FACETS OF POSITIVE AFFECT AND RISK FOR BIPOLAR DISORDER: ROLE OF THE BEHAVIORAL ACTIVATION SYSTEM

Allison Dornbach-Bender

Thesis Prepared for the Degree of

MASTER OF SCIENCE

UNIVERSITY OF NORTH TEXAS

December 2017

APPROVED:

Camilo Ruggero, Major Professor
Jennifer Callahan, Committee Member
Craig Neumann, Committee Member
Vicki Campbell, Chair of the Department of Psychology
David Holderman, Dean of the College of Liberal Arts and Social Sciences
Victor Prybutok, Dean of the Toulouse Graduate School

Dornbach-Bender, Allison. *Facets of Positive Affect and Risk for Bipolar Disorder: Role of the Behavioral Activation System*. Master of Science (Psychology), December 2017, 54 pp., 10 tables, references, 86 titles.

Bipolar disorder is characterized by disruptions in mood and affect that occur not only during mood episodes, but during euthymic periods as well. At the same time, sensitivity of the behavioral activation system (BAS) has been implicated in the disorder and is a risk marker for it. Less clear is the relationship between BAS sensitivity and positive affect, particularly lower level facets of positive affect. The aim of the present study was to examine the relationship between positive affect and vulnerability for mania as assessed using BAS sensitivity. Specifically, the link between daily levels and fluctuations of positive affect and baseline BAS sensitivity was examined. Following the hierarchical model of affect, this study also assessed the relationship between BAS sensitivity and the distinct facets of positive affect. Finally, this study examined whether BAS sensitivity moderates associations between daily rewards and positive affect. Undergraduates (N = 265) from a large university in the South were recruited to complete measures of BAS sensitivity, affect, and mood symptoms at baseline. Using ecological momentary assessment (EMA), participants completed daily surveys assessing affect and engagement with rewarding situations. An exploratory factory analysis revealed a four factor structure of positive affect, consisting of Serenity, Joviality, Attentiveness, and Self-Assurance. Greater daily levels of overall positive affect, as well as the lower order facets of Joviality, Self-Assurance, and Attentiveness, were predicted by heightened BAS sensitivity. In contrast, the facet of Serenity demonstrated minimal associations with BAS sensitivity. The study findings support a multi-faceted structure of positive affect and suggest that certain facets may be more closely related to risk for bipolar disorder. Specifically, Joviality and Self-Assurance may

represent maladaptive forms of positive affect, whereas Serenity may function as a protective element against bipolar disorder.

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CHAPTER 1

INTRODUCTION

Bipolar Disorder

Bipolar disorder is a severe mental illness characterized by extreme fluctuations in mood state. Although the disorder has symptomatic overlap with internalizing disorders (i.e. depression) and thought disorders (i.e., schizophrenia), it is unique due to the presence of severely elevated mood states, i.e. mania and hypomania. The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5*; American Psychiatric Association, 2013) defines a manic episode as persistently and abnormally elevated or irritable mood accompanied by at least three of five symptoms (i.e., inflated self-esteem, decreased need for sleep, pressured speech, racing thoughts, distractibility, increase in goal directed activity, or excessive involvement in activities likely to lead to negative consequences) that last 7 or more days, or require hospitalization. Hypomania, although defined by the same symptomatic criteria, persists for at least four days and generally causes less severe impairment in functioning (e.g., does not require hospitalization; APA, 2013). A diagnosis of Bipolar I disorder (BD-I) requires at least one manic episode. Although depressive episodes are not required to meet criteria for BD-I, they are frequently experienced by individuals with BD-I (Goodwin & Jamison, 2007; Perlis et al., 2006). In contrast, at least one major depressive episode and one hypomanic episode is required for a diagnosis of Bipolar II disorder (BD-II; APA, 2013). In addition to BD-I and BD-II, the DSM-5 recognizes three other disorders that are symptomatically similar to bipolar disorder (i.e., Other Specified Bipolar and Related Disorder, Unspecified Bipolar and Related Disorder, and Cyclothymic Disorder). These disorders all involve periods of elevated mood and are considered part of bipolar spectrum disorders.

According to the World Health Organization (WHO) World Mental Health Survey Initiative, the worldwide lifetime prevalence of bipolar disorder is 2.4%, with BD-I having a lifetime prevalence of 0.6%, BD-II having a lifetime prevalence of 0.4%, and subthreshold bipolar disorder having a lifetime prevalence of 1.4% (Merikangas et al., 2011). Lifetime prevalence rates vary across nations, with the United States and New Zealand having some of the highest rates (4.4% and 3.9%, respectively) and India and Bulgaria demonstrating some of the lowest (.01% and .03%, respectively). The National Comorbidity Survey (NCS) supports the finding of higher rates of bipolar disorder in the United States (Merikangas et al., 2007). The NCS revealed lifetime prevalence rates of 1.0% for BD-I, 1.1% for BD-II, and 2.4% for subthreshold bipolar disorders in the United States.

Despite relatively low prevalence rates in comparison to other mental illnesses (Narrow, Rae, Robins, & Regier, 2002), bipolar disorder is ranked as one of the top 10 causes of disability in the world (Murray & Lopez 1996). It is associated with increased risk of suicide, significant functional impairment, and early mortality. Individuals with bipolar disorder have a 20 – 30 times greater risk of suicide than the general population (Pompili et al., 2013). Further, rates of suicide attempts in bipolar disorder range from 30 – 50%, and rates of death by suicide range from 8 – 20% (Dennehy et al., 2011; Gonda et al., 2012; Medici, Videbech, Gustafsson, & Munk-Jørgensen, 2015). In addition to higher rates of suicide, bipolar disorder is associated with significant neurocognitive impairments (e.g., processing speed, verbal learning and memory) as well as functional deficits in daily living and work performance (Henry, Minassian, & Perry, 2013; Torrent et al., 2012). These deficits are shown to exist not only during mood episodes, but also during euthymic periods (Zarate Jr., Tohen, Land, & Cavanagh, 2000). Finally, individuals with bipolar disorder tend to die an average of 10 years younger than the general population

(Crump, Sundquist, Winkleby, & Sundquist, 2013; Laursen, 2011). The significant functional impairments and mortality rates associated with bipolar disorder underscore our need to better understand factors contributing to the disorder.

The present study therefore aimed to examine several factors that have been implicated in bipolar disorder. Specifically, the present study sought to examine the nature of positive affect and its relationship to the behavioral activation system (BAS), a system repeatedly implicated in the pathogenesis of bipolar disorder. In the following introduction, evidence will be outlined for the role of reward sensitivity and BAS in bipolar disorder, showing how these may reflect risk markers for the disorder. Discussion will follow on affective fluctuations in individuals with bipolar disorder and individuals at risk for the disorder. Although the structure of affect and, more specifically, positive affect, has been researched for decades now, few studies have examined the specific facet structure of positive affect, which may have more direct implications for bipolar disorder. This facet structure and its relation to bipolar disorder will therefore be explored. Finally, the introduction will conclude with a description of EMA methods to probe these issues and their utility for understanding risk factors associated with bipolar disorder.

The Behavioral Activation System (BAS) and Rewards

The BAS is a neurobiological system that was proposed, in conjunction with the behavioral inhibition system (BIS), by Gray (1981, 1987) to describe the approach-avoidance conflict found in the mammalian brain. Using a neurobiological model, Gray outlined the structures and emotion systems responsible for mammal approach and inhibition behavior. As applied to humans, Gray argued that the BIS inhibits behavior based on punishment and non-reward, whereas the BAS stimulates approach behavior in response to rewards and non-

punishment. These two systems work together to regulate behavior. The BIS serves to help an individual appropriately respond to threats and avoid punishment. In contrast, the BAS functions to lead an individual to engage in goal-directed behavior that is most likely to produce a rewards outcome.

The BAS has frequently been implicated in bipolar disorder. The BAS functions with inputs (i.e., stimuli initiating goal-directed behavior) and outputs, with individuals high in BAS sensitivity producing more BAS output than individuals low in BAS sensitivity (Johnson, Edge, Holmes, & Carver, 2012). BAS outputs include increased goal-directed behavior, increased involvement in pleasurable activities, and increased social activity. As described by Depue and Iacono (1989), these BAS outputs show great similarity to manic symptoms. Given this overlap between BAS outputs and manic symptoms, it is theorized that heightened BAS sensitivity is an endophenotype for bipolar disorder (Hasler, Drevets, Gould, Gottesman, & Manji, 2006).

