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Experience-Sampling Approach to Emotion Differentiation and Bipolar Mood Risk in Emerging Adults

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Abstract

Despite the prominence of emotion disturbance in bipolar disorder, few studies have assessed emotion differentiation. The present investigation used an experience-sampling approach to test the utility of emotion differentiation in predicting bipolar mood-related difficulties. Across two studies, emerging adults participated during a normative first year of college (Spring 2019; Study 1; n = 136) or during their first year of college marked by a naturalistic global pandemic stressor, which may have provided a context for amplified emotional experiences (Spring 2020; Study 2; n = 136). Results suggested that lower global emotion differentiation was associated with increased trait bipolar risk in Study 2, but not in Study 1. Secondary analyses in Study 1 suggested that greater positive emotion differentiation was associated with increased mania symptom severity. Taken together, results suggest that emerging adults at higher risk for bipolar disorder had more difficulty differentiating emotions in their daily life compared to those at lower risk during—but not before—the COVID-19 pandemic. These results highlight the importance of context when examining emotion processes and dimensions of mood disorder risk. This initial work could improve early risk identification for bipolar disorder and may have important treatment implications.

Keywords: emotion, bipolar disorder, emerging adulthood, COVID-19, college mental health.

Introduction

Bipolar disorder is a chronic and severe affective disorder characterized by periods of expansive and elevated positive mood (mania or hypomania), and frequently also by periods of depression, including dysphoric mood or loss of pleasure (e.g., American Psychiatric Association, 2022). Bipolar disorder is associated with significant and persistent impairments in social and occupational functioning (e.g., Judd et al., 2002), increases risk for other psychiatric and medical conditions, and is linked to a strikingly high suicide rate (e.g., Fagiolini et al., 2013). The onset of bipolar mood episodes often coincides with a vulnerable lifespan period in young adulthood (e.g., Kennedy et al., 2005), known as emerging adulthood (Arnett, 2007), which is characterized by increased risk for mental health difficulties (e.g., Auerbach et al., 2016; Bruffaerts et al., 2018) and often overlaps with heightened social, financial, and

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academic stressors common during college. Given the staggering costs of bipolar disorder and the heightened risk for onset during emerging adulthood (Chandler et al., 2008; Kennedy et al., 2005; Merikangas et al., 2011), it is critical to improve our understanding of potential factors that may help identify risk and precede disorder onset. Disrupted emotion processes have been underscored as key processes in bipolar disorder (e.g., Alloy et al., 2009; Gruber, 2011; Johnson et al., 2007; Phillips & Vieta, 2007), making them a promising avenue for further investigation.

Emotion Differentiation as a Window into Understanding Bipolar Disorder

Emotion-related difficulties are a hallmark feature of bipolar disorder. A growing body of research suggests that bipolar disorder is characterized by disruptions in emotion processes. Laboratory studies using a variety of standardized (e.g., film) and idiographic (e.g., autobiographical memory recall) stimuli have found that both a diagnosis of, and risk for, bipolar disorder are associated with heightened positive emotion reactivity (e.g., for review, see Gruber, Johnson, & Harvey, 2009; Gruber, 2011; though see Kjaerstad et al., 2016). In contrast, experience-sampling studies assessing momentary emotions in daily life often find reduced—or no significant differences in—positive emotions among individuals with or at risk for bipolar disorder compared to healthy controls (e.g., Gruber et al., 2013; Myin-Germeys et al., 2003). Findings related to negative emotion are mixed: laboratory studies frequently report few or no differences in negative emotion reactivity between individuals with BD and non-psychiatric healthy controls (e.g., Gruber, 2011; Johnson et al., 2007), while some experience-sampling studies suggest elevated negative emotions in daily life among those with BD (e.g., Gruber et al., 2013; Sperry & Kwapil, 2019). Despite variability in emotion reactivity findings, consistent evidence indicates that individuals with BD experience significant difficulties with emotion regulation—defined as the process by which individuals modify their emotions (Gross & Jazaieri, 2014)—for both positive and negative emotions (e.g., Gruber, Eidelman et al., 2011; Johnson et al., 2008), and utilize ineffective regulation strategies in both laboratory settings (e.g., Gruber et al., 2012) and daily life (Gruber et al., 2013). Taken together, this research highlights that disrupted emotion functioning is central to BD. However, less is known about specific factors that maintain these emotion-related disturbances in individuals at risk for, or diagnosed with, bipolar disorder.

