as you know, the Hepatitis B or HIV virus? If so how will the risks be handled

Do participants carry, as far as you know, any other contagious diseases or viruses? If so how will the risks be handled
11.12. SECTION F  Declarations for Signature

1. With respect to this project, I / We, the undersigned Investigator(s)/Assistant(s) agree:
   - To undertake human research activity or handle data confidentially in accordance with Swinburne requirements, including any standard or special ethics clearance conditions, under the proper direction of the responsible Swinburne manager and/or principal Swinburne (or other) researcher/supervisor.

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All listed applicants must sign. The Chief Investigator/Supervisor is also responsible for personnel subsequently joining the project. Expand this table or duplicate this page as required. NB This information is subject to Swinburne or external audit.

**** Please note that ****

PROJECTS MUST NOT COMMENCE WITHOUT PRIOR WRITTEN APPROVAL from the Human Research Ethics Committee (SUHREC) or its appropriate Subcommittee (SHESC)

2. Declaration of Compliance by Chief Investigator(s)/Student Supervisor(s).
I declare that the above project has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice, including any standard or special conditions for on-going ethics clearance. I further declare that all listed and subsequently appointed researchers or assistants involved in this project will be made aware of the conditions of ethics approval as communicated to me, including approved documentation and procedures.

Signature & Date: 

Name of Signatory & Position:

(Optional) Form checked by a Research & Ethics Advisor (REA)? Yes ☐ No ☐ REA Initials & Date: .........................
3. Endorsement of Head of Academic Unit (or Delegate) or Above.
I declare that this project: has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice; and has research merit, adequate resourcing and appropriate leadership/supervision.

Signature & Date: 

…..

Name of Signatory & Position: 

…..

(Please note: This endorsement must be given by an authorised official who is not also a chief or co-investigator of the project and who is not also the supervisor of a student investigator with an interest in the project.)
The Effect of Trait Mood Variability on Risk-Taking and Cognitive Flexibility

Investigators: Prof. Greg Murray, Dr. Conrad Perry, Mr. James Collett

Thank you for your interest in participating in this study. The aim of this study is to investigate the ways in which sensitivity to rewarding stimuli and sensitivity to threatening stimuli are associated with personality traits such as mood variability. This will be accomplished by administering a number of computerised tasks examining risky decision-making and learning flexibility.

Participation will involve the completion of four cognitive tasks and two self-report questionnaires. The cognitive tasks will involve (a) being presented with stimuli and placing them into categories, and (b) selecting different responses in order to obtain a high score. The questions that you are asked will consist of basic personal information (e.g., gender, age, employment status) and questions about your thoughts, feelings, behaviours. The entire process should take approximately 90-120 minutes. Please do not participate if you believe that the nature of the tasks or questions is likely to cause you distress.

Participation in this project counts towards completion of Swinburne University of Technology's Research Experience Program (REP), a program that encourages first-year psychology students to gain experience participating in advanced research projects. Participants must be studying first-year psychology and will receive 90 minutes towards their REP credit. In addition to this compensation, you will also have the chance to win a chocolate bar during the experiment!

Your participation in this study is completely voluntary. Your initial agreement of participation in this study does not stop you from discontinuing participation and you are free to withdraw at any time. Choosing not to participate in the project will not have any impact on the way your academic assessments are graded in your course.

The results of this investigation will be presented in a doctoral thesis as an assessment requirement in the completion of the student investigator’s Doctor of Philosophy (Clinical Psychology) qualification. Only group data will be presented and no individuals will be identified if the results of this study are published in a scientific journal.
If you have any psychological or physiological concerns during the course of this study then the following are the contact details for the Swinburne University Counselling and Medical Clinics (note that these services are free for all Swinburne students):

**Hawthorn Counselling Service**
36 Wakefield Street (corner Wakefield & John Streets)
Service hours are usually 9am - 5pm weekdays
Phone: 9214 8025
Fax: 9214 5993

**Hawthorn Medical Service**
McLeod Lane (Between John and William Streets Hawthorn)
Health Service Building
Room: SH102
Ph: 9214 8483
Fax: 9818 7548

**Lilydale Counselling Service**
Student Centre Reception
Phone: 9215 7101
Fax: 9215 7070

**Lilydale Medical Service**
Room LD108
Ph: 9215 7106
Fax: 9215 7070

In addition to the above services, in the event of a crisis note that Lifeline can be contacted for support on 13 11 14.

If you would like further information on this research project, please contact:
**James Collett, Doctoral Candidate, BA309, Swinburne University Hawthorn,**
jcollett@swin.edu.au

If there are any questions involving this study please contact:
**Prof. Greg Murray, Swinburne University of Technology, PO Box 218, Hawthorn, Victoria 3122,**
ph: (03) 9214 8300 or email gwm@swin.edu.au

This project has been approved by or on behalf of Swinburne’s Human Research Ethics Committee (SUHREC) in line with the *National Statement on Ethical Conduct in Human Research (2007)*. If you have any concerns or complaints about the conduct of this project, you can contact:
**Research Ethics Officer, Swinburne Research (H68), Swinburne University of Technology, PO Box 218, Hawthorn, VIC 3122; ph: (03) 9214 5218 or email resethics@swin.edu.au**

Please click Start to begin the experiment.

Note that your completion of the task and questionnaire package and the submission of your results will be taken as your implied consent to participate in this study.
Thank you for your interest in participating in this study. The aim of this study is to investigate the ways in which sensitivity to rewarding stimuli and sensitivity to threatening stimuli are associated with personality traits such as mood variability. This will be accomplished by administering a number of computerised tasks examining risky decision-making and learning flexibility.

Participation will involve the completion of four cognitive tasks and two self-report questionnaires. The cognitive tasks will involve (a) being presented with stimuli and placing them into categories, and (b) selecting different responses in order to obtain a high score. The questions that you are asked will consist of basic personal information (e.g., gender, age, employment status) and questions about your thoughts, feelings, behaviours. The entire process should take approximately 90-120 minutes. Please do not participate if you believe that the nature of the tasks or questions is likely to cause you distress.

In recognition of the length of time involved in completing this study, participants will be compensated for their participation in the experiment. Compensation will consist of $10.00 as reimbursement for the time involved in participation. In addition to this compensation, you have the chance to win a chocolate bar during the experiment!

Your participation in this study is completely voluntary. Your initial agreement of participation in this study does not stop you from discontinuing participation and you are free to withdraw at any time. Choosing not to participate in the project will not have any impact on the way your academic assessments are graded in your course.

The results of this investigation will be presented in a doctoral thesis as an assessment requirement in the completion of the student investigator’s Doctor of Philosophy (Clinical Psychology) qualification. Only group data will be presented and no individuals will be identified if the results of this study are published in a scientific journal.

If you have any psychological or physiological concerns during the course of this study then the following are the contact details for the Swinburne University Counselling and Medical Clinics (note that these services are free for all Swinburne students, but will attract a fee for participants who are not currently studying at Swinburne):
Hawthorn Counselling Service
36 Wakefield Street (corner Wakefield & John Streets)
Service hours are usually 9am - 5pm weekdays
Phone: 9214 8025
Fax: 9214 5993

Hawthorn Medical Service
McLeod Lane (Between John and William Streets Hawthorn)
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Ph: 9214 8483
Fax: 9818 7548

Lilydale Counselling Service
Student Centre Reception
Phone: 9215 7101
Fax: 9215 7070

Lilydale Medical Service
Room LD108
Ph: 9215 7106
Fax: 9215 7070

Even if you are not a student at Swinburne University of Technology, note that low-cost counselling can be obtained from the Swinburne Psychology Clinic (Level 4, George Swinburne Building, 36 Wakefield Street, ph: 9214 8653). In addition, the Australian Psychological Society’s Find-A-Psychologist service (http://www.psychology.org.au/findapsychologist/) can be used to locate a psychologist based in your local area. Students who are studying through Open Universities Australia (OUA) are also able to access free OUA student counselling services (ph: 1300 923 804 or email: counselling@open.edu.au).