Multiple studies have supported this possible role. For example, Meyer, Johnson, and Carver (1999) followed undergraduate students (n = 357) at high and low risk for bipolar disorder based upon the General Behavior Inventory, a clinical screening measure for mood symptoms. Participants completed the BIS/ BAS scales to determine their trait sensitivity of each of the two systems. Results indicated that BIS sensitivities only correlated with depressive symptoms, not manic ones. In contrast, individuals at greater risk for bipolar disorder demonstrated greater sensitivity of the BAS, with the BAS accounting for 27% of current manic symptoms. This study suggested that individuals who are vulnerable to bipolar disorder may have a heightened sensitivity of the BAS.

Salavert and colleagues (2007) corroborated these findings in a study comparing BAS sensitivity of individuals with bipolar disorder to that of healthy controls. Euthymic participants

with bipolar I disorder (n = 39) demonstrated significantly higher scores on the BAS scale of the BIS/ BAS than healthy controls (n = 38). When participants were re-assessed 18 months later, those who had entered into a depressive episode had lower BAS scores than those who had entered into a manic/ hypomanic episode or remained euthymic. These findings suggest that BAS sensitivity is linked to bipolar disorder and, more specifically, the manic episodes inherent to bipolar disorder. Salavert et al.'s (2007) study also linked bipolar disorder to a greater sensitivity to rewards. Specifically, individuals with bipolar disorder showed significantly higher scores on the Sensitivity to Rewards scale of the Punishment and Sensitivity to Rewards Questionnaire than healthy controls. Further, those who entered into a manic/ hypomanic episode had demonstrated higher Sensitivity to Reward scores 18 months prior than those who entered into a depressive episode.

High BAS sensitivity is not only linked with risk for bipolar disorder, but also to the high goal approach and reward valuation that is commonly observed in bipolar disorder. Using an adolescent sample (N = 290), Alloy and colleagues (2012) separated participants into groups according to BAS sensitivity. At follow up one year later, 12.9% of individuals in the high-BAS sensitivity group had developed bipolar disorder, whereas only 4.2% of those in the moderate-BAS sensitivity group, demonstrating the utility of BAS sensitivity as a risk marker for bipolar disorder. Further, Alloy et al. (2012) found that BAS sensitivity significantly predicted ambitious goal setting. Similarly, high reward responsiveness significantly predicted onset of bipolar disorder, even when controlling for the BAS-determined risk for bipolar disorder. This study not only supports the use of BAS sensitivity to assess risk for bipolar disorder, but also the link between reward sensitivity and bipolar disorder.

Through increased engagement in reward and goal-directed activities, dysregulated BAS sensitivity that is linked to manic symptoms may also be driving dysregulated levels of positive affect in bipolar disorder. Whereas healthy populations tend to experience a steady rise of positive affect in the morning, constant levels from approximately noon to evening, and then a rapid drop in positive affect (Clark, Watson, & Leeka, 1989), individuals with bipolar disorder tend to experience greater variations in their daily levels of positive affect (Henry et al., 2008). In a comparison study of euthymic bipolar disorder (n = 179) and controls (n = 86), Henry et al. (2008) found that the bipolar disorder sample had greater affective lability (i.e., rapid reversals and shifts in affect) and intensity (i.e., level of high or low affect endorsed) than the control sample. While the bipolar sample as a whole endorsed greater affective lability, those who experienced an early age of onset were found to have significantly higher levels of lability than those with a later age of onset. Similarly, affective intensity in the bipolar sample was associated with number of mood episodes, with higher number of mood episodes predicting greater affective intensity. These results suggest that, even when they are not in a depressive or manic mood state, individuals with bipolar disorder experience more affective reactivity than healthy controls.

Similarly, Farmer et al. (2006) conducted a pilot study to evaluate affective reactivity in individuals with bipolar disorder following a positive mood induction. Using a euthymic bipolar disorder sample (n = 15) and a control group (n = 19), Farmer and colleagues measured positive affect before and after a Go Task in which subjects were instructed to press a button as quickly as possible after seeing a stimulus. Test administrators provided feedback to participants that their response time was “very fast.” This feedback was able to successfully induce positive mood

in subjects. Prior to the reward task, the bipolar subjects reported lower levels of positive affect than those in the control group. However, after the reward task, the bipolar group exhibited a prolonged elevation of positive affect whereas the control group's positive affect steadily declined following the task. These results suggest that individuals with bipolar disorder may experience a dysregulation of positive affect following positive events which results in a greater persistence of positive mood relative to healthy controls.

Johnson, Ruggero, and Carver (2005) also found evidence that individuals with symptoms of bipolar disorder experience disruptions in positive affect in response to certain events. Using a student sample (N = 153), Johnson and colleagues measured positive affect and risk for bipolar disorder at baseline followed by positive affect and mood after a computer task with manipulated reward responses. Higher endorsement of hypomanic symptoms and risk for hypomania was associated with higher positive affect at baseline as well as a greater expectancy of success after reward. Individuals with current hypomanic symptoms also experienced greater positive affect after receiving a reward than those without current hypomanic symptoms. Although this study did not use subjects diagnosed with bipolar disorder, its finding that hypomanic symptoms are associated with greater positive affect after rewards may explain some of the situational increases in positive affect in bipolar disorder.

Gruber, Johnson, Oveis, and Keltner (2008) also found a relationship between hypomanic symptoms and positive affect in individuals at risk for bipolar disorder. A student sample of participants (N = 90) watched positive, negative, and neutral film clips and rated their affect following each clip. Gruber et al. (2008) found that subjects who were at higher risk for bipolar disorder, as measured by the Hypomanic Personality Scale, reported higher levels of positive emotion following each of the three film types than did the healthy controls. This finding

suggests that elevations in positive affect may be higher in bipolar disorder and may occur regardless of the situation encountered. That is, even upon encountering a negative stimulus, individuals with bipolar disorder may be prone to higher elevations in positive affect than those without bipolar disorder.

In light of findings that positive affect tends to be elevated in individuals with bipolar disorder, Gruber (2011) developed a theory regarding positive affect in bipolar disorder. Termed Positive Emotion Persistence (PEP), this theory posits that affective dysfunction in bipolar disorder is not only the result of too much positive affect, but also the result of elevated positive affect in response to neutral and negative stimuli. That is, not only are individuals with bipolar disorder prone to have higher baseline levels of positive affect than those without the disorder, but they are also prone to experience elevations in positive affect in situations when other individuals would experience either no change in positive affect or a decrease in positive affect.

Significance of Positive Affect Dysregulation in Bipolar Disorder

Positive affect dysregulation may serve as a risk marker for bipolar disorder. Family, twin, and adoption studies have shown that bipolar disorder is highly heritable, with heritability rates ranging from 59% to 87% (Smoller & Finn, 2003). In particular, children of a parent with bipolar disorder are up to 4 times more likely to develop a mood disorder than those without a parent with bipolar disorder (Lapalme, Hodgins, & LaRoche, 1997). Given the highly heritable nature of bipolar disorder, multiple studies have therefore explored the relationship between positive affect dysregulation and risk for bipolar disorder. As noted previously, Gruber et al. (2008) found that individuals at higher risk for bipolar disorder had greater elevations in positive affect across contexts. Using a community sample (N = 54), Hofmann and Meyer (2006) also

found evidence for a link between risk for bipolar disorder and disruptions in positive affect. Participants completed a 28-day daily diary involving mood and affect questionnaires as well as the Hypomanic Personality Scale at baseline to assess risk for bipolar disorder. Participants who had greater risk for bipolar disorder demonstrated significantly greater symptoms of mania and overall higher positive affect levels than those at low risk. Further, those at higher risk for bipolar disorder also had greater fluctuations in positive and negative affect. These results suggest that affective disruptions may be indicative of an increased vulnerability for bipolar disorder.

Understanding of the nature of affective disruptions in bipolar disorder may also serve as a predictor of future mood episodes. Using a daily assessment method, Gershon and Eidelman (2015) explored the predictive nature of affective intensity and instability in bipolar disorder. Individuals with bipolar I disorder who were currently euthymic (N = 27) completed measures of positive and negative affect once a day for an average of 49 days. Three months after the baseline assessment, participants were also administered mood and functional impairment measures. Results indicated that even when controlling for concurrent symptom levels, individuals with greater negative and positive affect during the daily assessment period had greater depressive symptoms at follow-up. Further, greater negative affect and more unstable affect was predictive of greater functional impairment at follow-up. These results indicate that affective intensity and instability, even during euthymic periods, may serve as predictive indicators of future depressive symptoms and functional impairment in bipolar disorder.