We argue that one understudied but central process that may contribute to and maintain emotion-related difficulties in bipolar disorder is *emotion differentiation*—the ability to identify and experience one's emotions with specificity (e.g., Pond et al., 2012; Smidt & Suvak, 2015). Individuals vary in their level of emotion differentiation based on how finely they distinguish between similar emotions across both valence (e.g., positive versus negative) and arousal (e.g., low versus high) dimensions (e.g., Barrett, 1998; Feldman, 1995). For example, a person who distinguishes between anger, annoyance, and anxiousness in response to different situations demonstrates higher emotion differentiation than someone who experiences all three emotions in response to the same event—or someone who simply reports feeling "bad" or "unpleasant" without specificity. Importantly, high emotion differentiation can be achieved through multiple routes. A person who tends to feel one emotion at a time (e.g., excitement) has higher emotion differentiation than a person who experiences a mix of different emotions at once (e.g., excitement, happiness, contentment). Alternatively, someone who experiences multiple emotions simultaneously can also be highly differentiated, so long as different contexts give rise to unique emotional blends with varying intensities—even if those emotions sometimes co-occur (Nook et al., 2018). Increased emotion differentiation is thought to provide valuable information about emotional experiences, including their sources and implications, thereby supporting more flexible and adaptive emotion regulation responses (Kashdan et al., 2015; Kalokerinos et al., 2019; Thompson et al., 2021).

Variation in emotion differentiation (ED) has been linked to a range of psychological and health outcomes. Higher ED is associated with more adaptive coping behaviors—such as more deliberate information processing before taking action—and greater resilience to stress (e.g., Tugade et al., 2004), as well as more effective emotion regulation skills in response to intense emotional experiences (e.g., Kalokerinos et al., 2019; O'Toole et al., 2014). Higher ED is also linked to fewer maladaptive emotional

responses, including a reduced likelihood of engaging in binge drinking when stressed (Kashdan et al., 2010) and lower aggression when angered (Pond et al., 2012). Notably, interventions aimed at improving ED have been shown to reduce distress (e.g., Kircanski et al., 2012). Conversely, low ED has been observed across a variety of emotion-related disorders, including depression (e.g., Demiralp et al., 2012; Liu et al., 2019; Willroth et al., 2019), anxiety (e.g., Kashdan & Farmer, 2014), autism (e.g., Erbas et al., 2013), borderline personality disorder (e.g., Suvak et al., 2011; Tomko et al., 2015), and anorexia-related eating disorders (e.g., Selby et al., 2014). Low ED is also associated with poorer clinical outcomes, such as higher rates of non-suicidal self-injury in patients with borderline personality disorder (Zaki et al., 2013), greater likelihood of relapse among substance users (Anand et al., 2017), and increased engagement in weight-loss behaviors among individuals with anorexia (Selby et al., 2014). With respect to mood disorders, specifically, lower ED has been associated with elevated depressive symptoms (e.g., Willroth et al., 2019). For example, in a one-week experience-sampling study, individuals with depression showed lower negative ED than healthy controls (Demiralp et al., 2012). Additionally, ED has been found to moderate the relationship between stressful life events and rumination among adults with depressive symptoms (Liu et al., 2019; Nook et al., 2021; Starr et al., 2017, 2019). Taken together, a growing body of evidence suggests that diminished ED is associated—both cross-sectionally and longitudinally—with clinically relevant mood and related outcomes.

