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Impulsive responses to positive mood and reward are related to mania risk

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Bipolar disorder is characterised by impulsivity, and recent research suggests it is important to consider more specific forms of impulsivity. In two student samples, we examined associations of self-reported impulsivity with mania risk (Hypomanic Personality Scale, HPS). We hypothesised that mania risk would relate to impulsivity in the context of opportunities for rewarding activities (Delaying Gratification Inventory, DGI), reward pursuit (Fun-Seeking subscale of the Behavioural Activation Scale, BAS), and when experiencing positive affect (Positive Urgency Measure, PUM). In Study 1 ($N = 823$), the HPS was uniquely related to Fun-Seeking and PUM scores. Study 2 ($N = 482$) replicated the correlation of HPS scores with PUM while documenting positive associations between PUM and trait-like responses to positive affect. Findings across both studies stress the importance of considering the role of positive emotion in driving the impulsivity among persons at risk for mania. These findings have implications for refining our understanding of the aetiology of bipolar disorder and for treatment development.

Keywords: Mania; Bipolar disorder; Impulsivity; Positive emotion.

Mania, the defining feature of bipolar disorder, is marked by an abnormally and persistently elevated, expansive, or irritable mood, as well as grandiosity, increased goal-directed activity, and excessive involvement in pleasurable activities that have a high potential for negative consequences, among other symptoms (American Psychiatric Association, 2000). Bipolar disorder is marked by severe occupational and social impairment (Coryell, 1993) and has high rates of suicide and mortality (Angst, Stassen, Clayton, & Angst, 2002; Swann, 2009). Despite evidence that treatments can decrease rates of relapse (Glick, Suppes, DeBattista, Hu, & Marder, 2001; Sachs, Printz, Kahn, Carpenter, & Docherty, 2000), even with the best available treatments, frequent relapse and chronic subsyndromal mood symptoms are normative (Gitlin, Swendsen, Heller, & Hammen, 1995). The poor outcomes suggest that a greater understanding of the risk factors involved in

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manic symptoms is needed in order to improve available treatments.

One potential risk factor for mania is impulsivity. Impulsivity involves excessive engagement in pleasurable yet risky activities (American Psychiatric Association, 2000). To begin, impulsivity is one of the defining criteria for a manic episode, and empirical findings confirm that impulsivity is elevated as severity of manic symptoms increases (Najt et al., 2007; Strakowski et al., 2010; Swann, 2009; Swann, Anderson, Dougherty, Moeller, & Steinberg, 2001). Of particular importance, elevations in impulsivity have been documented in remitted bipolar disorder, and so appear not to be just epiphenomena of manic symptoms (Strakowski et al., 2010; Swann et al., 2001). These elevations in impulsivity in bipolar disorder have been demonstrated across a range of measures, including the self-report Barratt Impulsiveness Scale (BIS-11; e.g., Swann et al., 2001) and behavioural tasks such as the Immediate Memory Task–Delayed Memory Task (IMT-DMT; Dougherty, Marsh, & Mathias, 2002; Dougherty, Mathias, & Marsh, 2003; Najt et al., 2007; Swann et al., 2007), a variant of the Continuous Performance Test (CPT). Impulsivity has also been found to predict the onset of bipolar disorder (Alloy et al., 2009; Kwapil et al., 2000) and lower quality of life among those diagnosed with bipolar I disorder (Victor, Johnson, & Gotlib, 2011), suggesting that impulsivity might be a vulnerability factor for the disorder.

It is important to acknowledge that impulsivity involves several facets (Gerbing, Ahadi, & Patton, 1987; Malle & Neubauer, 1991; Parker, Bagby, & Webster, 1993). At a broad level, "impulsivity encompasses actions that appear poorly conceived, prematurely expressed, unduly risky, or inappropriate to the situation and that often result in undesirable consequences" (Daruna & Barnes, 1993, p. 23). Many different models of the components of impulsivity have been developed (cf. Barratt, 1965; Strakowski et al., 2009; Swann, 2009; Whiteside & Lynam, 2001), based on both behavioural and cognitive manifestations of impulsivity.