Despite a growing literature exploring positive affect disruption in bipolar disorder, all of the above studies have assessed positive affect as a unitary construct. However, as reviewed in

the next section, positive affect may have multiple facets, with risk for bipolar disorder only being associated with some of these facets.

Structure of Affect

All of the aforementioned literature involving positive affect evaluated positive affect as a singular construct. However, multiple structures of affect have been proposed, including structures in which positive affect is broken down into different facets. In order to better understand the nature of positive affect dysregulation in bipolar disorder, it is therefore necessary to have an understanding of the overall structure of positive and negative affect. Several primary models of the structure of affect have been proposed and debated in the literature (Barrett & Russell, 1999; Dillard & Meijnders, 2002). The first and earliest model suggests that the two constructs of well-being, termed positive and negative feelings, are statistically independent (Bradburn, 1969). Rather than viewing positive and negative affect as negatively correlated with one another, this model holds that positive affect and negative affect are two separate constructs that are completely uncorrelated with one another. However, recent evaluations of Bradburn's methods suggest that his findings may have been the result of not properly accounting for personality aspects as well as improperly quantifying positive and negative experiences (Warr, Barter, & Brownbridge, 1983). In light of such critiques regarding the correlated nature of positive and negative affect, various other structures of affect have been proposed.

Green, Goldman, and Salovey (1993) directly challenged Bradburn's (1969) findings with their assertion that positive and negative affect are bipolar in nature. Using a multimethod design with a student sample, they found that positive and negative affect are negatively correlated with one another. Green and colleagues' resulting bipolar model of affect suggests

that positive and negative affect are perfectly negatively correlated with each other and therefore cannot be independent in nature. They cited random and systematic measurement errors as leading to findings in which positive and negative affect are independent. As such, Green et al.'s model suggests that positive and negative affect cannot be experienced simultaneously.

The third leading model of affect is the circumplex structure of affect proposed by Russell (1980). Using a multimethod, multisample approach, Russell was able to consistently find support for a circular model of affect. This model places highly related affective variables (e.g., sad and gloomy) close to each other on the circumplex's circumference, unrelated variables (e.g., aroused and satisfied) 90 degrees apart, and inversely related variables (e.g., displeasure and pleasure) 180 degrees apart. Yik, Russell, and Steiger (2011) later built upon this model to add multiple dimensions of mood. By conducting four correlational studies and cross-validating results, Yik et al. developed a 12-Point Affect Circumplex (12-PAC) model of affect. This model, while foundationally similar to Russell's 1980 model, further incorporated levels of activation. That is, positive affect can range from low levels of activation (e.g., tranquil) to high levels of activation (e.g., energetic). Similarly, negative affect can be expressed in states of low activation (e.g., sluggish) and high activation (e.g., frenzied). According to Yik et al.'s model, all values to the right of the vertical axis represent some form of positive affect, with higher activation appearing at the top and lower activation at the bottom, and all values to the left representing negative affect. Therefore, this model conceptualizes affect not only in terms of the two factor structure of affect, but also in terms of activation level.

The final model was proposed in response to Green's assertion that positive and negative affect are perfectly negatively correlated. Watson and Tellegen (1985) developed a factor model of affect by factor analyzing self-reported mood from seven studies. Their analyses suggested a

two-factor structure of affect, with positive and negative affect forming uncorrelated dimensions. Specifically, positive and negative affect consistently emerged as the two factors when using a varimax rotation in orthogonal factor analyses as well as in oblique factor analyses. In regards to findings that positive and negative affect are negatively correlated, Watson and Tellegen suggest that the terms used to study affect may in fact influence the structure correlations. They argued that using terms such as pleasant and unpleasant will lead to negatively correlated factors, whereas more affectively separate terms will lead to orthogonally related factors. In later analyses, Tellegen, Watson, and Clark (1999) conducted an exploratory analysis which supported the previously developed factor model of affect. In Tellegen et al.'s (1999) analysis, the authors not only found support for the two-factor model of affect, but also a hierarchy of affect with happiness and unhappiness forming one dimension, relatively independent positive affect and negative affect forming another dimension, and more circumscribed and discrete affects forming a base dimension.

As assessed with the hierarchical model, the higher order level of affect represents specific affect valence (i.e., positive vs. negative; Watson, Clark, & Stasik, 2011). In contrast, the base dimension of affect represents the specific type and quality of the valence. In order to further evaluate these base dimensions of positive and negative affect according to the hierarchal model of affect, Watson and Clark (1994) developed the Positive and Negative Affect Schedule – Expanded Form (PANAS-X). Repeated factor analyses of affective terms led to the creation of the following lower order dimensions, or facets, of affects: Fear, Sadness, Guilt, Hostility, Shyness, Fatigue, Surprise, Joviality, Self-Assurance, Attentiveness, and Serenity. The facets of Joviality, Self-Assurance, and Attentiveness have consistently loaded onto the general dimension

scale of positive affect across studies (Ready et al., 2011; Stanton & Watson, 2015; Watson & Clark, 1999), suggesting these three facets make up the lower order dimension of positive affect.

Implications of the Various Models of Affect

Although several different models of affect have been proposed, recent analyses seem to support the assertion that positive and negative affect are relatively independent factors (Cropanzano, Weiss, Hale, & Reb, 2003). Hence, individuals are able to experience positive and negative affect simultaneously. Further, according to the commonly used hierarchical model of affect, positive affect consists of the following lower-order facets: Joviality, Self-Assurance, and Attentiveness. The facet of Serenity has loaded onto the dimension of positive affect in recent studies, suggesting it may also represent a lower-order facet of positive affect (Gilbert et al., 2009; Stanton & Watson, 2015). However, few studies have explored how these different facets of positive affect interact with psychopathology.

One of the few studies was conducted by Stanton and Watson (2015) to assess the structure of positive affect at the facet level and the various facets' relations to certain psychiatric disorders. Using both an online community sample (n = 451) and an undergraduate sample (n = 436), the authors conducted a factor analysis of multiple affect measures to determine the facet structure of positive affect. This factor analysis revealed the following two facets of positive affect: Joviality and Experience Seeking. The Joviality facet shared content with the PANAS-X facet of Joviality (e.g., delighted, overjoyed, excited), whereas the Experience Seeking facet shared content with the PANAS-X Self-Assurance facet (e.g., bold, daring, fearless). When regressions were conducted between the facets and symptoms, the authors found that Experience Seeking was a more maladaptive type of positive affect, showing strong positive correlations

with manic and externalizing symptoms. Conversely, Joviality showed stronger associations with internalizing and schizotypal symptoms. This study demonstrates that multiple types of positive affect exist, with certain types being more closely linked to bipolar disorder than others.

Stanton, Stasik-O'Brien, Ellickson-Larew, and Watson (2016) conducted a similar study to examine the relationship between the PANAS-X facets of positive affect (i.e., Joviality, Self-Assurance, Attentiveness, and Serenity) and psychopathology. A community sample of 225 people completed the PANAS-X as well as multiple measures of symptoms and psychopathology. The authors then conducted multiple regressions to determine the relations between each facet and symptoms of psychopathology. Results revealed that the facets of positive affect show unique patterns of relations with psychiatric disorders. Specifically, it was found that Self-Assurance and Joviality show positive associations with manic symptoms, while Serenity and Attentiveness show negative associations with manic symptoms. These findings further suggest that multiple types of positive affect not only exist, but also show unique associations with bipolar disorder.

Ecological Momentary Assessment

One potentially promising method for understanding the role of positive affect in bipolar disorder is through Ecological Momentary Assessment (EMA), also referred to as daily diary assessment, experience sampling, or ambulatory assessment. EMA is a method of gathering data in real-time and in natural settings (Shiffman, Stone, & Hufford, 2008; Stone, Shiffman, Atienza, & Nebeling, 2007). EMA methods involve repeated collection of data from a participant as they are living in and engaging with their natural surroundings. EMA methods typically function by prompting the participant to complete a survey at selected times throughout the day. Because

participants are being surveyed during their everyday lives, ecological validity is greatly increased via EMA methods. Additionally, since this technique asks participants about their current state, it eliminates concerns of recall bias. Finally, EMA methods provide researchers with an abundance of naturalistic longitudinal data and an increase in within-subjects sample size.