The Present Investigation

The present investigation is the first, to our knowledge, to examine emotion differentiation (ED) in emerging adults at risk for bipolar disorder. We assessed ED in relation to bipolar-relevant mood outcomes during a critical socioemotional transition period: the first year of college. Among traditional-age college students, this period often coincides with the median age of bipolar disorder onset and is marked by heightened emotional challenges. Studying non-clinical college samples is an important first step, as subthreshold clinical symptoms and hypomanic traits are associated with increased psychopathological risk for bipolar disorder and occur at elevated rates during this developmental window (e.g., Auerbach et al., 2016; Bruffaerts et al., 2018; Chandler et al., 2008; Kennedy et al., 2005). We used an ecologically valid, two-week experience-sampling method (ESM) to assess ED. In Study 1, data were collected during a typical college transition period, while Study 2 captured ED during a time of amplified stress—the acute onset of the COVID-19 pandemic. We also assessed participants' abilities to differentiate both negative and positive emotions[1] allowing for a more nuanced examination of ED dimensions.[2] We hypothesized that bipolar risk would be associated with lower ED overall, as well as across both positive and negative ED subscales. We also examined whether these patterns held consistently across both studies (i.e., pre-COVID and COVID acute outbreak) and ensured that any findings remained significant when controlling for emotion intensity and symptom severity.

Study 1: Experience-Sampling Approach to Emotion Differentiation and Bipolar Risk

Study 1 examined the relationship between individual differences in emotion differentiation (ED) and bipolar risk severity among emerging adults in their first year of college, using a well-validated measure of bipolar risk and a rigorous, ecologically valid experience-sampling design.

[1] Recent studies that calculated ED as a sum score of positive emotion differentiation and negative emotion differentiation have found it explains unique variance above and beyond other measures of ED (Liu et al., 2019).
[2] Liu et al. (2019) hypothesized that positive ED may be uniquely important; however, the tendency for studies to include fewer positive emotion words may partially explain why several studies have not found any associations (Thompson et al., 2021).

Study 1 Method

Participants

Participants were 136 American emerging adults in their first year of college, recruited as part of a larger study on emotion and mental health in emerging adults at the University of Colorado Boulder (IRB #18-0483). See **Table 1** for details on demographic and clinical characteristics of participants. Participants were recruited through posted flyers, online advertisements, and email advertisements distributed to full-time first-year college students during the 2018-2019 academic year. Inclusion criteria required participants to be a self-reported full-time first-year college student at the University of Colorado Boulder, between the ages of 18-25, fluent in English, and to have completed usable datasets for the primary demographic and clinical study measures described below.[3]

Table 1. Demographics and Clinical Characteristics Across Study 1 and Study 2 Eligible Participants

	Study 1	Study 2	Test Statistic
Age (Years)	18.26 (0.73)	18.30 (0.64)	$F = 0.20$
Male	36.0%	20.7%	$\chi^2 = 7.78$***
Female	64.0%	79.3%	
Other	0.0%	0.7%	
Race/Ethnicity (Y/N)			
Caucasian/White	84.6%	77.9%	$\chi^2 = 1.96$
African-American/Black	2.2%	1.5%	$\chi^2 = .20$
Asian-American/Pacific Islander	19.9%	18.4%	$\chi^2 = 0.10$
Hispanic/Latinx	5.1%	11.8%	$\chi^2 = 3.85$
Native American	0.0%	2.2%	$\chi^2 = 3.03$
Other	0.7%	1.5%	$\chi^2 = .34$
In a Current Relationship (vs. Not)	40.4%	37.5%	$\chi^2 = .25$
First-Generation College Status	15.4%	16.9%	$\chi^2 = .11$
Living Arrangement (Y/N)			
Residence/Dorm Hall	93.4%	89.7%	$\chi^2 = 1.19$
Apartment Off campus	2.9%	2.9%	$\chi^2 = .00$
Alone	0.0%	1.5%	$\chi^2 = 2.02$
With Friend(s)/Roommate(s)	6.6%	18.4%	$\chi^2 = 8.61$**
With Family Member(s)	5.9%	5.9%	$\chi^2 = .00$
Other	1.5%	1.5%	$\chi^2 = .00$
Socioeconomic Status Rating	6.70 (1.43)	6.72 (1.56)	$F = .01$