Despite evidence that impulsivity relates to an array of psychopathologies, including alcohol abuse, gambling addiction, and depression (Carver, Johnson, Joormann, Kim, & Nam, 2011; Swann, Bjork, Moeller, & Dougherty, 2002; Zuckerman & Kuhlman, 2000), there is a paucity of research examining which specific domains of impulsivity are most relevant to risk for bipolar disorder specifically. In the only study of which we are aware, Strakowski et al. (2010) found that during remission, people with bipolar disorder demonstrated elevated levels of impulsivity compared with healthy subjects, as measured by the BIS-11 Motor Impulsiveness subscale, and the Non-planning Impulsiveness subscale. In contrast, they also found that these same people achieved normative scores on a range of other behavioural and self-report measures of impulsivity. Although these findings suggest the importance of developing a more refined understanding of the distinct domains of impulsivity involved in bipolar disorder, the profile of impulsivity measures gathered in this study was based more on widely used behavioural measures than on the established risk factors for bipolar disorder and their potential for informing impulsivity.

In this paper, we draw from the clinical phenomenology and risk factors of bipolar disorder to develop hypotheses regarding which domains of impulsivity might be most important in bipolar disorder. Episodes of mania are defined by extremes of high moods and risk taking behaviour during those moods (American Psychiatric Association, 2000). This would suggest the importance of considering whether impulsivity during high moods can be observed even outside of episodes. Beyond this, substantial research has suggested that reward sensitivity is elevated in bipolar disorder and can predict a more severe course of disorder (e.g., Johnson, Edge, Holmes, & Carver, 2012). One dimension of reward sensitivity, which has been labelled "Fun-Seeking", involves the impulsive pursuit of rewards. Fun-Seeking has been found to predict onset of disorder (Alloy et al., 2008, 2012; Meyer, Johnson, & Carver, 1999). Finally, people with bipolar disorder have been found to demonstrate deficits in the ability to

delay gratification during manic states (Strakowski et al., 2009) if not during remission (Strakowski et al., 2010). In this study, then, we hypothesised that three facets of impulsivity would be related to mania risk: impulsivity during positive mood states, impulsivity during the pursuit of reward, and difficulties with delay of gratification overall.

The present investigation

The present investigation was designed to examine the relationship between impulsivity and risk for mania (i.e., bipolar disorder) across two studies. The goal of Study 1 was to examine specific components of impulsivity among those at risk for mania. In both studies, we used the Hypomanic Personality Scale (HPS), a self-report scale measuring subsyndromal symptoms of mania and related characteristics that has been shown to robustly predict onset of bipolar disorder in longitudinal studies (Eckblad & Chapman, 1986; Kwapil et al., 2000). Although we considered testing a diagnosed sample, one concern is that endorsement of impulsivity among those with a history of mania might just reflect their experiences of impulsivity during manic episodes. We predicted that risk for mania would be associated with the inability to delay gratification, excessive pursuit of rewards without attention to potentially negative consequences, and impulsivity during positive mood states. We also attended to whether current symptoms, or lifetime history of depression, might explain the observed patterns. Study 2 replicated the relationship of the HPS with Positive Urgency in a separate sample and considered how Positive Urgency related to strategies to regulate positive emotions.

STUDY 1: TESTING A BATTERY OF IMPULSIVITY MEASURES

Study 1 was a cross-sectional online survey study among undergraduates across two sites: University of California Berkeley and Central Michigan University. The protocol and all measures were approved by the Internal Review Board at each university.

Method

Participants and procedure

Participants were 823 young adults (75.9% female) drawn from the University of California, Berkeley ($N = 323$) and Central Michigan University ($N = 500$) who participated in the study for course credit. Participants completed a series of measures online that lasted approximately one hour. Two response validity "catch items" (e.g., please mark this item as "4") were embedded within the measures, and those who responded incorrectly to both ($n = 34$; 4.1%), were excluded from primary analyses. Participants' mean age was 19.0 ($SD = 2.51$) and the sample was ethnically heterogeneous (Caucasian = 66.9%; Asian or Pacific Islander = 22.0%; Latino/a = 5.6%; Black or African American = 1.8%; Native American or Alaskan Native = 0.5%; Multiethnic/Other = 3.2%).