Ecological Momentary Assessment with Bipolar Disorder

EMA methods have been explored in bipolar disorder samples. For instance, Schwartz, Schultz, Reider, & Saunders (2016) sought to examine the feasibility of EMA methods in a pilot study using a sample of individuals with bipolar disorder. Participants were instructed to complete auto-generated surveys on their smartphones twice a day for fourteen days. Using a bipolar disorder group (n = 10) and a healthy control group (n = 10), the researchers compared completion rates of the various EMA surveys, which measured mood, energy, speed of thought, impulsivity, and social stress. Results indicated that the two groups did not differ in overall median completion rates of the surveys. Therefore, this pilot study suggests that EMA methods are a valid method of data collection in a bipolar disorder sample.

EMA methods have also been used in multiple studies to evaluate positive and negative affect in bipolar disorder. For instance, a 2010 study by Havermans, Nicolson, and Berkhof aimed to assess mood reactivity in bipolar disorder in response to daily events, particularly extremely positive or negative events. Participants, who included healthy controls (n = 38) as well as individuals diagnosed with BD-I or BD-II who were in remission (n = 38), completed self-report questionnaires ten times a day for six days. Multilevel regression analyses were performed to compare the mean affect levels and affect reactivity of individuals with bipolar

disorder to those of the healthy controls. Results found that affect reactivity was not significantly different in the two groups following positive and negative daily events. However, individuals with bipolar disorder had overall higher negative affect levels and lower positive affect levels than the healthy controls. These results contrast with previous findings such as Gruber's (2011) Positive Emotion Persistence theory. As noted by the authors, the finding of lower positive affect in the bipolar group may be due to methodological differences such as the higher age of participants used in this sample.

Affect levels and reactivity were also examined using EMA methods in a 2003 study conducted by Myin-Germeys et al. In addition to healthy controls (n = 49), this study included remitted participants diagnosed with bipolar disorder (n = 38) as well as major depressive disorder (MDD; n = 46) and non-affective psychosis (n = 42). Participants rated their affect and experience of stress ten times a day for six days. Multilevel analyses revealed that individuals with bipolar disorder endorsed significantly greater decreases in positive affect when experiencing stress than the healthy controls. However, individuals with bipolar disorder did not show any significant differences in negative affect when stressed. These results, as well as the results of the Havermans, Nicolson, and Berkhof (2010) study, indicate that affect in bipolar disorder is susceptible to fluctuations in response to daily events.

Gruber, Kogan, Mennin, and Mirray (2013) conducted a study to explore daily levels of emotionality and emotion regulation. Healthy controls (n = 32) and individuals with remitted bipolar disorder (n = 21) and major depressive disorder (n = 21) completed assessments of emotionality and emotion regulation once a day for six days. Participants completed the modified differential emotion scale, which assesses ten different positive emotions and eight negative emotions. Four different methods of emotion regulation were also assessed each day.

Results found that individuals with bipolar disorder reported higher levels of daily positive emotionality and similar levels of daily negative emotionality when compared to the MDD group. Individuals with bipolar disorder also engaged in greater emotion regulation strategies than those in the control group. This finding may reflect an attempt to regulate the heightened levels of emotionality experienced in bipolar disorder.

In summary, the EMA findings surrounding daily positive affect in bipolar disorder have been mixed. For instance, Havermans, Nicolson, and Berkhof (2010) found that individuals with bipolar disorder experience lower overall positive affect levels than healthy controls. In contrast, Gruber, Kogan, Mennin, and Mirray (2013) found that individuals with bipolar disorder experienced similar levels of daily positive affect as healthy controls and significantly greater levels when compared to an MDD group. Regarding reactivity of positive affect to daily events, Havermans, Nicolson, and Berkhof (2010) found that affect reactivity in bipolar disorder did not significantly differ from that of a healthy control population in response to both positive and negative daily events. In contrast, Myin-Germeys et al. (2003) found individuals with bipolar disorder experience significantly greater decreases in positive affect following stress than healthy controls. These mixed findings support the need for further research of positive affect in bipolar disorder using EMA methods.

Present Study

There are several major limitations in the current literature on positive affect in bipolar disorder. Specifically, few studies have assessed daily levels and fluctuations of positive affect using EMA methods in a bipolar disorder or bipolar-vulnerable sample. Similarly, few studies have examined the effects of stress on mood, and no EMA study has examined the effect of daily

rewarding events on positive affect. Moreover, none have assessed the extent to which bipolar disorder or risk for it moderates this relationship. Further, multiple studies have examined positive affect levels in individuals with bipolar disorder and individuals at risk for bipolar disorder, but few have examined the relationship between bipolar disorder or risk for bipolar disorder and specific facets of positive affect, and none have done so using EMA.

The present study therefore aimed to address these gaps in the literature by examining positive affect facets in relation to daily rewards in an undergraduate sample assessed based on level of risk for bipolar disorder as indexed by BAS sensitivity. The main innovations of this study were assessments of specific positive affect facets, not just overall positive affect, as well as the use of EMA methods to collect data at multiple time points in the participant's natural surroundings. Further, by exploring the relationship between bipolar disorder risk markers and positive affect facets, this study sought to help clarify the role that positive affect facets play in the development and course of bipolar disorder. Increased understanding of positive affect's role in bipolar disorder may lead to future targets for clinical interventions.

Research Aims and Hypotheses

Given the multiple structures of positive affect that have been proposed, the first aim of this study was to examine the overall structure of positive affect. It was hypothesized that a four factor structure would emerge. Consistent with the Stanton, Stasik-O'Brien, Ellickson-Larew, and Watson (2016) findings, factors were expected to consist of Joviality, Self-Assurance, Attentiveness, and Serenity.

The second aim was to assess the link between baseline BAS sensitivity, a hypothesized vulnerability for mania, and daily levels and fluctuations of positive affect. The literature

indicates individuals with and at risk for bipolar disorder experience greater levels of positive affect as well as greater variability in positive affect (Farmer et al., 2006; Gruber et al., 2008; Gruber, 2011; Johnson, Ruggero, and Carver, 2005). However, EMA studies of bipolar disorder have produced mixed findings regarding daily levels of positive affect in bipolar disorder relative to healthy controls. The present study attempted to address these contrasting findings by using baseline BAS sensitivity as a vulnerability for bipolar disorder and daily positive affect assessments. Consistent with the extensive non-EMA literature, it was hypothesized that greater BAS sensitivity would be associated with significantly higher daily levels of positive affect. Consistent with both sets of literature, it was hypothesized that greater BAS sensitivity would be associated with significantly greater fluctuations in daily positive affect.

The third aim of this study was to assess the link between bipolar disorder vulnerability, as measured by baseline BAS sensitivity, and distinct facets of positive affect. The literature suggests that bipolar disorder and BAS sensitivity are characterized by disruptions in positive affect. However, few studies have examined the disruptions in positive affect at the facet level. It was hypothesized that certain facets of positive affect would be more closely associated with baseline BAS sensitivity. Specifically, it was hypothesized that BAS sensitivity would be associated with daily levels of Self-Assurance and Joviality facets of positive affect, but would be less strongly related to Attentiveness and Serenity facets. This hypothesis was consistent with the Stanton, Stasik-O'Brien, Ellickson-Larew, and Watson (2016) findings in which the facets of Self-Assurance and Joviality were positively associated with symptoms of mania.

The fourth and final aim of this study was to determine whether BAS sensitivity moderates associations between daily rewards and positive affect facets. It was hypothesized

that high BAS sensitivity would lead to greater elevations in Self-Assurance and Joviality in response to daily rewards.

CHAPTER 2

METHODS

Participants

Participants (N = 265) were recruited from Sona Systems, an online research participation pool for students enrolled in undergraduate psychology courses. Participants received experimental credit for their psychology courses in exchange for participation in the study. Participants were 66.4% female, 50.9% Caucasian, 26.4% African-American, 28.7% Hispanic, 6.8% Asian, and 12.1% Other, and ranged in age from 18 to 37 years (M = 19.87, SD = 2.41). Participant demographics, as presented in Table 1, reflected demographics of students at this university generally, where the student population was approximately more than 50% females; age ranged primarily from 18 to 25; and racial demographics were approximately 60% Caucasian, 15% African-American, 15% Hispanic, 5% Asian, and 5% Other.