[3] Prior to conducting analyses, survey responses were initially checked to exclude any obvious non-completers or ineligible responses consistent with previous approaches from this broader study protocol. For Study 1, an initial sample size of 1165 online survey responses were collected that included at least the first question on the survey (i.e., consent form). Survey responses were excluded if they fell into one of seven non-mutually exclusive categories: did not provide a required study identification number ($n = 107$), outside of the eligible age range ($n = 124$), not fluent in English ($n = 35$), not a first-year freshmen ($n = 4$), had duplicate survey responses ($n = 92$), did not complete the survey past the initial consent and demographic questions ($n = 141$), failed any of the attention check items ($n = 221$). We also checked whether any of the remaining participants had incomplete or inconsistent responding on the primary measure of trait bipolar risk (i.e., HPS-20), and ($n = 2$) additional participants were excluded. We then excluded participants who completed <50% of experience-sampling survey prompts ($n = 31$).

HPS-20	7.40 (3.83)	8.01 (3.77)	$F = 1.80$
DSM5-Mania	1.20 (1.22)	1.20 (1.18)	$F = .00$
ASRM	5.79 (3.51)	1.12 (1.62)	$F = 191.53$**
DSM5-Depression	1.58 (1.14)	2.04 (1.16)	$F = 9.75$**
BDI-SF	--	7.83 (6.03)	--

Note: Race/Ethnicity and Living Arrangement options were six separate yes/no variables that were not mutually exclusive. Socioeconomic Ladder rated from 1 (people who are the worst off – those who have the least money, least education, and worst jobs or no job) and 10 (people who are the best off – those who have the most money, the most education, and best jobs). HPS-20 = Hypomanic Personality Scale at study enrollment, 20-Item Version; DSM5-Mania = DSM-5 Cross-Cutting Symptom Measure Mania Maximum Score; ASRM = Altman Self Rating Mania scale at the time of the experience-sampling study (Spring 2019 for Study 1, Spring 2020 for Study 2); DSM5-Depression = DSM-5 Cross-Cutting Symptom Measure Depression Maximum score; BDI-SF = Beck Depression Inventory – Short Form at the time of the experience-sampling study (Spring 2020 for Study 2). *$p < .05$ comparing Study 1 and Study 2; **$p < .01$ comparing Study 1 and Study 2

Bipolar Disorder Risk

Bipolar disorder risk was assessed using the validated 20-item version of the Hypomanic Personality Scale (HPS-20; Meads & Bentall, 2008; Sperry et al., 2015). The HPS-20 is a trait measure that assesses bipolar disorder risk through a self-report true/false questionnaire, focusing on trait-like bipolar-relevant changes in mood (e.g., *"I often feel excited and happy for no apparent reason"*), energy (*"I often have moods where I feel so energetic and optimistic that I feel I could outperform almost anyone at anything"*), and cognition (*"Sometimes ideas and insights come to me so fast I cannot express them all"*). Higher scores reflect increased risk for bipolar disorder. The HPS has demonstrated strong longitudinal predictive validity for the prospective onset of manic and hypomanic mood episodes in emerging adult samples (e.g., Eckblad & Chapman, 1986; Kwapil et al., 2000; Meyer & Hautzinger, 2003). One study found that 28% of individuals scoring in the upper 95th percentile developed a BD diagnosis (Kwapil et al., 2000), while another study among emerging adults reported that 58% of participants in the upper quartile developed a BD spectrum disorder over a 3-year follow-up period (Walsh et al., 2015). Given our interest in examining continuous bipolar disorder risk in a large emerging adult student sample, HPS-20 scores were treated as a continuous variable in our regression models. Internal consistency for the HPS-20 was good ($\alpha = 0.75$).