Measures

Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1986). The HPS is a 48-item self-report scale designed to assess risk for future manic episodes, the defining feature of bipolar disorder. The HPS consists of 48 true–false items capturing episodic shifts in emotion ("I often feel excited and happy for no apparent reason" and "I often have moods where I feel so energetic and optimistic that I feel I could outperform almost anyone at anything"), behaviour ("I often get into excited moods where it's almost impossible for me to stop talking" and "There are often times when I am so restless that it is impossible for me to sit still"), and energy ("I very frequently get into moods where I wish I could be everywhere and do everything at once" and "I often get so happy and energetic that I am almost giddy"). The original measure features a true–false response format, but considering the occasionally extreme behaviours described in the HPS, and in light of evidence indicating that multiple-choice item formats are preferable in that they achieve higher internal consistency and temporal stability (Comrey, 1988), we used a 4-point Likert scale with options ranging from "*Strongly agree*" to "*Strongly disagree*" to capture more subtle variability in hypomanic

traits in this study. In the original validation study using the true–false version (Eckblad & Chapman, 1986), 78% of undergraduates with scores at least two standard deviations above the mean on the HPS scale reported experiencing hypomanic episodes. In a 13-year follow-up study, those who scored highly on the HPS were nine times as likely to experience hypomanic episodes as those with lower scores (Kwapil et al., 2000). Most relevant to this study, the scale has been found to correlate highly with the Impulsive Nonconformity Scale, $r = .44$ (Kwapil et al., 2000). To be conservative, two authors rated each HPS item for potential overlap with impulsivity (kappa = .88). Items 3, 11, 29 and 35 were considered to include content relevant to impulsivity. An adjusted HPS score without these four items was constructed, and parallel analyses were conducted using this scale alongside the original HPS score.

Altman Self-Rating Mania Scale (ASRM; Altman, Hedeker, Peterson, & Davis, 1997). Current manic symptoms were assessed by the 5-item ASRM scale. Items include increased self-confidence, talkativeness, elevated mood, decreased need for sleep and excessive activity level. For each item, participants were asked to rate statements on a scale ranging from 0 (*Not present*) to 4 (*Present to a severe degree*) over the preceding week. The five items were summed to create the total score ranging from 0 to 20; scores > 14 indicate clinically significant levels of current manic symptoms. Items on this scale have been shown to load onto a single component in factor analyses (Altman et al., 1997). This scale correlates highly with other measures of mania such as the Clinician-Administered Rating Scale for Mania ($r = .77$) and the Young Mania Rating Scale ($r = .72$), and has high test–retest reliability ($r = .86$). In the present study, 16 participants (1.9%) met criteria for current mania.

Inventory to Diagnose Depression – Lifetime version (IDD-L; Zimmerman & Coryell, 1987). Lifetime depressive symptoms were assessed by the IDD-L, a 22-item self-report measure of the number of DSM-IV major depressive disorder (MDD) symptoms experienced by a person for at least two weeks during their most severe lifetime period of depression. These items assess symptoms such as restlessness, guilt, and psychomotor retardation, as well as whether or not such symptoms persisted at least two weeks continuously. The IDD-L yields a total symptom severity score and also a dichotomous score indexing whether the person met criteria for the DSM-III diagnosis of a Major Depressive Episode. Previous studies have shown that split-half reliability is good, Spearman–Brown coefficient = .90, and that the overall rate of agreement between the IDD-L and a clinical diagnosis of DSM-III MDD is 81.7% (Zimmerman & Coryell, 1987). In the present study, 17.2% of participants reported a lifetime history of MDD.

Beck Depression Inventory – Short Form (BDI-SF; Beck & Beck, 1972). The BDI-SF consists of 13 self-report items designed to measure depressive symptom severity, including changes in appetite and sleep patterns, weight loss, and difficulty accomplishing everyday tasks. Total scores range from 0 to 39, with higher scores indicating greater depressive symptom severity. The BDI-SF has adequate internal consistency (Beck, Steer, & Carbin, 1988), and high correlations with lengthier, interview-based depression measures (Luty & O'Gara, 2006). The BDI-SF has been shown to achieve a correlation of $r = .96$ with the longer version of the BDI (Love, Grabach, & Clarke, 2004). In the present study, 93 participants (11.3%) met the criteria for moderate or severe depressive symptoms (≥ 10).

Behavioural Activation System – Fun-Seeking Subscale (BAS-Fun-Seeking; Carver & White, 1994). The BAS-Fun-Seeking Subscale was designed to reflect a tendency to pursue new, potentially rewarding experiences (e.g., "I will often do things for no other reason than that they might be fun") and to act spontaneously and reflexively during goal pursuit (e.g., "I often act on the spur of the moment") indicating a disregard for the consequences of these actions. It consists of four questions rated on a scale of 1 (*Very true for*

me) to 4 (*Very false for me*). Participants' responses were reverse scored and summed. Higher scores reflect a greater desire to strive for novel positive experiences without attention to potential consequences. The BAS Fun-Seeking subscale has shown good test–retest reliability, $r = .69$, in previous studies (Carver & White, 1994) and has been widely used in studies of depression and mania (cf. Kasch, Rottenburg, Arnow, & Gotlib, 2002). The Fun-Seeking subscale has been found to correlate with measures of impulsivity (Carver & White, 1994), including the General Temperament Survey Disinhibition-Constraint Scale (Watson & Clark, 1993).