Procedures

Informed consent was obtained prior to participation in the study. Participants completed the informed consent process in-person during the baseline assessment visit. Participants were provided time to read the informed consent form and ask any questions. If participants chose to participate, they provided a signature acknowledging they had read the informed consent form. If they chose not to participate, they declined to sign the form and the visit ended. Upon providing informed consent, participants completed baseline self-report measures. Baseline measures took approximately 90 minutes to complete. After completing the questionnaires, participants were provided instructions and a practice session regarding how to complete the

ecological momentary assessment measures. Participants then received an email notification three times a day for seven days prompting them to complete the online survey measures.

Baseline Only Measures

Behavioral Inhibition System/ Behavioral Activation System (BIS/BAS) Scale

The BIS/BAS scale was developed to measure the two motivational systems that are thought to influence behavior and affect: the behavioral inhibition system (BIS) and the behavioral activation system (BAS; Carver & White, 1994). The measure consists of 20 statements to which the respondent rates their agreement on a 4 point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree). The measure produces a total of four scales, with one scale representing the BIS and three scales representing the different aspects of the BAS (i.e., Reward Responsiveness, Drive, and Fun Seeking). The BIS/ BAS has exhibited adequate validity and reliability in the BIS scale (Cronbach's $\alpha = 0.76$) and the overall BAS scale (Cronbach's $\alpha = 0.83$; Jorm et al., 1998). BIS and BAS internal consistencies were generally high in the current study ($\alpha = .70$ and .81, respectively). Additionally, the three subscales of the BAS have demonstrated adequate internal consistencies, with Reward Responsiveness achieving a Cronbach's α of 0.65, Drive achieving a Cronbach's α of 0.80, and Fun Seeking achieving a Cronbach's α of 0.70. In this sample, Reward Responsiveness achieved a Cronbach's α of 0.71, Drive achieved a Cronbach's α of 0.78, and Fun Seeking achieved a Cronbach's α of 0.63.

Types of Positive Affect Scale

The Types of Positive Affect Scale (TPAS) is an 18-item self-report measure designed to measure various types of positive affect (Gilbert et al., 2008). The measure consists of 18 words

that describe different positive emotions. Participants rate each word on a Likert scale from 0 (not characteristic of me) to 4 (very characteristic of me). The measure yields three lower-order scales, or facets, of positive affect: active positive affect, relaxed positive affect, and safe/ warmth positive affect. The TPAS has demonstrated good retest reliability for the active and safe/ warmth facets (r = .84 and r = .77 respectively) but poor retest reliability for the relaxed facet (r = .34), perhaps due to the measure assessing for trait positive affect instead of state positive affect. The TPAS does demonstrate good internal consistency, with the active scale showing a Cronbach's α of .83, the relaxed scale showing a Cronbach's α of .83, and the safe/warmth scale showing a Cronbach's α of .73. For this study, the TPAS was used to assess baseline positive affect only. Because some TPAS items are the same as PANAS-X items, seven TPAS items were removed to avoid repetition. Overall TPAS internal consistency was very high in the current study (α = .90). In the current sample, the active scale demonstrated a Cronbach's α of .87, the relaxed scale demonstrated a Cronbach's α of .83, and the safe/warmth scale demonstrated a Cronbach's α of .76.

Baseline and Daily Measures

Inventory of Depression and Anxiety Symptoms, expanded version

Mood and anxiety symptoms were assessed at baseline using the Inventory of Depression and Anxiety Symptoms, expanded version (IDAS-II; Watson et al., 2012). The IDAS-II is a 99-item self-report questionnaire assessing symptoms on a 5-point Likert scale ranging from *not at all* to *extremely*. This measure produces 18 symptom scales (i.e., dysphoria, lassitude, suicidality, appetite loss, appetite gain, insomnia, traumatic intrusions, traumatic avoidance, panic, social anxiety, claustrophobia, cleaning, ordering, checking, euphoria, mania, well-being

and ill temper) which have all been well validated (Watson et al., 2007, Watson et al., 2012). At baseline, participants completed the entire IDAS-II and answered items in regards to the last two weeks. Participants additionally completed the euphoria, mania, social anxiety, and general depression scales of the IDAS-II during the daily evening assessments. Participants answered these items in regards to that day. Baseline internal consistency for the IDAS-II scales ranged from $\alpha = .67$ to .91 in the current sample.

Positive and Negative Affect Schedule, Expanded Form

The Positive and Negative Affect Schedule, Expanded Form (PANAS-X) is a 60-item self-report measure designed to assess positive and negative affect (Watson, Clark, & Tellegen, 1988; Watson & Clark, 1994). The measure presents words reflective of positive and negative affect (e.g., afraid, happy, irritable). Participants rate the extent to which they have felt each word during a selected time frame on a scale from 1 (very slightly or not at all) to 5 (extremely). Thus, higher scores are indicative of greater positive and/or negative affect while lower scores are indicative of minimal or absent positive and/or negative affect. The PANAS-X yields 11 facet scales. The facet scales of Fear, Hostility, Guilt, and Sadness are negative affect scales whereas the facet scales of Joviality, Self-Assurance, and Attentiveness are positive affect scales. The facets of Shyness, Fatigue, Serenity, and Surprise have links to both affective states. The PANAS-X has been shown to demonstrate adequate reliability in each of the facets across samples (Cronbach's $\alpha > .70$ for all facets). The full PANAS-X was administered at baseline, and participants responded to items in regards to the last two weeks. Items from the Joviality, Self-Assurance, Attentiveness, and Serenity facets were administered at each daily assessment.

Participants completed these items in regards to how they felt in that moment. The baseline internal consistencies for all facets were generally high in the current study (α = .65 - .92).

Daily Only Measures: Daily Events Survey

A modified version of the Daily Events Survey (DES) was used during the evening assessments in this study. The DES was designed to assess individuals' daily events and their reactions to the events (Butler, Hokanson, & Flynn, 1994). This study included 28 items from the DES that were modified to update language and broaden the types of social interactions. Participants reported whether or not each event occurred during the day and, if the event did occur, they rated their satisfaction with the event on a Likert scale from 1 (negative) to 5 (positive). The DES includes four scales of events: positive achievement events, negative achievement events, positive social events, and negative social events. In the present study, the total number of daily positive events were calculated for each person (M = 4.05, SD = 3.36).These scales have displayed good reliability (Cronbach's α > .70 for all scales; Zeigler-Hill, Myers, & Clark, 2010).

Data Analysis

The first hypothesis of this study was that the overall structure of positive affect consists of four lower order factors. To test this hypothesis, an exploratory factor analysis (EFA) was conducted using baseline PANAS-X and TPAS data to examine the facet structure of positive affect. The factors were examined using an oblique promax rotation. The EFA analysis was conducted in SPSS version 24. Parallel analysis was used to provide an initial determination of the number of factors to be extracted. The parallel analysis used eigenvalues from 100 randomly

generated correlation matrices which were then compared to the eigenvalues in the present dataset. The sample sizes of the randomly generated matrices were the same as the sample size of the present study's sample. Factors with eigenvalues greater than those produced by the random generator were retained.

The second hypothesis of this study was that greater BAS sensitivity would be associated with significantly higher daily levels of positive affect as well as significantly greater fluctuations in daily positive affect. To test this, a hierarchical linear model (HLM; Osborne, 2000) was estimated. In HLM, the level 1 (i.e., within person) equation was:

$$PA_{ij} = \beta_{0j} + \varepsilon_{ij}$$

The level 2 (i.e., between person) equation was:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(BAS) + \mu_{0j}.$$

For the combined model, daily levels of positive affect were a linear function of average positive affect across the sample, baseline BAS sensitivity at the between person level, and random effect terms at both levels. This combined equation was written as:

$$PA_{ij} = \gamma_{00} + \gamma_{01}(BAS) + \mu_{0j} + \varepsilon_{ij}$$

A significant fixed effect coefficient for BAS would support the first part of hypothesis 2 (i.e., higher levels of positive affect). The level 1 within person random effect was correlated with BAS scores to test the second part of hypothesis 2 (i.e., greater fluctuations of positive affect).

The third hypothesis of this study was that greater baseline BAS sensitivity would be associated with daily levels of Self-Assurance and Joviality facets of positive affect, but would be less strongly related to Attentiveness and Serenity facets. To test these hypotheses, the same HLM models as before were run, but the dependent variable was each of the lower order facets

instead of overall positive affect. The standardized coefficients from each of these 4 multilevel models were compared to one another and tested for significant differences.