In the event of a crisis note that Lifeline can be contacted for support on 13 11 14. If you are concerned that this study will distress you and unsure that you will be able to access support if this occurs, please do not participate.

If you would like further information on this research project, please contact:
James Collett, Doctoral Candidate, BA309, Swinburne University Hawthorn, jcollett@swin.edu.au

If there are any questions involving this study please contact:
Prof. Greg Murray, Swinburne University of Technology, PO Box 218, Hawthorn, Victoria 3122, ph: (03) 9214 8300 or email gwm@swin.edu.au

This project has been approved by or on behalf of Swinburne’s Human Research Ethics Committee (SUHREC) in line with the National Statement on Ethical Conduct in Human Research (2007). If you have any concerns or complaints about the conduct of this project, you can contact:
Research Ethics Officer, Swinburne Research (H68), Swinburne University of Technology, PO Box 218, Hawthorn, VIC 3122; ph: (03) 9214 5218 or email resethics@swin.edu.au

Please click Start to begin the experiment.

Note that your completion of the task and questionnaire package and the submission of your results will be taken as your implied consent to participate in this study.
Debriefing Statement

Thank-you for your participation in this research project! With your help, our research team will be able to examine how mood variability relates to the way in which people pursue short-term goals and make decisions.

This project included an element of deception that was not outlined in the initial information statement. This debriefing statement has been prepared to explain this deception to you.

As you will recall, during the study you were informed that for obtaining a high score across the final three computer tasks (the box-selection task, the balloon task, and the card-selection task) you would receive a chocolate bar. However, all participants are being awarded chocolate bars. The research team sincerely apologises for this element of deception.

But why was this deception judged to be necessary? The computerised tasks that you completed were to examine goal-oriented motivation – that is, in what way and with what intensity do you pursue rewards? One way of looking at reward is think of it internally – this is when motivation come from within, such as when individuals experience feelings of satisfaction or pride for achieving something. Another way of looking at reward is to think of it externally – this is when people are rewarded through compensation from outside sources, such as receiving a gift voucher for spending a certain amount on your credit card. Both internal and external rewards motivate people to achieve their goals.

In this experiment, it was important that we made individuals as motivated as we could to want to do well at the computerised tasks, so that the tasks became as similar to a real-life reward situation as possible. Hence, the competitive aspect of receiving the chocolate bar acted as an internal source of reward, whilst receiving the chocolate bar itself acted as an external source of reward. However, given that all participants have kindly volunteered a similar amount of their time in participating in the experiment, and because the computerised tasks involve a high element of chance, in the interests of fairness all participants are being provided with a chocolate bar.

We hope that you understand why this element of deception was necessary. If you were upset by this aspect of the study, please provide feedback to Swinburne University of Technology’s Research Ethics Office (ph: 9214 5218 or email: resethics@swin.edu.au).

Thank-you for your participation in this study!
Appendix 6: Ethics Proposal, Participant Information and Consent Form, and Ethics Approval for Study 3
Declaration of Adherence to Ethical Standards: Study 3

In submitting this thesis as a requirement for the Doctor of Philosophy (Clinical Psychology) program at Swinburne University of Technology, I declare that:

1. Ethical standards were upheld in the conducting of this research;
2. All conditions pertaining to ethics clearance were properly met;
   and
3. All final reports to the Swinburne University Human Research Ethics Committee have been submitted.

Signed:

James Collett

29/04/2016
Dear Greg and James

SUHREC Project 2012/287 Trait Mood Variability and Susceptibility to Behavioural Change following Mood Induction

Professor Greg Murray, Mr James Collett, Dr Conrad Perry; FLSS
Approved Duration: 09/01/2013 To 01/04/2014 [Adjusted]

I refer to the ethical review of the above project protocol by Swinburne's Human Research Ethics Committee (SUHREC). The responses to the review, as emailed on 6 January 2013 with attachments including revised appendices, were put to a SUHREC delegate for approval. The delegate would like to thank you for a concise and clear response to the SUHREC review. I am pleased to advise that, as submitted to date, the project may proceed in line with standard on-going ethics clearance conditions here outlined.

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the National Statement on Ethical Conduct in Human Research and with respect to secure data use, retention and disposal.

- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator/supervisor requires timely notification and SUHREC endorsement.

- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants and any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.

- At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project.

- A duly authorised external or internal audit of the project may be undertaken at any time.

Please contact the Research Ethics Office if you have any queries about on-going ethics clearance, citing the SUHREC project number. Copies of clearance emails should be retained as part of project record-keeping.

Best wishes for the project.

Yours sincerely,

Sheila
for Keith Wilkins
Secretary, SUHREC
**HUMAN RESEARCH ETHICS COMMITTEE**  
**APPLICATION FOR ETHICS APPROVAL**  
**of a**  
**RESEARCH PROTOCOL**  

### 11.13. SECTION A: GENERAL INFORMATION

*Nb This application form should not be used for research involving clinical trials or ionising radiation. See below.*

<table>
<thead>
<tr>
<th>PROJECT FULL TITLE</th>
<th>Trait Mood Variability and Susceptibility to Behavioural Change following Mood Induction</th>
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<tbody>
<tr>
<td>SHORT TITLE</td>
<td>Trait Mood Variability and Decision-Making on a Gambling Task</td>
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<td>(If applicable)</td>
<td>(this title will be used on the informed consent statement)</td>
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<tr>
<th>RESPONSIBLE SWINBURNE FIRST INVESTIGATOR / SUPERVISOR</th>
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<tbody>
<tr>
<td>Name &amp; Title/Position: Professor Greg Murray</td>
</tr>
<tr>
<td>Tel No(s): 9214 8300</td>
</tr>
<tr>
<td>Email: <a href="mailto:GWMurray@groupwise.swin.edu.au">GWMurray@groupwise.swin.edu.au</a></td>
</tr>
<tr>
<td>Faculty / School / Centre / Institute: Faculty of Life &amp; Social Sciences</td>
</tr>
<tr>
<td>Swinburne Status: ☒ Swinburne Staff Member ☐ Adjunct Staff Member</td>
</tr>
<tr>
<td>Address for correspondence: PO Box 218 John St., Hawthorn, 3122</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main Student Investigator(s): James Collett</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email: <a href="mailto:jcollett@swin.edu.au">jcollett@swin.edu.au</a></td>
</tr>
<tr>
<td>Tel No(s): 04 1712 4032</td>
</tr>
<tr>
<td>Student ID Number: 4162293</td>
</tr>
<tr>
<td>Fax: N/A</td>
</tr>
<tr>
<td>Degree Being Undertaken: Doctorate of Philosophy (Clinical Psychology)</td>
</tr>
</tbody>
</table>

Please complete as clearly as possible. (For Honours, higher degree and)

List below the names of other Chief/Associate Investigators and Research Assistants (including those with access to identifiable data).
(Add (copy/paste) cells as required for additional investigators/assistants. Append Student lists for class projects.)