Positive Urgency Measure (PUM; Cyders et al., 2007). This scale is designed to measure the self-reported tendency to respond to positive mood states by engaging in risky or harmful behaviour. This scale consists of 14 true–false questions (e.g., "When I am very happy, I can't seem to stop myself from doing things that can have bad consequences"). The PUM shows high magnitude correlations with a range of psychological syndromes such as problem drinking and gambling (Cyders et al., 2007; Smith et al., 2007). PUM items have been shown to be distinct from BAS Fun-Seeking in factor analyses (Cyders et al., 2007), and the PUM is predictive of risky behaviour, problem drinking, and gambling even after accounting for the influence of other forms of impulsivity (Cyders et al., 2007).

Delaying Gratification Inventory (DGI; Hoerger, Quirk, & Weed, 2011). The DGI is 35-item measure designed to assess individual differences in the tendency to forgo strong immediate satisfaction in an effort to pursue salient long-term rewards. The DGI covers five domains of delay behaviour: eating behaviour (e.g., "If my favourite food were in front of me, I would have a difficult time waiting to eat it"); physical pleasures (e.g., "I prefer to explore the physical side of romantic involvements right away"); social behaviour (e.g., "I do not consider how my behaviour affects other people"); money management (e.g., "I try to spend my money wisely"); and achievement behaviour (e.g., "I cannot motivate myself to accomplish long-term goals"). The DGI is scored by summing the items (some of which are reverse scored) for a possible composite score of 175, comprised of a total of 35 points on each of the five subscales. A higher DGI score indicates more difficulty with delay behaviour. In previous research involving a diverse international sample of over 10,000 participants, the scale demonstrated strong internal consistency, test–retest reliability, construct validity, and predictive validity. For example, DGI scores were correlated with psychological well-being, physical health, a range of health behaviours, academic achievement, social functioning, personal financial management, and symptoms of externalising problems, hypomania, depression, and binge eating (Hoerger et al., 2011).

Results

The primary hypothesis was that the DGI, the BAS Fun-Seeking subscale, and the PUM would demonstrate unique and robust correlations with risk for bipolar disorder as measured by the HPS. To test this hypothesis, we conducted a hierarchical multiple regression analysis with HPS as the criterion, and the three impulsivity measures as potential predictors. Because symptoms could exacerbate impulsivity levels, these analyses controlled for current depression (BDI-SF) and mania symptoms (ASRM). Before conducting primary analyses, we examined univariate distributions as well as bivariate and partial correlations (controlling for symptom scores) of impulsivity measures with HPS scores.

Preliminary analyses

Before excluding participants we examined whether those participants who failed the catch items were more likely to be impulsive. As one might expect, impulsivity demonstrated small positive correlations with the number of catch items missed (all rs $< .20$). These effects, although small, were significant for PUM, $r = .10$, $N = 847$, $p < .01$, and the total DGI scale, $r = .13$, $N = 841$, $p < .01$, the Social, Money, and Achievement

DGI subscales, rs = .07 to .18, $N = 841$, $p < .05$, and both the adjusted HPS, $r = .08$, $N = 856$, $p < .01$, and the original HPS total score, $r = .10$, $N = 857$, $p < .01$. Nonetheless, as wrong responses indicated a lack of care in completing items, the 34 participants who failed both catch items were excluded from further analyses, leaving a sample of 823 for analyses of hypotheses.

As shown in Table 1, most variables demonstrated adequate variability. As one might expect, some variables were positively skewed, including the original and adjusted HPS scales, ASRM, BDI-SF, IDD-L, and all DGI measures with the exception of the DGI Food and Physical subscales.

Correlations among symptom measures were as expected in that lifetime and current depression scores were correlated, $r = .44$, mania risk and current mania symptoms were correlated, $r = .33$, and inverse correlations were observed of current depression and current mania symptoms, $r = -.21$. Furthermore, consistent with the idea that people at risk for bipolar disorder often experience depression, HPS scores were correlated with current depression symptoms, $r = .18$, and lifetime depression history, $r = .16$. Internal consistency estimates were adequate, with the exception of the DGI Physical subscale. As shown in Table 2, impulsivity measures demonstrated modest intercorrelations, as expected.