The fourth and final hypothesis of this study was that BAS sensitivity would moderate associations between daily rewards and positive affect facets. A multilevel model was again estimated, with a cross-level interaction supportive of the hypothesis. For this model, the level 1 (i.e., within person) equation had daily rewarding events added to it:

$$PA_{ij} = \beta_{0j} + \beta_{1j}(\text{Reward Event}) + \varepsilon_{ij}$$

The level 2 (i.e., between person) equation predicted two coefficients:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{BAS}) + \mu_{0j}.$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{BAS}) + \mu_{1j}.$$

The combined equation was written as:

$$PA_{ij} = \gamma_{00} + \gamma_{01}(\text{BAS}) + \gamma_{10}\,(\text{Reward Event}) + \gamma_{11}(\text{BAS*Reward Event}) +$$

$$\mu_{0j}. + \mu_{1j}(\text{Reward Event}) + \varepsilon_{ij}$$

Hypothesis 4 would be supported if the fixed effect coefficient γ_{11} was significantly greater than 0.

Because Hypotheses 2 and 3 required the most rigorous power to detect effects, a power analysis was conducted with respect to these hypotheses' analyses. Using the methods outlined by Pan and McBee (2014), a power analysis for HLM was run in R. Given the variance-covariance matrix in positive affect that has been found in previous EMA data (Dornbach-Bender et al., 2016), it was calculated that a minimum sample size of 150 was required to achieve 0.8 power and a medium effect size (0.20 gamma). Given the sample size of $N = 265$, this study was sufficiently powered to run HLM analyses. All HLM analyses were conducted using PROC MIXED procedure in SAS® 9.4.

CHAPTER 3

RESULTS

Data Cleaning

To prepare for analyses, the baseline and EMA data was examined and cleaned. Variable scores were evaluated for outliers, normality, and other primary test assumptions. At baseline, 265 participants were recruited and completed baseline assessments. However, 5 subjects failed to complete any EMA surveys. Further, 3 subjects were excluded because they completed fewer than 6 of the 21 daily surveys. After removing these subjects, 256 subjects remained. To clean the EMA data, instances in which subjects completed 2 or more EMA surveys within 2 hours of each other were removed. When removing these instances, preference was given to the evening survey, followed by the morning and afternoon surveys, in order to retain as much data as possible. Additionally, for instances in which a subject completed the same EMA survey multiple times, the first survey was retained and the duplicated surveys were removed. After cleaning the EMA data accordingly, 354 daily surveys were removed and a sample of 4,821 daily surveys remained.

The reward responsiveness domain of the BIS/BAS was negatively skewed, with a skewness of -2.16 (*SE* = .15). The baseline BAS scales were therefore transformed by squaring in order to correct for skew (skewness = -1.18, *SE* = .15). Upon completion of these steps, the dataset was considered cleaned and ready for analysis.

Exploratory Factor Analysis

The 24 PANAS-X positive affect items and the 11 TPAS items were submitted together to an EFA with an oblique promax rotation. Parallel analysis suggested extraction of a

maximum of 4 factors. Therefore, one to four factor solutions were examined for interpretability. The first 4 eigenvalues were 12.51, 2.77, 1.93, and 1.64. The 1- and 2-factor solutions explained relatively little variance (i.e., 43% or less). A 3-factor solution explained 49.18% of the variance whereas a 4-factor solution explained 53.90% of the variance. The 3- and 4-factor models diverged with respect to Serenity content, with the 3-factor model spreading Serenity content across the three factors, whereas the 4-factor model included a separate Serenity factor. Given that the 4-factor solution explained more variance and was consistent with previous findings of a distinct Serenity factor (Gilbert et al., 2009; Stanton & Watson, 2015), the 4-factor solution was retained. Its factor loadings are presented in Table 2.

Factor 1 can be understood as a Serenity factor, with content related to being relaxed, at ease, and secure positively loading onto this factor. Factor 2 was found to represent Joviality, with items such as cheerful, energetic, and delighted comprising the factor. Factor 3 was composed of items relating to Attentiveness such as concentrating and interested. Finally, Factor 4 was found to represent Self-Assurance, with variables such as daring, bold, and dynamic positively loading onto this factor. The Joviality and Attentiveness factors had the highest correlations (r = .73), whereas the Serenity and Self-Assurance factors had the lowest correlations (r = .43). Table 3 reports the correlations between all factors.

BAS Sensitivity and Baseline Positive Affect

Next, the relationship between baseline BAS sensitivity and baseline positive affect was explored. Correlation analyses were conducted, and results are summarized in Table 4. Positive affect was positively and significantly correlated with BAS Drive and Reward Responsiveness (r = .26 and .16, respectively). All positive affect facets had significant positive correlations with

BAS Drive (r = .13 to .35), with Self-Assurance demonstrating the strongest correlation. Serenity, Joviality, and Self-Assurance had significant correlations with BAS Fun Seeking (r = .14 to .40), with Self-Assurance again demonstrating the strongest correlation. Finally, Joviality, Attentiveness, and Self-Assurance demonstrated small but significant correlations with BAS Reward Responsiveness (r = .12 to .20).

Baseline Positive Affect and IDAS-II Euphoric Activation

Correlation analyses were also conducted to examine the association between specific positive affect facets and symptoms of mania, as measured by the IDAS-II Euphoric Activation scale. The results of the correlation analyses are presented in Table 5. All positive affect facets were significantly correlated with Euphoric Activation (r = .27 to .51), with Serenity demonstrating the lowest correlation and Self-Assurance demonstrating the highest correlation.

BAS Sensitivity and Daily Overall Positive Affect

HLM analyses were conducted to assess whether individuals' baseline BAS sensitivity would influence daily positive affect levels. Results of the HLM analyses are summarized in Table 6. Daily positive affect levels were found to be a function of baseline BAS Drive (β = .120, p = .007) and Reward Responsiveness (β = .096, p = .030).

A correlation analysis was conducted to examine whether individual positive affect variance was correlated with baseline BAS scores. The correlation results are presented in Table 7. Although positive affect variance was significantly correlated with all BAS scales, the correlations were small (r < .25; Cohen, 1992).

BAS Sensitivity and Daily Positive Affect Facets

HLM analyses were also conducted to assess whether individuals' baseline BAS sensitivity would influence daily levels of the four positive affect facets. The results of these analyses are summarized in Table 8. None of the baseline BAS scales (i.e., Drive, Fun Seeking, Reward Responsiveness) significantly predicted daily levels of the Serenity facet. In contrast, the baseline BAS Drive scale did significantly predict levels of the Self-Assurance, Joviality, and Attentiveness facets (β = .081 to .160, p < .050 to .001), with Self-Assurance showing the strongest effect (β = .160, p < .001). BAS Fun Seeking significantly predicted daily levels of Joviality and Self-Assurance (β = .090 to .120, p = .011 to .044), with Self-Assurance again showing the stronger effect. Finally, BAS Reward Responsiveness significantly predicted daily Joviality and Attentiveness (β = .099, p = .026 and β = .085, p = .035 respectively).

Correlation analyses were run between positive affect facets' variance and baseline BAS scores. The correlation results are presented in Table 9. Significant correlations existed between Joviality and all BAS scales as well as between Self-Assurance and all BAS scales. Further, Serenity and Attentiveness were significantly correlated with BAS Reward Responsiveness, and Attentiveness was significantly correlated with BAS Fun Seeking. However, the correlations were small (r < .27; Cohen, 1992).

BAS Moderation of Daily Positive Affect and Response to Rewarding Events

To test the fourth and final hypothesis of this study, HLM analyses were conducted to assess whether baseline BAS sensitivity would moderate associations between daily rewards and positive affect facets. The results of these analyses are presented in Table 10. There were no significant interaction effects between baseline BAS scales (i.e., Drive, Fun Seeking, Reward

Responsiveness) and daily positive events (β = -.044 to .049, p = .150 to .221). However, the pattern of beta weights indicates that the interaction effects were smallest for Serenity and greatest for Attentiveness and Self-Assurance. Hence, the direction of effects was consistent with hypotheses, but results did not reach level of significance.