**Name & Title:** Dr. Conrad Perry, Senior Lecturer

Institutional Address: FLSS, Swinburne University of Technology, Internal Mail H99 (ATC Level 9)

Tel No(s): 9214 8363

Email: cperry@groupwise.swin.edu.au

<table>
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<th>Proposed Period During Which Human Research Activity Requiring Ethics Approval is Needed:</th>
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[Double-click on ☑ YES/NO ‘check box’ to select box, then enter Default Value as Checked ☒ or leaving as Not Checked □ ]
### 11.13.1. Broad Category of Research

Select one category box which best fits the application:

- Social/Cultural/Humanities
- Business/Management
- Education/Training/Program Evaluation
- Psychological/Brain/Neuro-sciences
- Health/Safety
- Engineering/Science/Technology
- Other (please specify) ……………………………………………………

[** For research involving Clinical Trials or Ionising Radiation, please contact the Research Ethics Officer.]

### 11.13.2. Human Research Risk/Review Classification (Nb Checking to be consistent with published risk criteria. *)

To enable a determination as to whether prima facie your research activity is Minimal Risk and/or Low Impact, please clarify by selecting [X] any one or more boxes below as to whether your research activity involves:

[Double-click on YES /NO 'check box' to select X by entering in Default Value as Checked ☑ or leaving as Not Checked ☐]

- Vulnerable participants, children or those dependent on care*
- Externally funded research requiring HREC-level clearance*
- Research conducted overseas
- Data access/use without an individual’s prior consent*
- Identification of participant individuals/groups in research outcomes without full consent or there is unclear consent for this*
- Sensitive information/issues vis-à-vis context/impact (legal*, regulatory compliance*, commercial, professional, cultural, etc)
- Personally intrusive/confronting or quite inconvenient/embarrassing questioning or other activity
- Physically confining/invasive techniques or significant physical contact/stimulation (TMS*, X-ray*, CT scan*, MRI*, clothing change, etc)
- Working in hazardous environments (asbestos dust*, infectious disease*, war or civil strife*, etc)
- Handling hazardous substances (eg, asbestos*, radioactive material*, explosives*, etc) or equipment
- Administration of medical/herbal substances*/treatments*
- Administration of other (non-medical) substances/treatments

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<tr>
<th>TYPE OF ACTIVITY</th>
<th>Research by Staff Member</th>
<th>Contract Research (Attach copy of contract)</th>
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<td>(Select as many boxes as applicable)</td>
<td>☑ Supervised Postgraduate Research</td>
<td>☑ Supervised Undergraduate Research</td>
</tr>
</tbody>
</table>

No of students involved:

Subject Code & Short Title:
Participants will complete a mood induction procedure wherein they receive false feedback regarding their performance on a cognitive task, consistent with the paradigm used by Farmer et al. (2006) and Roiser et al. (2009). Participants will be fully debriefed regarding this use of deception at the close of the experiment.

In addition, participants will not be informed (a) which mood induction condition they have been allocated to, and (b) that the experiment is using a mood induction procedure, until they are debriefed following their completion of the experiment. It is established practice to administer mood induction procedures implicitly (i.e., without explicitly informing the participant of the aim of the mood induction) because awareness of the intent of the mood induction may result in the participant readjusting their mood in a compensatory manner, attenuating the mood induction affect (Roiser et al., 2009; Schwarz, 1990).

References:


This study is being undertaken as a course requirement for the completion of the Doctor of Philosophy (Clinical Psychology) postgraduate degree. The study will also make a novel contribution to psychological science by adopting an integrated approach to investigating cognitive and affective features of the *trait of mood variability*. It is important to note that, although this personality trait is associated at its clinical extreme with bipolar disorder (Depue, Krauss, Spoont, & Arbisi, 1989), and the study's findings will have implications for pathological mood states, the present study uses a normal population sample and will not recruit participants at the clinical extreme of the trait. Similarly, although the study’s specific hypotheses derive from literature investigating clinically significant bipolar disorder, the present study aims to extend these findings back into the normal population by investigating correlates of the normal range trait of mood variability. The background and rationale of the study's scientific aims are summarised below. This study outline overlaps with a second study also being conducted for the student researcher’s Doctor of Philosophy (Clinical Psychology), namely, *The Effect of Trait Mood Variability on Risk-Taking and Cognitive Flexibility*.

Bipolar disorder is an affective disorder characterised by extreme fluctuations in mood; at clinical levels, these mood states are termed mania and depression (American Psychiatric Association, 2000). However, many researchers now view mood variability as an important affective phenomenon that is also present in the non-psychiatric population and characteristic of normal mood (Depue, Krauss, Spoont, & Arbisi, 1989; Murray, Goldstone, & Cunningham, 2007). This *trait mood variability* has been successfully and meaningfully examined in non-clinical participants, although the reasons behind such mood variability and its relationships with other personality traits remain poorly understood (Carver & Johnson, 2009; Depue, Krauss, Spoont, & Arbisi, 1989).

A promising candidate variable potentially influencing trait mood variability (in terms of both mood fluctuation and the experience of depressed or elevated moods) is sensitivity to reward (Alloy et al., 2008), commonly studied within the conceptual framework of reinforcement sensitivity theory (RST; Gray, 1972). Gray’s (1972) RST proposes two main neurobehavioural motivational systems: a Behavioural Activation System (BAS), and a Behavioural Inhibition System (BIS). BAS is a goal-oriented, appetitive motivational system that is responsive to potential rewards and also stimuli associated with the active avoidance or cessation of punishment (Heubeck, Wilkinson, & Cologon, 1998). BIS is a threat-oriented, aversive motivational system that is responsive to punishment and frustrative non-reward, and promotes actions such as ceasing behaviours that are not readily reinforced (Heubeck, Wilkinson, & Cologon, 1998).

Although it is difficult to separate trait and state (i.e., transient or temporary) effects when examining trait mood variability, at the trait’s clinical extremes theorists have suggested that BAS hypersensitivity may explain the intense and excessive fluctuations in mood that individuals with bipolar disorder experience (Alloy et al., 2008). BAS hypersensitivity theory postulates that individuals with bipolar disorder undergo excessive BAS activation (e.g., drive for reward) in response to goal-salient events, inducing a manic state. Conversely, individuals with bipolar disorder who undergo excessive BAS deactivation (e.g., frustrated attempts to obtain a reward) are likely to experience a depressive state (Alloy et al., 2008). Support for BAS hypersensitivity/dysregulation in bipolar disorder has been shown on a consistent basis and is consistent with the clinical phenomenology of bipolar disorder (for a review, see Alloy, Abramson, Urošević, Bender, & Wagner, 2009). In addition, similarities between BAS and mood phenomenology have been found in electro-encephalographic research, and it would appear that similar neurotransmitter systems propagate both goal-oriented motivation and the excessive affective states characteristic of bipolar disorder (Carver, Johnson, & Joorman, 2008), providing biological evidence for an association between BAS and trait mood variability, and further strengthening the hypothesis that the two phenomena are related.
In a real-world context, settings that by definition involve BAS and BIS processes are situations with an element of risk, where the potential for gain (BAS-driven) needs to be balanced by the potential for loss (BIS-driven). Computerised risk-taking tasks have been used to examine risky decision-making in bipolar disorder (Holmes et al., 2009). However, it remains difficult to discern whether risky decision-making is influenced by trait or state effects. Despite the utility of using trait questionnaires to assess aspects of trait mood variability across both clinical and subsyndromal samples (Depue, Krauss, Spoont, & Arbisi, 1989), and whilst BAS hypersensitivity has been observed on a trait basis and remains characteristic of bipolar disorder even during euthymic periods of normal mood (Alloy et al., 2006; Alloy et al., 2009), mood state variability remains a defining characteristic of both trait mood variability and bipolar disorder, and it is unequivocal that the clinical extremes of mania and depression are accompanied by pronounced changes in affect, thought, and behaviour (Goodwin & Jamison, 2007).