Correlations of impulsivity measures with the HPS and the other symptom measures are shown in Table 3. As expected, the HPS was significantly correlated with all impulsivity measures. When adjusted HPS scores without impulsivity items were used, findings were largely parallel, but the small correlations of mania risk with the DGI subscales for Food and Achievement were no longer significant. The HPS was particularly strongly correlated with PUM and BAS Fun-Seeking. Current mania symptoms were correlated positively with the PUM and BAS Fun-Seeking, and negatively with the DGI and its subscales of Food and Achievement. Lifetime depression was modestly but significantly correlated with all impulsivity measures except for BAS Fun-Seeking and DGI Social. Current depression symptoms were positively correlated with the

Table 1. *Descriptive statistics for key variables in Studies 1 and 2*

	Study 1, UC Berkeley (N = 823)[1]					*Study 2, Yale (N = 482)*				
	Min	*Max*	*Mean*	*SD*	*α*	*Min*	*Max*	*Mean*	*SD*	*α*
HPS	2.00	41.00	19.59	6.48	.86	1.00	44.00	17.57	8.15	.86
Adjusted HPS	3.17	37.86	18.39	6.06	.85	2.00	40.00	16.62	7.11	.83
ASRM	0.00	18.00	5.84	3.43	.69	0.00	20.00	5.42	3.74	.75
BDI-SF	0.00	35.00	3.95	4.68	.88	0.00	27.00	4.95	4.77	.85
BAS Fun-Seeking	4.00	16.00	12.17	2.23	.72	—	—	—	—	—
PUM	13.00	51.00	24.37	7.51	.95	14.00	56.00	26.45	8.22	.95
RPA Emotion	—	—	—	—	—	5.00	20.00	14.10	2.86	.72
RPA Self	—	—	—	—	—	4.00	16.00	9.66	2.60	.74
RPA Dampening	—	—	—	—	—	8.00	29.00	14.40	4.23	.75
DGI Food	7.00	35.00	19.47	4.83	.65	—	—	—	—	—
DGI Phys	9.00	30.00	18.36	4.06	.54	—	—	—	—	—
DGI Soc	7.00	29.00	12.92	3.84	.78	—	—	—	—	—
DGI Money	7.00	34.00	14.33	5.34	.84	—	—	—	—	—
DGI Ach	7.00	29.00	13.07	4.67	.82	—	—	—	—	—
DGI Total	39.00	127.00	78.15	15.83	.87	—	—	—	—	—
IDD-L	0.00	10.00	1.79	2.88	.91	—	—	—	—	—

Notes: [1]BDI $n = 820$; DGI $n = 808$. HPS = Hypomanic Personality Scale; Adjusted HPS = HPS excluding items that relate to impulsivity; ASRM = Altman Self-Rating Mania Scale; BDI-SF = Beck Depression Inventory – Short Form; BAS = Behavioural Activation System; PUM = Positive Urgency Measure; RPA = Rumination over Positive Affect; DGI = Delaying Gratification Inventory; IDD-L = Inventory to Diagnose Depression – Lifetime Version.

Table 2. *Correlations among impulsivity measures in Study 1 (N = 823)*

	PUM	*BAS Fun-Seeking*	*DGI Food*	*DGI Phys*	*DGI Soc*	*DGI Money*	*DGI Ach*	*DGI Total*
PUM	—							
BAS Fun-Seeking	.28**	—						
DGI Food	.31**	.03	—					
DGI Physical	.46**	.22**	.38**	—				
DGI Social	.38**	.05	.22**	.37**	—			
DGI Money	.36**	.22**	.30**	.40**	.33**	—		
DGI Achievement	.37**	.03	.28**	.45**	.41**	.39**	—	
DGI Total	.53**	.16**	.64**	.73**	.64**	.73**	.73**	—

Note: $^{**}p < .01$; $^{*}p < .05$.

PUM, and positively correlated with the DGI Total and all DGI Subscales.

Given the strong links of current manic symptoms with impulsivity scales, further analyses examined whether HPS scores related to impulsivity after controlling for symptoms (ASRM and BDI-SF). As shown in Table 3, after controlling for current symptoms (ASRM and BDI-SF scores), adjusted HPS scores remained moderately to highly correlated with the PUM and BAS Fun-Seeking and modestly correlated with all other measures of impulsivity, again with the exception of the DGI subscales of Food and Achievement.