CHAPTER 4

DISCUSSION

Previous research has implicated elevated BAS sensitivity as a risk marker for bipolar disorder (Alloy et al., 2012; Meyer, Johnson, & Carver, 1999; Salavert et al., 2007). Further, BAS sensitivity has been linked to the increased goal approach and reward valuation that is characteristic of bipolar disorder (Alloy et al., 2012; Salavert et al., 2007). As it relates to positive affect in bipolar disorder, elevated BAS sensitivity may drive dysregulated levels of positive affect through an increased engagement in reward and goal-directed activities. Multiple studies have found evidence supporting dysregulation (i.e., increased levels, increased fluctuation) of positive affect in individuals with bipolar disorder and at risk for bipolar disorder (Farmer et al., 2006; Henry et al., 2008; Johnson, Ruggero, & Carver, 2005; Gruber et al., 2008; Gruber, 2011). However, few studies have assessed positive affect in bipolar disorder using EMA methods, and those that have done so yielded mixed findings (Gruber, Kogan, Mennin, & Mirray, 2013; Havermans, Nicolson, & Berkhof, 2010; Myin-Germeys et al., 2003). Further, even fewer studies have assessed the relationship between bipolar disorder and positive affect using the lower order facets of positive affect (Stanton & Watson, 2015; Stanton et al., 2016). An examination of these lower order facets may reveal unique associations between bipolar disorder and specific forms of positive affect (e.g., adaptive, maladaptive).

Results of the current study highlight three important findings. First, joint factor analysis of the PANAS and TPAS revealed a four factor structure of positive affect consisting of Serenity, Joviality, Attentiveness, and Self-Assurance, consistent with a priori hypotheses and prior work (Gilbert et al., 2009; Ready et al., 2011; Stanton & Watson, 2015; Watson & Clark, 1999). Second, risk for bipolar disorder – as indexed by BAS sensitivity– and symptoms of

mania were not equally related to all forms of positive affect. Rather, they were most related to Self-Assurance, a type of positive affect marked by heightened activation and excitement seeking (e.g., adventurous, fearless, lively). Greater daily levels of Joviality and Attentiveness were also significantly predicted by heightened BAS sensitivity, but to a lesser extent. Third, the facet of Serenity was unique due to its minimal to no association with BAS sensitivity and symptoms of mania.

The present findings demonstrate that certain facets of positive affect may serve adaptive roles in daily functioning, whereas other facets may serve maladaptive roles. As it relates to bipolar disorder, certain facets of positive affect may be maladaptive in that they are more closely associated with symptoms and risk for the disorder. Specifically, Self-Assurance appears to serve a maladaptive role in individuals at risk for mania due to its positive associations with mania symptoms and BAS sensitivity, a finding consistent with Stanton et al. (2016). Theoretically, associations between Self-Assurance and mania symptoms/ risk are likely tied to reward seeking behaviors due to shared content. The content of Self-Assurance (e.g., feeling daring, bold, fearless) is strongly associated with reward seeking behaviors (Watson 2000; Stanton & Watson 2015), behaviors that are mirrored in BAS and manic symptoms. Similarly, associations between Joviality and mania risk can be tied to overlap between Joviality content (e.g., delighted, excited, energetic) and mania symptoms.

Although Self-Assurance and Joviality both share associations with mania and bipolar disorder risk, the direction of the relationship is unclear. That is, are these facets of positive affect driving BAS sensitivity and mania symptoms, or are elevated levels of these facets a result of bipolar disorder risk? In the former case, higher levels of daily Self-Assurance may increase one's engagement in excitement-seeking behaviors, a common symptom observed during mania.

Increased engagement in excitement-seeking behavior would also result in increased BAS outputs, a characteristic of individual with and at risk for bipolar disorder. Similarly, higher daily levels of Joviality may make an individual more susceptible to the heightened mood symptoms seen during mania. Through their shared content with mania, Self-Assurance and Joviality may therefore be driving the maladaptive mood and behaviors characteristic of mania. Alternatively, these facets may be inflated as a result of bipolar disorder risk markers such as heightened reward responsiveness and fun seeking. Individuals at risk for bipolar disorder are predisposed to have heightened BAS sensitivity (Alloy et al., 2012; Meyer, Johnson, & Carver, 1999; Salavert et al., 2007), and heightened BAS sensitivity may naturally inflate daily levels of Self-Assurance. Further, individuals with bipolar disorder have elevated baseline levels of positive affect (Gruber, 2011), which may be driven by heightened daily levels of Joviality. Given the unclear nature of the direction of the relationship between positive affect and bipolar disorder risk markers, future studies should seek to clarify the direction of the relationship. Further, future studies should continue to explore the possible maladaptive role of these facets through their associations with mania and other risk markers common to bipolar disorder (e.g., heightened reward sensitivity, substance use).

Whereas Joviality and Self-Assurance may represent a maladaptive variant of positive affect, Serenity may serve as a protective factor against mania. Serenity was not found to be associated with bipolar disorder risk and demonstrated only small correlations with mania symptoms. This finding is consistent with previous literature in which the facet of Serenity was not associated with baseline BAS sensitivity (Stanton et al., 2016). Given Serenity's lack of association with mania and bipolar disorder risk, elevated levels of Serenity may serve to protect an individual from experiencing symptoms of mania. As evidenced by the lack of overlap

between the content of Serenity and bipolar disorder symptoms, the low-activation content of Serenity (e.g., tranquil, at ease, calm) may serve as a counterbalance not only to the highly activated content of Joviality and Self-Assurance, but also to overall mania symptoms. Therefore, greater levels of Serenity may defend against potentially maladaptive positive affect (i.e., Joviality, Self-Assurance) as well as mania symptoms.

The existence of protective and maladaptive forms of positive affect, as suggested in the literature (Stanton & Watson, 2015; Stanton et al., 2016) and supported by the present findings, may help explain the transition from a euthymic mood state to a manic mood state in individuals with bipolar disorder. According to the Cognitive Model of Bipolar Disorder (Mansell, Morrison, Reid, Lowens, & Tai, 2007), individuals with bipolar disorder experience changes in internal state that are subject to extreme appraisals. The extreme appraisal of changes in affective states lead to ascent (i.e., behaviors that increase the state of activation) or decent behaviors (i.e., behaviors that decrease the state of activation) that feed manic or depressive symptoms, respectively. The model is consistent with evidence that individuals with bipolar disorder experience significant changes in affect outside of mania, as the model suggests that individuals with bipolar disorder experience fluctuations in their internal state prior to manic episodes. Through resulting cognitive distortions and ascent behaviors, the fluctuations therefore increase the potential for mania. As applied to this model, heightened levels of Joviality and Self-Assurance may drive ascent behaviors through their higher activation and reward seeking content. If an individual experiencing fluctuations in internal states has heightened levels of Self-Assurance and Joviality, they may be predisposed to engage in ascent behaviors. In contrast, Serenity may help protect against ascent behaviors via its low activation content.

Hence, positive affect facets may play a critical role in the Cognitive Model of Bipolar Disorder through their relationship with experienced internal states and resulting ascent behaviors.

The present findings may have important clinical implications. As research has shown that one's ability to effectively regulate emotions is associated with positive outcomes (Folkman & Moskowitz, 2000; Tamir, John, Srivastava, & Gross, 2007; Tugade & Fredrickson, 2004), the current findings may support targeted emotion regulation interventions. Specifically, future interventions may benefit from a focus on increasing the Serenity facet of positive affect in individuals at risk for bipolar disorder, as Serenity did not demonstrate significant positive associations with bipolar disorder risk. Emotion regulation interventions may also focus on recognizing heightened levels of Self-Assurance and learning techniques to decrease this positive affect facet. Further, as technology continues to take on a greater role in the therapeutic process (e.g., Amichai-Hamburger, Klomek, Friedman, Zuckerman, & Shani-Sherman, 2014; Anthes, 2016; East & Havard, 2015; Firth et al., 2017), future interventions may involve daily tracking of positive affect facets in order to identify and address changes in positive affect that may be indicative of mania, particularly before a manic episode begins. Future interventions may involve tracking, and therefore recognizing, early changes in positive affect. Such recognition may enable individuals to prevent ascent behaviors and therefore alter the cognitively driven cycle of mania outlined in the Cognitive Model of Bipolar Disorder (Mansell et al., 2007). Hence, by supporting previous findings that Joviality and Self-Assurance are associated with bipolar disorder, the present study may pave the way for future clinical interventions guided by daily monitoring of these positive affect facets.

The present study had a number of strengths. First, the study analyzed positive affect at the facet level rather than as a singular construct, adding to the growing body of literature

demonstrating that positive affect is not a singular construct, but rather that it can be broken down into distinctive facets (Gilbert et al., 2009; Ready et al., 2011; Stanton & Watson, 2015; Watson & Clark, 1999; Watson & Tellegen, 1985). The importance of facet level examinations was highlighted by the pattern of results. Across the different types of analyses, effects were continuously stronger and more apparent when examined at the facet level than at the higher order level of overall positive affect. Whereas overall positive affect consistently demonstrated significant associations with BAS sensitivity, effects were stronger and more apparent when examined at the facet level than at the level of overall positive affect. Facet level examinations elucidated which facet was driving the association between overall positive affect and BAS scales (i.e., Self-Assurance) and uncovered associations not apparent when examining at the higher order level (i.e., BAS Fun Seeking and Self-Assurance). Second, the current study utilized EMA techniques to more effectively capture the daily rhythm of positive affect. The use of EMA techniques allowed positive affect and its facets to be examined at 21 separate time points throughout a week, yielding a detailed look into the daily rhythm of positive affect.