As such, to be confident in the inferences that will be drawn from the data provided in the companion project Trait Mood Variability: An Investigation of its Effects on Risk-Taking and Cognitive Flexibility, it is necessary to examine how trait mood variability moderates susceptibility to mood-induced behavioural change, and how risk-taking behaviour varies in the context of different moods. A variety of mood induction methodologies have been used in psychological research; these methods include reflective memory, affective picture slideshows, and the presentation of audiovisual clips, all of which have their strengths and limitations. However, an alternative method, mood induction via false feedback on a cognitive task, is most appropriate to the present study as it matches the other section of the experiment (also a cognitive task) and has been previously used in the investigation of clinical bipolar disorder (Farmer et al., 2006; Roiser et al., 2009).

The false feedback mood induction paradigm used by Farmer et al. (2006) and later modified by Roiser et al. (2009) essentially consists of a brief cognitive task wherein participants are provided with feedback that they had performed well, regardless of actual performance. This feedback is provided in the form of auditory feedback (chimes for “correct” responses) during the task and a written message (for example, stating that the participant had performed “very fast”) following the task. The assumption of this mood induction protocol is that when an individual perceives that they have excelled at a task, it will induce a positive mood. Neither Farmer et al. nor Roiser et al. applied their methodology to the induction of a negative mood state (due to their exclusive interest in cognitions associated with mania); however, consistent with the mechanism for false feedback inducing a positive mood, it is reasonable to surmise that providing feedback that the participant has performed poorly will induce a negative mood.

The proposed experiment will investigate the relationship between trait mood variability and susceptibility to mood-induced changes in risky decision-making behaviour, using self-report questionnaires, a false feedback mood induction procedure, and a computerised cognitive risk-taking task. Three mood induction conditions (Positive, Negative, and Neutral) will be implemented in a mixed within-between group design consisting of two repeated measures groups (Positive-Neutral and Negative-Neutral). Non-clinical participants will be recruited and rated on a validated quantitative self-report measure of trait mood variability. The core research questions addressed by the study are as follows:

1. Are individuals more likely to engage in greater risk-taking following a positive mood induction, and does this differ as a function of trait mood variability? It is hypothesised that individuals will exhibit greater risk-taking in the Positive Mood Induction condition, but will be more cautious in the Negative Mood Induction condition. It is also hypothesised that individuals higher in trait mood variability will be more susceptible to behavioural change following the Positive Mood Induction, with an interaction present between level of trait mood variability, risky decision-making, and mood induction condition.

2. How are trait mood variability, BAS and BIS drives, and risky decision-making interrelated? It is hypothesised that higher trait mood variability will be associated with greater risk-taking on the computerised cognitive decision-making task. This research question is also examined more fully in the accompanying study Trait Mood Variability: An Investigation of its Effects on Risk-Taking and Cognitive Flexibility, and as such this experiment will serve as a partial replication of that study.
References:


In plain English

The study (refer to Figure 1) uses a mixed repeated measures and between-groups design. Participants will be randomly allocated to either Condition 1, where they will complete the risk-taking task under a Positive Mood Induction procedure and a Neutral Mood Induction procedure, or Condition 2, where they will complete the risk-taking task under a Negative Mood Induction procedure and a Neutral Mood Induction procedure. Participant completion of the testing procedure is projected to take approximately 45 minutes. A sample of convenience will be recruited by online advertisement of the project and psychology students at Swinburne will be recruited via the Research Experience Program (REP) and advertisement prior to lectures. Individuals participating in Trait Mood Variability and Susceptibility to Behavioural Change following Mood Induction will be a separate sample from those who participate in Trait Mood Variability: An Investigation of its Effects on Risk-Taking and Cognitive Flexibility.

Note that although a repeated measures design where participants complete both Positive and Negative conditions would be technically preferable to minimise inter-individual effects, this is infeasible due to uncertainty regarding the effect of administering multiple mood inductions of different valences within a single protocol. There is a paucity of published data concerning (a) the duration and time course (on an affective level rather than in terms of measurable electrophysiological responses) of an induced mood under controlled or standardised conditions, (b) the precise relative strength of different mood valences and the ability of one mood to override and replace another (for example, mood may be continuous in strength rather than categorical in nature, with alteration attempts needing to reflect this), and (c) the ability of an individual to become habituated, and accordingly, desensitised to mood induction techniques across repeated exposures. Hence, it has been judged necessary to compare positive and negative mood valences between groups, however the neutral mood induction has been included as a within-group variable to establish a mood baseline. A description of the design of the current study is depicted in Figure 1.

Self-report questionnaires.

The questionnaire battery will be administered using the Opinio and Inquisit software applications. The General Behaviour Inventory (GBI; Depue et al., 1989) and BIS/BAS Scales (Carver & White, 1994) will be included in the questionnaire battery (these questionnaires are described below).

Prior to and following completion of the cognitive task battery, participants will complete the Positive Affect and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) to allow measurement of the effectiveness of the mood induction procedure, to permit statistical control of mood as a mediator of reward sensitivity effects, and to test the degree to which a participant’s prior mood affects their responsiveness to the mood induction.

Mood induction.

Mood induction will be accomplished using a computerised false feedback task, in a similar manner to the mood induction procedure used by Farmer et al. (2006) and Roiser et al. (2009). The adapted false feedback task is outlined in the following section. Although alternative mood induction techniques (namely reflective memory, affective...
pictures, and use of audio/video clips) have been used in a number of previous studies, the use of a false feedback task was judged to be most desirable for the present study due to its similarity to the other cognitive task (increasing face validity and allowing for better integration with the testing procedure).

Participants will be randomly allocated to either the Positive, Negative, or Neutral Mood Induction condition once they have volunteered to participate in the study. The participants will not be informed of the mood induction condition to which they have been allocated. This is necessary because cueing the participant toward the source of their mood risks attenuating the mood induction effect, as explicit awareness of the intended mood state may cause the participant to readjust their mood in a compensatory manner (Schwarz, 1990).

The risk-taking task.

Following the mood induction, participants will complete the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), a risk taking task commonly used as a behavioural measure of BIS/BAS processes. The BART has been designed to more closely reflect real-life escalation of risk, using a dynamic algorithm that means that as the participant’s score becomes higher, the probability of loss also increases (with the participant limited in their ability to individually control the amount of score that they could lose). The balloon metaphor central to the BART also makes the nature of the task immediately recognisable to most participants, circumventing the confounding speed-of-learning effects that have been ascribed to alternate risk-taking tasks. Following completion of the BART, participants will once again complete the PANAS, in order to examine the stability of the mood induction effect and the degree to which the induced mood is modulated by performance on the BART.
Figure 1. Flowchart describing the research protocol of the project.

References: See the Procedures section below.

11.13.6. A3  HOW - PROCEDURES
Please detail clearly and sufficiently the proposed research/statistical method(s), procedures and instruments to be used in the project, including all screening and research 'procedures' to which the participants will be subjected, and asterisk those which may have adverse consequences. Please include as appendices all screening instruments, questionnaires, interview protocols etc (at least in draft form if not finalised).