Main analyses

A hierarchical multiple regression model examined the unique correlations of different forms of impulsivity with the adjusted HPS.[1] Current symptoms of mania and depression were entered in block 1, so as to examine the role of impulsivity after controlling for mania and depression. To determine which of the measures of impulsivity accounted for the largest unique portion of variance, the measures of impulsivity were entered using forward selection in the next block. As shown in Table 4, current mania and current depression accounted for 17% of the variance in

Table 3. *Correlations of symptom measures with impulsivity measures in Study 1 (N = 823)*

	HPS: Bivariate correlations	*Adjusted HPS: Bivariate correlations*	*HPS: Partial correlations controlling for symptoms*	*Adjusted HPS: Partial correlations controlling for symptoms*	*IDD-L*	*ASRM*	*BDI-SF*
BAS Fun-Seeking	.46**	.45**	.32**	.29**	.00	.29**	−.03
PUM	.39**	.36**	.42**	.40**	.11**	.13**	.25**
DGI Food	.08*	.05	.04*	.03	.16**	−.09*	.30**
DGI Physical	.23**	.21**	.18**	.17**	.07*	−.01	.26**
DGI Social	.13**	.12**	.12**	.11**	−.06	−.02	.13**
DGI Money	.21**	.19**	.17**	.15**	.07*	.04	.16**
DGI Achievement	.08*	.05	.05	.03	.11**	−.14**	.34**
DGI Total	.21**	.18**	.17**	.14**	.11**	−.06	.34**

Notes: BAS = Behavioural Activation System; PUM = Positive Urgency Measure; DGI = Delaying Gratification Inventory; HPS = Hypomanic Personality Scale; IDD-L = Inventory to Diagnose Depression – Lifetime Version; ASRM = Altman Self-Rating Mania Scale; BDI-SF = Beck Depression Inventory – Short Form. $^{**}p < .01$; $^{*}p < .05$.

[1] Parallel regression analyses were conducted with the original HPS scores as the criterion variable. Findings were entirely congruent, $F_{total}(4, 800) = 109.32$, $R^2 = .35$, $p < .01$.

HPS scores. After accounting for current symptoms, BAS Fun-Seeking and Positive Urgency were significantly related to HPS scores. After accounting for symptoms, BAS Fun-Seeking accounted for an additional 13% of the variance, and PUM accounted for 3% of the variance in HPS scores. The Delaying Gratification Inventory and the Inventory to Diagnose Depression – Lifetime Version did not predict HPS scores above and beyond PUM and Fun-Seeking $F_{total}(4, 799) = 99.254$, R^2 total = .33, $p < .01$. These results suggest that individuals who are at risk for mania reported the most difficulty controlling impulses when pursuing novel goal-oriented experiences and during happy states.

Discussion

Findings from Study 1 fit with previous findings that impulsivity is robustly related to both bipolar disorder (Najt et al., 2007; Swann et al., 2001) and risk for mania (Kwapil et al., 2000). They also extend previous results by suggesting that risk for mania may be particularly related to impulsive behaviour specifically when in positive mood or goal-striving states (Strakowski et al., 2010). As hypothesised, heightened impulsivity might be one of the consequences of highly activated, positive mood states in bipolar disorder.

Table 4. *Multiple regression summary for symptom and impulsivity measures predicting mania risk in Study 1 using HPS with impulsivity items removed (N = 823)*

Block	R^2	R^2 *change*	*df*	β *at final step*	*p*
Block 1	.17***	.17***	2, 801		
ASRM				0.26***	.000
BDI-SF				0.18***	.000
Block 2	.30***	.13***	1, 800		
BAS Fun-Seeking				0.33***	.000
Block 3	.33***	.03***	1, 799		
PUM				0.19***	.000

Notes: ASRM = Altman Self-rating Mania Scale; BDI-SF = Beck Depression Inventory – Short Form; BAS = Behavioural Activation System-Fun Seeking Subscale; PUM = Positive Urgency Measure. ***$p < .005$.

Previous research has demonstrated difficulties with delay of gratification during manic episodes, but this form of impulsivity normalised after recovery among people with bipolar disorder (Strakowski et al., 2009, 2010). We found that mania risk was related to higher scores on four of the Delaying Gratification Inventory (DGI) subscales, and on three of the subscales after controlling for symptoms. Nonetheless, these effects were less pronounced than those observed for other forms of impulsivity, and the DGI did not uniquely relate to the HPS after controlling for other forms of impulsivity. Ongoing research on the ability to delay gratification is still warranted, as other researchers have found that persons with bipolar disorder performed poorly on laboratory measures of delay of gratification (Strakowski et al., 2009).