Although the current study had a number of strengths, it was not without limitations. First, the present study relied on an undergraduate student sample. Effects may be more robust with clinical samples than with a student sample due to an increased rate of bipolar symptoms in a clinical sample. Therefore, future studies would be strengthened by examining this study's hypotheses using a sample of individuals diagnosed with bipolar disorder. Second, BAS may not be the best indicator of bipolar disorder risk. Indeed, having a family history of bipolar disorder is considered one of the best indicators of bipolar disorder risk (Barmier et al., 2009; DelBello & Geller, 2001; Goodwin & Jamison, 2007; Smoller & Finn, 2003). Additional studies would benefit from using this stronger definition of bipolar disorder risk. Third, future studies should

improve upon the measurement of daily rewards. The present study used a measure of daily events to determine the number of positive (i.e., rewarding) events an individual experienced. However, the definition of rewarding events can vary from person to person, resulting in increased unreliability and error in the data. Further, the aforementioned measure may not have adequately captured all types of rewarding events in the study sample. It is possible that better measurement techniques for capturing daily rewards may serve to decrease error and increase the likelihood of capturing significant interaction effects. This is particularly relevant to hypothesis four in which no significant interaction effects between baseline BAS scales and daily positive events were found, but results trended in the predicted direction.

Despite these limitations, the present study provided increased insight into the structure of positive affect and the relationship between positive affect and bipolar disorder risk. The study findings supported a four factor structure of positive affect consisting of Serenity, Joviality, Attentiveness, and Self-Assurance. Overall positive affect, as well as the lower order facets of Joviality, Self-Assurance, and Attentiveness, were found to have positive associations with BAS sensitivity, as heighted BAS sensitivity significantly predicted daily levels of these positive affect facets. In contrast, Serenity demonstrated minimal associations with BAS sensitivity and symptoms of mania. The study findings support a multi-faceted structure of positive affect and highlight importance of examining positive affect at the facet level. Results indicate certain facets of positive affect (i.e., Joviality, Self-Assurance) may be maladaptive due to their association with risk for bipolar disorder. Serenity, on the other hand, may play a protective role in preventing mania.

Table 1

Participant Demographics

Item	Category	*N*	Percentage
Gender	Male	89	33.60
	Female	176	66.40
Race	White	135	50.90
	Black	70	26.40
	Asian	18	6.80
	Native American	6	2.30
	Other	32	12.10
Ethnicity	Hispanic	76	28.70
	Non-Hispanic	149	56.20
Marital Status	Single	233	87.90
	Cohabitating	19	7.20
	Married	9	3.40
	Remarried	1	.40
	Divorced	2	.80
Grade	Freshman	113	42.60
	Sophomore	64	24.20
	Junior	62	23.40
	Senior	22	8.30
	Graduate	4	1.50

Table 2

Exploratory Factor Analysis of Positive Affect Items

	Factor			
Component	Serenity	Joviality	Attentiveness	Self-Assurance
Laid Back	.81			
Tranquil	.75			
At Ease	.75			
Peaceful	.71			
Calm	.68			
Serene	.65			
Relaxed	.64			
Secure	.46			
Safe	.38			
Content	.31			
Cheerful		.92		
Happy		.88		
Delighted		.86		
Joyful		.85		
Excited		.78		
Enthusiastic		.42		
Warm		.37		
Energetic		.36		
Concentrating			.89	
Determined			.78	
Interested			.72	
Inspired			.53	
Attentive			.52	
Confident			.49	
Alert			.45	
Proud			.44	
Strong			.35	
Active				
Daring				.95
Bold				.76
Adventurous				.66
Fearless				.57
Dynamic				.50
Eager				.35
Lively				.33

Table 3

Correlations between Factors

Factor	1	2	3	4
1	1.00			
2	.57	1.00		
3	.58	.73	1.00	
4	.43	.58	.61	1.00

Note. Factor 1 = Serenity, Factor 2 = Joviality, Factor 3 = Attentiveness, Factor 4 = Self-Assurance

Table 4

Correlations between Baseline Positive Affect and BAS Scales

	BAS Drive	BAS Fun Seeking	BAS Reward Resp.
Positive Affect	.26**	.11	.16*
Serenity	.13*	.14*	.05
Joviality	.23**	.22**	.20**
Attentiveness	.25**	.08	.12*
Self-Assurance	.35**	.40**	.14*

Note. * Correlation is significant at the .05 level.** Correlation is significant at the .01 level

Table 5

Correlations between Baseline Positive Affect Facets and IDAS-II Euphoric Activation

	Euphoric Activation
Serenity	.27**
Joviality	.46**
Attentiveness	.32**
Self-Assurance	.51**

Note. ** Correlation is significant at the .01 level

Table 6

HLM Results for Positive Affect and BAS Scales

	PA
Variables	*β (SE)*
Intercept	-.006 to -.002 (.04 to .04)
BAS Drive	.120 (.04)**
BAS Fun Seeking	.081 (.04)
BAS Reward R.	.096 (.04)*

Note. PA = positive affect. Results were derived from 3 separate analyses. * $p < .05$; ** $p < .01$; *** $p < .001$

Table 7

Correlations between Positive Affect Variance and BAS Scales

	BAS Drive	BAS Fun Seeking	BAS Reward Resp.
Positive Affect	.20**	.20**	.24**

Note. ** Correlation is significant at the .01 level

Table 8

HLM Results for Positive Affect Facets and BAS Scales

Variables	Serenity	Joviality	Attentiveness	Self-Assurance
	β (SE)	*β (SE)*	*β (SE)*	*β (SE)*
Intercept	.000 to .000 (.04 to .04)	-.005 to -.002 (.04 to .04)	-.007 to -.001 (.04 to .04)	.003 to .001 (.05 to .05)
BAS Drive	.057 (.04)	.087 (.04)*	.081 (.04)*	.160 (.05)***
BAS Fun Seeking	.039 (.04)	.090 (.04)*	.032 (.04)	.120 (.05)**
BAS Reward R.	.045 (.04)	.099 (.04)*	.085 (.04)*	.066 (.05)

Note. PA = positive affect. * $p < .05$; ** $p < .01$; *** $p < .001$

Table 9

Correlations between Positive Affect Facets' Variance and BAS Scales

	BAS Drive	BAS Fun Seeking	BAS Reward Resp.
Serenity	.04	.08	.15*
Joviality	.16*	.19**	.26**
Attentiveness	.10	.14*	.17**
Self-Assurance	.21**	.26**	.25**

Note. * Correlation is significant at the .05 level. ** Correlation is significant at the .01 level

Table 10

HLM Results for Positive Affect and BAS Scales' Interaction with Daily Positive Events

Variables	Serenity	Joviality	Attentiveness	Self-Assurance
	β (SE)	*β (SE)*	*β (SE)*	*β (SE)*
Intercept	.057 to .059 (.04 to .04)	.077 to .080 (.04 to .04)	.005 to .008 (.04 to .04)	.060 to .062 (.05 to .05)
DPE	.243 to .248 (.03 to .03)***	.388 to .393 (.03 to .03)***	.257 to .262 (.03 to .03)***	.311 to .315 (.03 to .03)***
BAS Drive	.037 (.04)	.090 (.04)*	.104 (.04)*	.167 (.05)***
DPE*BAS Drive	-.044 (.03)	-.018 (.03)	.027 (.03)	.015 (.03)
BAS Fun Seeking	.057 (.04)	.108 (.04)*	.064 (.04)	.143 (.05)**
DPE*BAS Fun Seeking	-.003 (.03)	-.005 (.03)	.012 (.03)	.019 (.03)
BAS Reward R.	.030 (.04)	.076 (.04)	.073 (.04)	.065 (.05)
DPE*BAS Reward R.	.016 (.03)	.034 (.03)	.049 (.03)	.038 (.03)

Note. DPE = Daily Positive Events. Results were derived from 3 separate analyses. * $p < .05$; ** $p < .01$; *** $p < .001$

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