Bipolar Disorder Mood Symptoms

Current symptoms of mania and depression—common diagnostic criteria for bipolar disorders—were self-reported using the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition Cross-Cutting Symptom Measure (DSM5-CCSM; American Psychiatric Association, 2013). The DSM5-CCSM scale is a 23-item self-report measure of psychiatric symptoms rated over the past two weeks, covering 13 distinct psychiatric dimensions. Each item is rated on a 0 (none) to 4 (severe) scale indicating the extent to which each symptom has bothered the individual during the past two weeks. The present study focused specifically on the depression and mania symptom domains. The depression domain included two items: anhedonia (*"little interest or pleasure in doing things"*) and dysphoria or sad mood (*"feeling down, depressed or hopeless"*). The mania domain included two items: hyperactivity (*"starting lots more projects than usual or doing more risky things than usual"*) and reduced sleep *("sleeping less than usual, but still have a lot of energy?*). Current depression (i.e., DSM5-Depression) and mania (i.e., DSM5-Mania) symptoms were scored using the maximum or highest value from one of the two depression items and one of the two mania items. Following scoring guidelines, mania severity was also assessed using the Altman Self Rating Mania Scale (ASRM; Altman

et al., 1997), a 5-item self-report scale assessing current symptoms of mania over the past week. Items were rated on a 0 to 4 scale, and total scores were computed by summing the individual items, with higher scores indicating increased mania symptom severity. Internal consistency for the ASRM was adequate (α = 0.67).

Experience-Sampling Measures

Experience-sampling methodology (ESM) is a well-validated, robust, and ecologically valid approach to capturing emotion in the daily lives of individuals, providing an important window into emotion and psychopathology (e.g., Myin-Germeys et al., 2009). Participants completed an experience-sampling procedure using the ExpiWell smartphone-based application (formerly Expimetrics), which was downloaded to their personal smartphones (https://app.expiwell.com). Specifically, participants completed four brief quasi-random surveys per day between 9:00 am and 9:00 pm (i.e., 9:00 a.m. – 12:00 p.m., 12:00 – 3:00 p.m., 3:00 – 6:00 p.m., and 6:00 – 9:00 p.m.) for 2 weeks, resulting in a total of up to 60 experience-sampling events. Participants were prompted to fill out the questionnaires within 15 minutes of receiving a notification; after that time, the survey would deactivate and no longer accept responses. Questions included current emotions, thoughts, and the context or activities in which the prompt occurred. At the end of the experience-sampling data collection period, participants who completed at least 50% of the prompts were compensated $40, and those who completed more than 85% of the prompts received an additional bonus of $10, for a total of $50.

Per inclusion criteria stated in the consent form, participants who completed less than 50% of experience-sampling prompts were not included in data analysis (n = 31). We note that there were no significant differences in any of the clinical characteristics between participants who completed less than 50% of prompts and participants who were retained in analyses for completing at least 50% of prompts (ps > .05). However, compared to completers, non-completers (i.e., <50% ESM prompts) had significantly higher mean socioeconomic status (M = 7.35, SD = 1.23 vs. M = 6.71, SD = 1.43). Participants included in the analysis completed an average of M = 44.03 total prompts (SD = 7.28; range: 30-58). With respect to emotion experience, participants self-reported their current experience of 12 emotion items commonly used for momentary assessment studies (Kahneman et al., 2004). Participants rated how they felt right now for distinct positive and negative emotions rated on a 7-point Likert scale from 0 (not at all) to 6 (very much). These emotion items were used to compute ED and control for positive and negative emotion intensity (i.e., PA and NA).