STUDY 2

Given the robust effects and the novelty of findings, Study 2 sought to replicate the links of the HPS with the Positive Urgency measure in a separate sample of college students. Given that our findings and others suggest the importance of impulsivity during positive mood states, a second goal was to identify whether people who tend to amplify their positive moods might be more vulnerable to this form of impulsivity. We examined correlations of positive urgency with the tendency to dwell upon and amplify positive moods.

Method

Participants and procedures

Participants were 482 young adults (56.9% female) from Yale University and the New Haven community who participated in the present study for extra course credit. Sessions were conducted anonymously using an online survey and lasted about 60 minutes, during which other measures not central to the present study were also obtained. Participant's mean age was 19.33 ($SD = 4.33$) and the sample was ethnically heterogeneous (Caucasian = 54.4%; Asian American = 18.2%;

African American = 9.8%; Latino/a = 10.4%; Multiethnic/Other = 3.3%).

Measures

As in Study 1, participants completed the PUM, HPS, ASRM, and BDI-SF (see Table 1 for descriptive statistics and internal consistency).

Responses to Positive Affect (RPA; Feldman, Joormann, & Johnson, 2008). Trait-like responses to positive affect were assessed using RPA. The RPA is a 17-item measure rated on a 1 (*Almost never respond in this way*) to 4 (*Almost always respond in this way*) scale. The RPA includes three factor-derived subscales, including Emotion-focused Responses (e.g., "Think about how happy you feel"), Self-focused Responses (e.g., "Think about how proud you are of yourself"), and Dampening Responses (e.g., "Remind yourself that these feelings won't last"). Previous studies have documented that RPA subscales are elevated among those with high HPS scores (Feldman et al., 2008) and those diagnosed with bipolar spectrum disorder (Gruber, Eidelman, Johnson, Smith, & Harvey, 2011; Johnson, McKenzie, & McMurrich, 2008).

Results

Preliminary analyses

First, we examined whether the responses of any participants indicated a lack of care. Data was reviewed by visually scanning data for inconsistent responses, looking for participants who had completed the survey more quickly than is reasonable, and conducting multivariate regressions for outliers. From this data quality check, a total of 27 of 505 (5.3%) original participants were excluded, leaving a final sample of 482.

Second, we examined univariate distributions. HPS, ASRM, and BDI-SF scales were positively skewed. The BDI-SF was also leptokurtic. This is consistent with expectations, in that few students would be expected to be at high risk for mania or exhibit clinically significant levels of manic and depressive symptoms. Because the distribution of these variables mirrored the expected population distribution and that correlational analyses are robust with respect to skew, we did not transform variables before conducting analyses.

Third, we examined potential confounds of HPS and PUM with current symptoms. HPS total scores demonstrated expected positive correlations with manic ($r = .32$, $p < .001$) and depressive ($r = .15$, $p < .01$) symptoms. Parallel correlations with manic ($r = .31$, $p < .001$) and depressive ($r = .16$, $p < .001$) symptoms with the adjusted HPS scale were parallel although slightly diminished. PUM was positively correlated with depressive symptoms ($r = .32$, $p < .001$). Current symptoms were thus controlled for in subsequent analyses.

Main analyses

We first examined the relationship between PUM with HPS using Pearson's correlations. As shown in Table 5, PUM was positively correlated with HPS scores. This relationship remained significant when current symptoms were controlled for using partial correlations. Next, we examined the relationship of PUM with the three RPA subscales. PUM was correlated with increased emotion-focused and dampening RPA subscales (see Table 5). After controlling for current symptoms, only the association between PUM and emotion-focused RPA subscale remained significant.

Table 5. *Associations of positive urgency (PUM) with mania risk (HPS) and responses to positive affect (RPA) in Study 2 (N = 483)*

	Bivariate correlations	*Partial correlations*
HPS	.40**	.32**
Adjusted HPS	.38**	.29**
RPA		
Emotion-focused	.14*	.15*
Self-focused	.06	.08
Dampening	.21**	.07

Notes: HPS = Hypomanic Personality Scale; Adjusted HPS = HPS excluding items that relate to impulsivity; RPA = Responses to Positive Affect. Partial correlations include current symptoms of mania and depression as covariates. *$p < .05$; **$p < .01$.

Discussion

Findings of Study 2 replicated those of Study 1 in that risk for mania, as measured with the HPS, was robustly correlated with Positive Urgency. Study 2 also extended these findings by demonstrating that Positive Urgency was related to a tendency to amplify positive moods. That is, people who intensified their positive moods also experienced difficulties regulating cognition and behaviour during those positive mood states.