**The Trait Questionnaire Battery.**

The entire study protocol will be administered online. Participants will first complete two scales in an online questionnaire (hard copies of the scales are appended to this application):

i) **The General Behaviour Inventory**, a 73-item measure of trait bipolarity with subscales assessing mania, depression, biphasic symptoms, and mood lability (Depue, Krauss, Spoont, & Arbisi, 1989).

ii) **The BIS/BAS Scales**, a 24-item measure of sensitivity to rewarding and threatening stimuli and situations (Carver & White, 1994). The BAS factor is broken down into three subscales – Drive, Fun Seeking, and Reward Responsiveness. Although the BIS factor was originally viewed as holistic (Carver & White, 1994), more recent studies have separated BIS into two factors, BIS (reflective of anxiety) and Fight-Flight-Freezing System (FFFS; reflective of fear), consistent with modern revisions of RST (e.g., Beck, Smits, Claes, Vandereycken, & Bijntebier, 2009).

**Quantitative Assessment of Mood State.**

The **Positive Affect and Negative Affect Schedule** is a 20-item measure assessing (a) Positive Affect, a pleasant state of high energy and full concentration, with low scores suggesting sadness and lethargy, and (b) negative affect, an unpleasant state encompassing generally aversive moods, with low scores indicating a state of calm (Watson, Clark, & Tellegen, 1988). Participants will rate the degree that they are experiencing each item at the present moment. In addition, a simple visual scale where participants rate their overall mood from 0 (extremely negative) to 10 (extremely positive) will also be included with the PANAS.

Further scaled questions focusing on motivation, optimism, and overconfidence will also be administered with the PANAS in order to check for the presence and degree of the positive cognitive distortions (such as the illusion of control over chance events) that characterise clinical mania (an extreme of trait mood variability). The PANAS and accompanying state questions are appended to this ethics application.

**The Balloon Analogue Risk Task (BART).**

The BART (Lejuez et al., 2002) involves a computer simulation representing a balloon being inflated with a pump that the participant controls. Each time that the participant inflates the balloon, a set monetary reward of one (virtual) cent is deposited into a temporary reserve (the hypothetical bank balance). However, the balloon is capable of popping due to overinflation. The probability of overinflation increases with each pump. Initially, the balloon has a 1 in 128 chance of popping, however this continues to decrease to 1/127, 1/126, and so forth until on the 128th pump there is a 1/1 probability of the balloon exploding. Using this algorithm sets the average breaking point for the balloon at 64 pumps – hence, although the probability of success per individual trial is
randomly computer-generated, across trials the BART rewards the participant’s ability to maintain a balance between caution and excessive risk-taking. The participant can choose to abandon the trial at any time, retaining their score and proceeding to the next trial. As the number of pumps progresses, the amount that the participant has to lose increases whilst the value of the potential reward relative to what they have already accumulated decreases. Participants will be instructed that their goal is to accrue as much money in their hypothetical bank balance as possible.

The False Feedback Mood Induction.

Studies conducted by Farmer et al. (2006) and Roiser et al. (2009) both used false feedback on a short cognitive task as a means to examine positive mood induction effects in bipolar disorder and to investigate how participants with bipolar disorder differed from non-psychiatric controls. The present study will implement a modified form of this mood induction that makes use of an initial “practice” trial to establish a (false) reference point to allow the participant to gauge how pleased they are with their performance. This is important as it helps to control for varying expectations of the task’s difficulty (for example, a participant may believe that most participants are “very fast” or score greater than 90%).

The basic principle behind the false feedback mood induction paradigm is that a participant initially completes several trials of a decision-making task as neutral practice trials, and then completes another series of trials where they are rewarded with false feedback as to their success (e.g., sounds indicative of successful responding, favourable percentile feedback following the task), irrespective of actual performance. Both Farmer et al. and Roiser et al. used an adapted five-choice serial reaction time “Go” task as part of their mood induction paradigm. However, these authors only validated the mood induction in terms of positive valence. Following the same paradigm rationale, the present study will emphasise use of the initial practice trials as a baseline, with the valence of mood induction being determined by the degree to which the false feedback differs from this baseline. Participants will not be informed of the intention of the false feedback task during the experiment as conscious awareness risks attenuating the mood induction effect (Schwarz, 1990).

All participants will be informed that their correct response rate (CRR) following the practice trials was 48.2%. Following the second series of trials, participants in the Positive Mood Induction condition will be informed that their CRR was 87.5%, participants in the Negative Mood Induction condition will be informed that their CRR was 26.8%, and participants in the Neutral Mood Induction condition will be informed that their CRR was 48.7% (note that this is slightly different to the practice value in order to avoid arousing participant suspicion). In a similar manner, all participants will be provided with feedback that their response speed was “Moderately Fast” following the practice trials, however following the second series of trials they will either be informed that their response speed was “Very Fast” (Positive), “Moderately Fast” (Neutral), or “Slow” (Negative) dependent on the mood induction condition. CRR and response speed messages will always be congruent with the mood induction condition (for example, all individuals in the Positive Mood Induction condition will be informed that their CRR was 87.5% and that their response speed was “Very Fast”).

The results will be analysed using regression and analysis of variance techniques. For
certain hypothesis tests, the sample will be divided into high versus low groups based on trait bipolarity score in order to maximise sensitivity in detecting a significant effect.

References:


If you feel that it is necessary to include further material, please append.

**11.13.7. A4 DESCRIBE ANY RISK THAT MAY ARISE TO THE PARTICIPANT / DONOR?**

Risk to participants (and to researchers) can be real but does not need to be physical. Risk includes such as self esteem, regret, embarrassment, civil or criminal liability, disease, physical harm, loss of employment or professional standing, etc. Please consider such possibilities carefully.

Some research activities may put the participant at risk through what is being done or simply through their participation.

Please describe the risk you perceive and the protective measures to be taken.

No foreseeable risk to the participants is associated with this project. Neither the task nor the questionnaires are likely to elicit distress. Debriefing regarding the false feedback will be presented to the participant immediately upon completing the experiment.

**11.13.8. A5 DESCRIBE ANY RISK THAT MAY ARISE TO THE RESEARCHER / ADMINISTRATOR?**
Some research activities may put the researcher at risk through what is being done or simply through their participation. Please describe the risk you perceive and the protective measures to be taken.

This project holds no risks for the researcher.

11.13.9. A6 WHAT BENEFITS ARE ANTICIPATED FROM THE PROJECT

Ethical principles would require that benefits flowed from the activities - but please avoid grandiose claims.

(a) To the Participant (what and how so)

Participants will benefit from an increased understanding of psychological research, and through their participation will gain an understanding of how psychometric and behavioural research designs operate.

(b) More generally (to society, profession, knowledge, understanding, etc, and how so.)

Expanding the present knowledge base regarding bipolar vulnerability and the mechanism for mood lability in bipolar disorder will ultimately allow for more accurately focused preventative therapies and screening/monitoring of at-risk cases.

11.13.10. A7 POTENTIAL PROBLEMS

From time to time in the course of a research project important information, such as an individual found to be at risk, or entirely unforeseen events may come to pass. What procedures are in place to handle unexpected or particularly significant personal or other information that may come to light through the project, eg, unknown medical/psychiatric condition, a particularly distressed participant, civil or criminal liability, etc.

Whilst such an event is judged to be unlikely, should a participant become distressed in the process of participating in the study (before, during, or after) they will be able to access Swinburne’s student counselling service, Swinburne Psychology Clinic, or Lifeline as appropriate.

11.13.11. A8 PROFESSIONAL/ETHICAL ABILITY & TRAINING

(Researchers/Students/Assistants)

NS 1.15 Research must be conducted or supervised only by persons or teams with experience, qualifications and competence appropriate to the research … using (appropriate) facilities … (and with appropriate skills and resources for dealing with any contingencies…

(a) Sufficiently detail what investigators/assistants will do in this project and their expertise/competence to do so.