Emotion Differentiation (ED)

Following previous conventions (e.g., Demiralp et al., 2012; Smidt & Suvak, 2015), individual emotion items were used to compute an index of ED. We computed ED separately for *negative ED* (using the 6 negative emotion items, i.e., frustrated/annoyed, depressed/blue, hassled/pushed around, angry/hostile, worried/anxious, criticized/put down; referred to as ED-Negative), *positive ED* (using the 3 positive emotion items, i.e., happy, warm/friendly, enjoying myself; referred to as ED-Positive), and *general ED* (modeled after Liu et al., 2019 as the sum of ED-Negative + ED-Positive; referred to as ED-General). Following Kahneman and colleagues' (2004) computations, we excluded three items (i.e., tired, impatient for it to end, competent/capable) that were not directly measuring emotion concepts. From this, ED-General, ED-Positive, and ED-Negative were computed using intra-class correlation coefficients (ICCs; absolute agreement; Thompson et al., 2021; Tugade et al., 2004) between emotion terms across the sampling period, which provided a measure of how ratings for different emotions covary, or change in tandem, across the experience-sampling data collection period. In line with previous ED studies, ICCs were then Fisher z-transformed and subtracted from 1, such that higher scores

indicated increased ED or the tendency for participants to rate emotions differently (versus similarly) across multiple time points. [4]

Mean Positive (PA) and Negative (NA) Emotion Intensity

In line with prior research that has demonstrated consistent correlations between ED and emotion intensity, we controlled for mean positive and negative emotion intensity scores (PA and NA, respectively) in all analyses to ensure observed effects were independent of emotion intensity level (Thompson et al., 2021). PA and NA emotional intensity scores were calculated by averaging across the ratings for all the time points (i.e., up to 60 total) of the sampling period individually for each of the emotion items (i.e., a mean score was first computed separately for each of the 6 negative emotion items and 3 positive emotion items). We then computed composite PA and NA scores by averaging across the mean scores for each of the positive emotion items (i.e., to create the mean PA composite) and averaging across the mean scores for each of the negative emotion items (i.e., to create the mean NA composite). Higher scores indicate higher mean PA and NA intensity, respectively. PA ranged from 0.35 - 5.72 (M = 3.33, SD = 1.02). NA ranged from 0.06 - 3.65 (M = 1.18, SD = 0.78).

Procedure

Participants completed a cross-sectional Qualtrics survey during either the Fall 2018 or Spring 2019 semester. The survey lasted approximately 60 minutes and included the HPS-20, current clinical symptoms (i.e., ASRM, DSM5-Depression, DSM5-Mania), and additional measures not part of the present investigation (see Supplementary Materials). Participants were compensated via cash, Amazon gift card, or course credit. Participants who consented to be recontacted were invited at the end of the Spring 2019 semester to complete a follow-up survey to re-collect current symptom information (for Fall 2018 participants) and to participate in the experience-sampling (ESM) study. All participants completed the ESM phase during the end of their first year of college. On average, ESM data collection began M = 29.68 days (SD = 13.41) after completion of the Spring 2019 survey that included self-reported current clinical symptoms.

Study 1 Results

Preliminary Analyses

We first examined the distribution of all variables included in the analyses. None of the variables significantly departed from normality based on established thresholds for skewness (+/-2) and kurtosis (+/-7; Hair et al., 2016). As seen in **Table 2**, ED-General was positively correlated with ED-Positive and ED-Negative, indicating consistency across differentiation indices. Consistent with past research (e.g., Boden et al., 2013), there was a moderate positive correlation between ED-Positive and ED-Negative. Additionally, ED-General and ED-Negative were both negatively correlated with NA, suggesting that greater emotion differentiation was associated with lower average negative affect. Notably, ED-Positive was positively correlated with ASRM scores, suggesting that greater differentiation of positive emotions was associated with increased mania symptom severity. Correlations between clinical measures (e.g., HPS-20, DSM5-Depression, DSM5-Mania) and emotion intensity (PA and NA) were in the expected directions. No other correlations were statistically significant.

[4] Theoretically, ICCs range from 0 to 1. Participants with negative ICCs were changed to 0 before performing transformations and retained in analyses: Study 1 (n = 4); Study 2 (n = 5). This approach is consistent with past emotion differentiation studies (e.g., Boden et al., 2013; Liu et al., 2019). Per current recommendations (Thompson et al., 2021), we ran regression analyses excluding these participants and it did not change significant results in Study 1 or 2.