GENERAL DISCUSSION

The current paper provided a first examination of how risk for mania relates to specific domains of impulsivity. More specifically, we examined a set of impulsivity domains that were shaped by conceptual models of positive affectivity and reward sensitivity, increasingly recognised to be key to the aetiology of bipolar disorder. Consistent with hypotheses in Study 1, mania risk was related to impulsive responses to positive moods and reward contexts. Specifically, mania risk was robustly correlated with measures of poor impulse control in the context of happy or approach-oriented mood states. Moreover, in multivariate analyses risk of mania robustly related to two forms of impulsivity: impulsivity during pursuit of novel and exciting activities (BAS Fun-Seeking) and impulsivity during positive moods (Positive Urgency). Study 2 replicated the strong correlations of the HPS with Positive Urgency and extended this work to examine whether the tendency to amplify positive moods (i.e., responses to positive affect) was associated with impulsivity during positive moods in Study 2. Results from Study 2 suggested that tendencies to amplify positive moods do tend to relate to difficulties controlling thoughts and behaviour during those good moods, providing further validation for the Positive Urgency scale.

In considering these findings, it is important to acknowledge several limitations. First, both studies were conducted on subclinical undergraduate samples, and further research in clinical populations is needed. Second, the current studies used self-report measures. Clinical interviews of symptoms and behavioural measures of impulsivity can be useful for avoiding self-report response biases. Third, this research was cross-sectional, and prospective cohort studies with extensive longitudinal data would be more ideal for evaluating risk.

In spite of these limitations, this study had several strengths. These include the use of multivariate profile analysis of a set of impulsivity measures, a large sample size ($N = 1{,}308$) and the inclusion of participants at three universities. Much of the previous research on impulsivity in bipolar disorder has relied on a single measure of impulsivity, frequently relying upon measures of attentional impulsivity such as continuous performance tests (CPT; Bearden, Hoffman, & Cannon, 2001; Swann, Pazzaglia, Nichols, Dougherty, & Moeller, 2003), which has identifiable limitations (Hoerger et al., 2011).

Multivariate analyses suggested that the particular impulsivity scales that were most directly relevant both include items that focus on difficulty controlling thoughts and behaviours during good moods (PUM) or when seeking novel approach-oriented activities (BAS Fun-Seeking). These findings indicate that state-dependent impulsivity may be an important factor for those at risk for mania. These findings can provide valuable insight by suggesting more specific times when people predisposed to mania might be most at risk for behaviours with regrettable consequences. In future research, it will be important to conduct more carefully controlled studies of the role of mood on impulsivity, perhaps using experience sampling to more carefully assess impulse control as mood states shift.

Current findings also indicate that emotion researchers might do well to consider not just the intensity of emotion responses in bipolar disorder, but differences in the way that a given emotion state will influence cognition and behaviour. A profile of greater dysregulation during emotion states is consistent with the neurobiological research suggesting that bipolar disorder is characterised by deficits in prefrontal cortical regions involved in controlling and regulating responses to

emotion (Phillips, Drevets, Rauch, & Lane, 2003). These findings are also consistent with other research suggesting the merits of studying cognitive responses to emotion, such as the growing literature suggesting that individuals with bipolar disorder tend to appraise internal states in conflicting ways (Mansell, Morrison, Reid, Lowens, & Tai, 2007). This difficulty with mood appraisal can interfere with attempts to regulate these states and contribute to mood swing symptoms (Kelly et al., 2011), indicating a reciprocal relationship between cognition and behaviour and subsequent mood.

Beyond links with mania risk, impulsivity was correlated with current and lifetime depressive symptoms. These findings extend previous findings that have suggested that depression is related to impulsive non-attention (Swann et al., 2002) and impulsivity during negative mood states (Cyders & Smith, 2008). Taken together, several forms of impulsivity appear relevant for further study in relation to depression.

The suggestion that mania risk may relate to impulsivity in certain mood states could also pose possibilities for novel treatments. Treatments developed to control impulsivity in general may not be as effective for such patients; rather, treatments could be tailored to increasing awareness of possibly regrettable behaviour when in happy or goal-striving states. Recent research suggests that asking patients to develop implementation intentions of how they might cope during an intense mood state has beneficial effects on mood regulation and in reducing negative mood state urgency (Webb et al., 2010). Future research might consider whether similar strategies could help reduce impulsivity during positive mood states.

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