The investigator will be required to set up the online implementation of task. The role of the investigator will also involve ensuring that the anonymity, confidentiality, and integrity of the stored data are maintained. The investigator’s previous training in communication, research, and ethical considerations has adequately prepared him to carry out these tasks.

(b) Sufficiently detail any further training/qualifications required for investigators/assistants to carry out the project.

No further training is necessary to facilitate completion of this research project.

11.13.12. A9 FUTURE USE OF DATA

Will any of these data be used by yourself, your students or others for any purpose other than for this project as described in the protocol? If so please describe.

The data collected in the course of the present research project will only be used directly for the present thesis project, and scientific publications arising from the thesis project.

11.13.13. A10 EXTERNAL INVOLVEMENT

Is a body external to Swinburne involved in initiation or support of the project?

☐ Yes Name of body/organisation.  .................................................................
If an external body is associated with the project you must provide the HREC with detail of the arrangements, including details of any funding or other resources being provided. A copy of relevant pages from the contractual arrangements should be attached.

☐ No

Projects involving other organisations or entities may require approval from other institutions or their ethics committees, etc. for such things as access to prospective participants, contact lists, data, facilities, etc. A copy of such approvals may be required to be provided to the HREC at the time of application or be made available as soon as possible. In which case, the project may not commence, until such evidence is provided.

Please indicate, as appropriate, if formal clearance/permission has been obtained or sought:
Institutional Yes ☐ Documentation Attached ☐ or to follow ☐
Next of Kin (for special groups) Yes ☐ Documentation Attached ☐ or to follow ☐
(estimate when likely to be obtained)

☐ N/A
☐ No (please explain)

11.13.15. A12 RESEARCHER / SPONSOR RELATIONSHIP
Is there any relationship or association between the sponsor and any of the researchers listed in Section A of this form, for example are any of the researchers directors, officers, employees, shareholders or promoters of the sponsor or do they receive any personal benefits from the sponsor under any other contracts or arrangements?
☐ No
☐ Yes (please explain the relationship(s), including how a vested or a conflict of interest situation does not arise.)

11.14. SECTION B: ETHICAL ISSUES OVERVIEW

11.14.1. B ETHICAL ISSUES

[Double-click on ☐ YES/NO 'check box' to select box, then enter Default Value as Checked ☒ or leaving as Not Checked ☐]

(a) Non-/Limited Disclosure or Deception: Is any detail in relation to research purposes, methods or questions being withheld from participants? Or will deception of any kind be involved? Or any covert/undeclared observation? (Refer National Statement Chap 17)

(b) Does the data collection process involve access to confidential personal data (including access to data provided for a purpose other that this particular research project) without the prior consent of subjects?

(c) Will participants have pictures taken of them, e.g., photographs, video recordings? If "YES", please explain how you intend to retain confidentiality and ultimately dispose of the material.

(d) If interviews are to be conducted, will they be recorded by electronic device? If "Yes", please explain how you intend to retain confidentiality and ultimately dispose of the material.

(e) Will participants be asked to perform any acts or make statements which might compromise them, diminish self esteem or cause them embarrassment or regret (minimal, moderate or significant)?
Might any aspect of your study reasonably be expected to place the participant at risk of criminal or civil liability (not just immediately or directly)?

Might any aspect of your study reasonably be expected to place the participant at risk of damage to their professional/social/cultural/financial standing or employability?

Will the research involve access to data banks subject to privacy legislation?* (NOTE: Annual reporting to Government may be required on this item. For info: please contact the Research Ethics Officer.)

Will participants come into contact with any equipment which uses an electrical supply in any form e.g., audiometer, biofeedback, electrical stimulation, magnetic stimulation, etc.? If "YES", please outline below what safety precautions will be followed.

Will any treatment be used with potentially unpleasant or harmful side effects?

Does the research involve any stimuli, tasks, investigations or procedures which may be experienced by participants as stressful, noxious, aversive or unpleasant during or after the research procedures?

Will the research involve the use of placebo control conditions or the withholding/substitution of treatment, programs or services (health, educational, commercial, other)?

Will any samples of body fluid or body tissue be required specifically for the research which would not be required in the case of ordinary treatment?

Will participants be fingerprinted or DNA "fingerprinted"?

Are there in your opinion any other ethical issues involved in the research?

NOTE: If the answer to any of the above questions is "yes", please explain and justify below in sufficient clear detail. (The box below will expand to fit your response.)

The deception and temporary (duration of the experiment) non-disclosure is necessary to allow the mood induction technique to operate at full effectiveness.

Attach further documents if appropriate

11.15. SECTION C: PARTICIPANT DETAILS

11.15.1. C1 PARTICIPANT DETAILS
The composition of the participant group may, in some circumstances, distort and invalidate an outcome, and risks may arise through the composition of the participant group.

How many individual participants will be involved?  (Number/number ranges for which approval is sought)

Males: 50-75  Females: 50-75  Total participants 100-150

Over what range of ages?
From (youngest): 18  To (Oldest): 70

If there is a gender or age imbalance in the number of participants please explain why.

A gender-balanced sample is desirable for this project, however it is not integral to the design and participants will not be screened or excluded on the basis of gender.

11.15.2. C2 RECRUITMENT
How will participants be recruited/selected?

Please outline the process in sufficient detail how this is to occur.

Note: Where participants are obtained from or through schools, hospitals, prisons or other institutions, appropriate institutional or other authority will probably be needed. If soliciting for participants by advertisement or poster please attach proposed copies or text.
Participants will be recruited in two ways:

i) Students in the Open Universities Australia subject PSS120 Introduction to Psychology 2 will have the option of participating in the study as part of a teaching exercise. The participants will use a subset of the data from the study to write a research report for course credit. Those who do not volunteer to participate will not be disadvantaged, however those who participate will gain experience participating in a cognitive task.

ii) Other participants will be recruited via advertisement to second-, third-, and fourth-year psychology students (at Swinburne University of Technology Hawthorn), email contacts, social networking sites, community message-boards, and acquaintances of the experimenters.

Prospective participants will be provided with a URL address taking them to an information statement and online version of the task. Submission of the data following completion of the task will be taken as implied consent to participate in the experiment.

11.15.3. C3 PRE-EXISTING CONDITIONS

In some situations an underlying medical or other significant condition of a participant may result in an otherwise relatively innocuous situation causing excessive stress and exacerbate the condition. Researchers must, therefore, be alert to such situations and be able to address the resulting issues.

Do participants have any medical or other significant condition of which you are aware, eg. diabetes, asthma, depression, epilepsy? What steps are in place to handle any resulting problems (you may need to correlate with A3, A4 and A7 of this form)?

If an unexpected psychological or physiological problem were to occur during the study, the university counselling and medical clinic information supplied in the consent statement can be referred to.

11.15.4. C4 DISCLOSURE AND INFORMED CONSENT

How will participants be informed about the project in order to give valid consent:

☑ Consent Information Statement(s)/Letter(s) and Signed Consent Form(s) will be used. A copy must be attached to your application. A guide to consent instruments is given at the end of this form.

☑ Consent Information Statement(s)/Letter(s) and consent implied by return of anonymous questionnaire

☐ Verbal advice (Please explain how and why)

☐ Other (Please explain how and why)

Consent to participate in the experiment will be recorded using a signed consent form. The participants will be provided with an information sheet outlining the procedure and goals of the project and reminding them of their ethical rights. This sheet will also be emailed to them for their consideration before consenting to participate in the experiment.

Copies of appropriate consent instruments must be attached to your application. Please consult the Guide to Human Research Informed Consent Instruments in carefully preparing informed consent instruments.