Table 2. Bivariate Correlations Between Clinical and Experience-Sampling Study Measures in Study 1

	1	2	3	4	5	6	7	8	9
1. HPS-20	--	0.32**	0.16	0.08	-0.07	-0.11	-0.00	0.03	0.10
2.DSM5-Mania		--	0.28**	0.18	-0.03	-0.12	0.05	0.01	0.02
3. ASRM			--	-0.22*	0.13	0.24*	0.00	0.35**	-0.03
4. DSM5-Depression				--	-0.18	-0.18	-0.12	-0.35**	0.45**
5. ED-General					--	0.78**	0.84**	0.17	-0.30**
6. ED-Positive						--	0.31**	0.14	-0.04
7. ED-Negative							--	0.13	-0.43**
8. PA								--	-0.30**
9. NA									--

Note: HPS-20 = 20-item Hypomanic Personality Scale; DSM5-Mania = DSM-5 Cross-Cutting Symptom Measure Mania Maximum Score; ASRM = Altman Self Rating Mania; DSM5-Depression = DSM-5 Cross-Cutting Symptom Measure Depression Maximum Score; ED = Emotion Differentiation; ED-General = General Emotion Differentiation (i.e., ED-Positive + ED-Negative); ED-Positive = Positive Emotion Differentiation; ED-Negative = Negative Emotion Differentiation; PA = Positive Affect Mean Intensity; NA = Negative Affect Mean Intensity. *p < .05; **p < .01.

Study 1 Main Analyses: ED and Bipolar Disorder Risk

To examine the relationship between emotion differentiation (ED) and bipolar disorder risk, we conducted hierarchical linear regression analyses. Two separate regression models were run with bipolar disorder risk (HPS-20 scores) as the outcome variable: one model tested global ED (ED-General), and the second model examined the positive and negative ED indices (ED-Positive and ED-Negative). For each model, predictors were entered in three blocks: Block 1 included demographic covariates: age and gender (coded as Male=0, Female=1). Block 2 included mean positive affect (PA) and negative affect (NA) intensity scores to control for emotion intensity. Block 3 included either ED-General or both ED-Positive and ED-Negative as the primary predictors of interest. All variables met assumptions for linear regression. No significant outliers were identified based on Cook's distance, and multicollinearity diagnostics indicated acceptable tolerance levels. Missing cases were deleted listwise. This analytic strategy allowed us to assess the unique contribution of emotion differentiation—both globally and across valence-specific subscales—to bipolar disorder risk, above and beyond demographic and affective intensity factors.[5]

[5] Eligible study participants who had ICCs with zero variance on either positive emotions or negative emotions did not have reliable ED indices, and thus, were excluded from primary analyses: Study 1 (n = 23); Study 2 (n = 14). Zero variance was flagged by the SPSS warning: "scale has zero variance items". Further examination of these participants' ESM data indicated that there was little to no variability on negative or positive emotion items. Therefore, main analyses were run on a subset of participants who did not have emotion differentiation scores with a zero variance SPSS warning: Study 1 (n = 113); Study 2 (n = 122). In Study 2, when zero variance ICCs were included in analyses, ED-General (HPS-20: β = -.14, p = .091) was no longer a significant predictor of decreased trait bipolar disorder risk.

We first examined whether ED-General predicted trait bipolar disorder risk. As shown in **Table 3**, demographic variables in Block 1 were not significantly associated with HPS-20 scores (Model 1: $F_{(2, 110)} = 0.87$, $p = .421$; $R^2 = .02$). Adding current PA and NA intensity in Block 2 did not significantly improve the model (Model 2: $F_{(4, 108)} = 1.06$, $p = .378$; $R^2 = .04$, $\Delta R^2 = .02$). Finally, the addition of ED-General in Block 3 also did not result in a significant model (Model 3: $F_{(5, 107)} = 0.84$, $p = .522$; $R^2 = .04$, $\Delta R^2 = .00$). These results remained consistent when controlling for current mood symptoms (see Supplementary Materials).[6] Overall, this suggests that ED-General was not a significant predictor of trait bipolar disorder risk in this sample.