11.15.5. C5 COMPENSATION

Consent to participate must be freely given and not induced through the level of reward, perceived reward, or power relationships.
Provide details of any financial or other reward or inducement is being offered to subjects for participation. Indicate the source of the funds.

Participants will not be financially compensated or otherwise rewarded for participation in this experiment.

### 11.15.6. C6 RELATIONSHIP TO INVESTIGATOR(S)
Free consent may be difficult to ensure if the participant is dependent upon the investigator for employment, assessments etc.

Some relationships cause special ethical issues to arise

Are participants linked with the investigator through some particular relationship - eg. employees ultimately responsible to or superiors of the investigator, students of investigator, family members, friends etc.

Participants enrolled in psychology at Swinburne University may come into contact with the investigators as all three are teaching staff. All participants will be informed that their acceptance or refusal to participate in the project will in no way impact the grading of their assessment tasks submitted as a student in their course.

### 11.15.7. C7 INVOLVEMENT OF SPECIAL GROUPS

Particular issues of consent may arise where special groups of participants are to be involved. There may be, for example, a need to obtain informed consent from persons other than the direct participant. Examples of such special groups include:

- special cultural groups - eg. indigenous Australians;
- children and young persons (Guidelines section 4.2);
- groups with special circumstances - eg. persons with an intellectual or mental impairment (Guidelines s. 5)

Please identify and describe the nature of the groups and procedures used to obtain permission.

Note. Persons proposing research projects involving Indigenous Australians should consult with the relevant University manager of indigenous programs prior to finalising definition of the project.

No special groups are participating in this research project.

### 11.15.8. C8 PRIVACY

The University is subject to the Victorian Information Privacy and Health Records Acts as well as the Commonwealth Privacy Act and, in particular, the Information/Health/National Privacy principles (IPPs/HPPs/NPPs) set out therein and is required to report annually on projects which relate to or utilise particular records.

Does the research involves access to data which was collected by an organisation for its own purposes (ie. not specifically collected for this project) such as student records, other data banks, human pathology or diagnostic specimens provided by an institution/s?

If yes, please indicate source/s.

No external data is being utilised in this project.

### 11.15.9. C9 LOCATION OF STUDY

Please indicate where the research will be carried out. If the research will not be on University premises permission of owner / occupier may be required. If so, please indicate what authority or permission may be required and how will be obtained. **NB**: Where required, please attach to this application evidence of authority obtained or provide the Secretary, HREC as soon as practicable.

The study will be offered online and participants will complete the experiment wherever they are able to access a computer with an internet connection.

### 11.16. SECTION D: DATA & PUBLICATION ARRANGEMENTS

(Nb Section D Revised Aug 2007)

PLEASE CONSIDER CAREFULLY YOUR RESPONSES TO THIS SECTION. YOU NEED TO BE CLEAR AS TO WHAT IS OCCURRING WITH RESPECT TO DATA COLLECTION, RETENTION and DISPOSAL.
11.16.1. D1 DATA COLLECTION/RECORDING (Nb Section D1 Revised Aug 2007)

Please note that, with any information or data collected/retained, if any individual can reasonably be identified, the information can be deemed “personal information” or “health information” under National/Health/Information Privacy Principles (NPPs/HPPs/IPPs).

(a) How or in what form will data be collected/recorded?

(eg, notes; verbatim, audio and/or video recordings; transcriptions of recordings; recorded or signed consents; etc)

Data from the experiment will be collected via computer and stored electronically in a password-protected form. An informed consent statement will be presented to the participant prior to the commencement of the experiment. Consent to participate will be implied by submission of the data following completion of the experiment.

(d) As regards any individual, in relation to any data collection or retention, you need to acknowledge either or both of the following:

[Double-click on ‘check box’ to select X by entering in Default Value as Checked ☑ or leaving as Not Checked ☐]

☐ An Individual can be identified OR is Potentially Identifiable / Re-Identifiable

(An individual can be identified at some point or by the very nature of the data collected/retained: at time of an interview, by signed consent form, identified or labelled voice or image recording, pen-and-paper questionnaire, on-line survey instruments, etc.
Whilst data may not have (explicit) identifiers, an individual’s identity can still reasonably be worked out.

Or data may have (explicit) identifiers removed and replaced by codes that permit matching of an individual with the data collected/retained, in which case it is possible to identify or re-identify the person to whom the data relates.)

☒ An Individual is Non- or Un-identifiable

(Data collected/retained anonymously and with no reasonable possibility of being identified.)

Your acknowledgement may require further explanation or clarification; if so, please include in the following box.

Participant responses will be recorded under an identification number only, and hence participant data will not be reasonably able to be matched to their identity.

11.16.2. D2 DATA SECURITY (Nb Section D2 Revised Aug 2007)

Please note that “data must be held for sufficient time to allow reference. For data that is published this may be for as long as interest and discussion persists following publication. It is recommended that the minimum period for retention is at least 5 years from the date of publication but for specific types of research, such as clinical research, 15 years (or more) may be more appropriate.” (Sect 4.3 of Swinburne’s Policy on the Conduct of Research)

Please indicate how data (all types of data, including, eg, signed consent forms) will be securely retained (eg, electronic form in password-protected disk drive, locked filing cabinet, etc) and where?

With more than one type of data, will the types be separately stored?

In your explanation, you will need to make clear how due confidentiality and/or anonymity will be maintained.

(a) During the study
Data will be stored in a password-protected data file on the main hard-drive at Swinburne University of Technology.

(b) Following completion of study

All information related to the study will be stored securely on a password protected data file on the Swinburne main drive. Data will be held for a minimum of 7 years post publication.

11.16.3. D3 PUBLICATION/OUTPUT (Nb Section D3 Revised Aug 2007)

Please explain in sufficient detail:

(a) What, if any, publication (conference, news media, academic journal, other journal, etc) is envisaged following on or in relation to this project, both in terms of data proper and/or analysis of data?

(b) Will participants be informed about any envisaged research publication/outcome? (This information is normally to be included in the information given prior to obtaining informed consent.)

(c) Would any participants be able to be identified through the publication of data proper or research findings? If so, explain why this is necessary.

(a) Publication may occur in one or more international refereed journals in which no identification of individuals will be possible.

(b) Participants will be informed of this during the informed consent process.

(c) Participants would be completely unidentifiable through the publication of data or research findings.

11.16.4. D4 INDIGENOUS ISSUES

Storage arrangements for data relating to research into Indigenous matters must be determined in compliance with the Policy on the Conduct of Research after consultation with the communities involved.

What consultation has taken place and what arrangements have been made.

N/A

11.16.5. D5 OTHER ISSUES (Nb Section D5 Revised Aug 2007)

Are there any other issue relating to data collection, retention, use or disclosure which the ethics committee should be made aware of and, if so, please explain how you are to deal with this.

(Eg, Research outcomes unduly impacting on any individual or group not directly participating, etc.)

N/A

11.17. SECTION E: SUBSTANCES & CLINICAL ISSUES

☒ No matters in this section are applicable to the study

11.17.1. E1 ADMINISTRATION OF SUBSTANCES/AGENTS

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<td>Frequency of administration</td>
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<td>Total amounts to be administered</td>
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Anticipated effects:
NOTE: If the research involves administration of foreign substances or invasive procedures, please attach a statement accepting responsibility for those procedures by a medical or paramedical practitioner with Indemnity insurance. STATEMENT ATTACHED

11.17.2. E2 BODY FLUIDS OR TISSUE

What fluids or tissue? How will be samples be obtained?

Frequency and volume

How are samples to be stored?

How will samples be disposed of?

Who will take the samples?

What are their qualifications for doing so?

Do participants carry, as far as you know, the Hepatitis B or HIV virus? If so how will the risks be handled

Do participants carry, as far as you know, any other contagious diseases or viruses? If so how will the risks be handled

11.18. SECTION F Declarations for Signature

1. With respect to this project, I/We, the undersigned Investigator(s)/Assistant(s) agree:
   - To undertake human research activity or handle data confidentially in accordance with Swinburne requirements, including any standard or special ethics clearance conditions, under the proper direction of the responsible Swinburne manager and/or principal Swinburne (or other) researcher/supervisor.

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All listed applicants must sign. The Chief Investigator/Supervisor is also responsible for personnel subsequently joining the project. Expand this table or duplicate this page as required. NB This information is subject to Swinburne or external audit.

**Please note that**

PROJECTS MUST NOT COMMENCE WITHOUT PRIOR WRITTEN APPROVAL from the Human Research Ethics Committee (SUHREC) or its appropriate Subcommittee (SHESC)

2. Declaration of Compliance by Chief Investigator(s)/Student Supervisor(s).
I declare that the above project has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice, including any standard or special conditions for on-going ethics clearance. I further declare that all listed and subsequently appointed researchers or assistants involved in this project will be made aware of the conditions of ethics approval as communicated to me, including approved documentation and procedures.

Signature & Date: ...............................................................

.......  
Name of Signatory & Position: ...............................................................

......

(Optional) Form checked by a Research & Ethics Advisor (REA)?  Yes ☐  No ☐  REA Initials & Date: ..............................

3. Endorsement of Head of Academic Unit (or Delegate) or Above.
I declare that this project: has been developed and will be conducted in accordance with relevant Swinburne standards, policies and codes of practice; and has research merit, adequate resourcing and appropriate leadership/supervision.

Signature & Date: ...............................................................

......  
Name of Signatory & Position: ...............................................................

......
(Please note: This endorsement must be given by an authorised official who is not also a chief or co-investigator of the project and who is not also the supervisor of a student investigator with an interest in the project.)
Thank you for your interest in participating in this study. The aim of this study is to investigate the ways in which sensitivity to rewarding stimuli and sensitivity to threatening stimuli are associated with personality traits such as mood variability. This will be accomplished using two computerised tasks and two self-report questionnaires.

Participation will involve the completion of two cognitive tasks (that are repeated once each) and two self-report questionnaires. The cognitive tasks will involve (a) reacting to a series of stimuli as quickly and as accurately as possible, and (b) attempting to obtain as high a score as possible on a task in which you are awarded points for inflating a digital representation of a balloon. The questions that you are asked will consist of basic personal information (e.g., gender, age, employment status) and questions about your thoughts, feelings, behaviours. The entire process should take approximately 60 minutes. Please do not participate if you believe that the nature of the tasks or questions is likely to cause you distress.

Your participation in this study is completely voluntary. Your initial agreement of participation in this study does not stop you from discontinuing participation and you are free to withdraw at any time. Choosing not to participate in the project will not have any impact on the way your academic assessments are graded in your course.

The results of this investigation will be presented in a doctoral thesis as an assessment requirement in the completion of the student investigator’s Doctor of Philosophy (Clinical Psychology) qualification. Only group data will be presented and no individuals will be identified if the results of this study are published in a scientific journal.

If you have any psychological or physiological concerns during the course of this study then the following are the contact details for support services that you may find helpful:

Open Universities Australia Student Counselling Service
Phone: 1300 923 804
Email: counselling@open.edu.au

Hawthorn Counselling Service
36 Wakefield Street (corner Wakefield & John Streets)
Service hours are usually 9am - 5pm weekdays
Phone: 9214 8025
Fax: 9214 5993

Hawthorn Medical Service
McLeod Lane (Between John and William Streets Hawthorn)
Health Service Building
Room: SH102
Ph: 9214 8483
Fax: 9818 7548
Lilydale Counselling Service
Student Centre Reception
Phone: 9215 7101
Fax: 9215 7070

Lilydale Medical Service
Room LD108
Ph: 9215 7106
Fax: 9215 7070

Even if you are not a student at Swinburne University of Technology, note that low-cost counselling can be obtained from the Swinburne Psychology Clinic (Level 4, George Swinburne Building, 36 Wakefield Street, ph: 9214 8653). In addition, the Australian Psychological Society’s Find-A-Psychologist service (http://www.psychology.org.au/findapsychologist/) can be used to locate a psychologist based in your local area. If you are studying an online psychology unit from overseas or from an isolated location, consider carefully whether participation in this study is likely to cause you distress before participating.

In the event of a crisis note that Lifeline can be contacted for support on 13 11 14. If you are concerned that this study will distress you and unsure that you will be able to access support if this occurs, please do not participate.

If you would like further information on this research project, please contact:
James Collett, Doctoral Candidate, BA309, Swinburne University Hawthorn, jcollett@swin.edu.au

If there are any questions involving this study please contact:
Prof. Greg Murray, Swinburne University of Technology, PO Box 218, Hawthorn, Victoria 3122, ph: (03) 9214 8300 or email gwm@swin.edu.au

This project has been approved by or on behalf of Swinburne’s Human Research Ethics Committee (SUHREC) in line with the National Statement on Ethical Conduct in Human Research (2007). If you have any concerns or complaints about the conduct of this project, you can contact:
Research Ethics Officer, Swinburne Research (H68), Swinburne University of Technology, PO Box 218, Hawthorn, VIC 3122; ph: (03) 9214 5218 or email resethics@swin.edu.au

Please click Start to begin the experiment.
Note that your completion of the task and questionnaire package and the submission of your results will be taken as your implied consent to participate in this study.
Debriefing Statement

Thank-you for your participation in this research project! With your help, our research team will be able to examine how mood variability relates to the way in which people pursue short-term goals and make decisions.

This project included an element of deception that was not outlined in the initial information statement. This debriefing statement has been prepared to explain this deception to you.

As you will recall, during the study you were provided with feedback following the go/no-go task. Although this feedback was presented as if it were accurate, it was in fact preset and not related to your performance on the task. We did not compare participants’ task performance to other participants or previous test data during the experiment. Participants were allocated into groups that either received positive feedback (87.5%, Very Fast) or negative (26.8%, Slow) feedback on one trial of the task, and neutral feedback (48.7%, Moderately Fast) on the other trial.

But why was this deception judged to be necessary? The computerised tasks that you completed were used to examine goal-oriented motivation – that is, in what way and with what intensity do you pursue rewards? However, an experimental setting is only one occasion where goal-oriented motivation takes place, and this occasion might be influenced by your mood at the time of testing. For example, somebody in a more positive mood with regard to the experiment (e.g., confident) might be more willing to take risks, whereas somebody in a more negative mood (e.g., discouraged) might be more cautious. How you act when in a positive or negative mood may not reflect how you normally act.

The aim of this research project was to explore whether mood affects the tendency to engage in more or less risky decision-making during a gambling task. Although it is difficult to change an individual’s mood in an experimental setting, we attempted to use the false feedback that you were given as a way to check whether or not mood had an effect on how you made decisions on the balloon task. We apologise that this deception was necessary, however being conscious that we were trying to place you in a positive or negative mood might have cancelled out any effect from the mood induction.

We hope that you understand why this element of deception was necessary. If you were upset by this aspect of the study, please provide feedback to Swinburne University of Technology’s Research Ethics Office (ph: 9214 5218 or email: resethics@swin.edu.au).

Thank-you for your participation in this study!