Table 3. Regression Analyses using ED-General to Predict HPS-20 Scores

	HPS-20 Study 1 (n = 113)			HPS-20 Study 2 (n = 121)		
Predictor	R^2	ΔR^2	β	R^2	ΔR^2	β
Block 1	.02	.02		.01	.01	
Age			.07			.01
Gender			.11			-.05
Block 2	.04	.02		.13**	.12**	
PA			.07			.24**
NA			.15			.23*
Block 3	.04	.00		.16**	.03*	
ED-General			-.00			-.19*

Note. Regression analyses were conducted using a subset of eligible participants who had usable ED scores (see Footnote 5). HPS-20 = 20-item Hypomanic Personality Scale; Gender (Male = 0, Female = 1); PA = Positive Affect Mean Intensity; NA = Negative Affect Mean Intensity; ED = Emotion Differentiation; ED-General = General Emotion Differentiation (i.e., ED-Positive + ED-Negative); β = Standardized beta coefficients from Model 3; *$p < .05$, **$p < .01$.

We next examined whether ED-Positive and ED-Negative were significant predictors of trait bipolar disorder risk. As shown in **Table 4**, demographic variables in Block 1 were not significant predictors of HPS-20 scores (Model 1: $F_{(2, 110)} = 0.87$, $p = .421$; $R^2 = .02$). The addition of PA and NA intensity in Block 2 did not significantly improve the model (Model 2: $F_{(4, 108)} = 1.06$, $p = .378$; $R^2 = .04$, $\Delta R^2 = .02$). Contrary to our hypotheses, the final model including ED-Positive and ED-Negative in Block 3 was also not significant (Model 3: $F_{(6, 106)} = 0.78$, $p = .591$; $R^2 = .04$, $\Delta R^2 = .00$). These results remained unchanged after controlling for current mood symptoms (see Footnote 6 and Supplementary Materials). These findings suggests that valence-specific emotion differentiation scores (ED-Positive and ED-Negative) also did not predict trait bipolar disorder risk.

[6] Consistent with previous studies on bipolar risk and emotion functioning, we ran parallel analyses controlling for clinical symptoms. The main findings for Study 1 and Study 2 remained largely consistent when controlling for symptoms (see Supplementary Tables S1 and S2).

Table 4. Regression Analyses Using ED-Positive and ED-Negative to Predict HPS-20 Scores

	HPS-20 Study 1 (*n*=113)			HPS-20 Study 2 (*n*=121)		
Predictor	R^2	ΔR^2	β	R^2	ΔR^2	β
Block 1	.02	.02		.01	.01	
Age			.06			-.01
Gender			.10			-.05
Block 2	.04	.02		.13**	.12**	
PA			.09			.24**
NA			.17			.23*
Block 3	.04	.00		.16**	.03	
ED-Positive			-.06			-.10
ED-Negative			.06			-.14

Note. Regression analyses were conducted using a subset of eligible participants who had usable ED scores (see Footnote 5). HPS-20 = 20-item Hypomanic Personality Scale; Gender (Male = 0, Female = 1); PA = Positive Affect Mean Intensity; NA = Negative Affect Mean Intensity; ED = Emotion Differentiation; ED-Positive = Positive Emotion Differentiation; ED-Negative = Negative Emotion Differentiation; *β* = Standardized beta coefficients from Model 3; **p* < .05, ***p* < .01

Study 1 Brief Discussion

Contrary to our predictions, emotion differentiation (ED) did not significantly predict trait bipolar risk in Study 1. However, preliminary bivariate correlations suggested that specific dimensions of ED may still relate to bipolar-relevant mood symptomatology. Specifically, ED-Positive was associated with elevated mania symptoms as measured by the ASRM, a pattern not observed for ED-General or ED-Negative. This finding highlights the potential value of examining valence-specific ED in relation to specific symptom dimensions, even in the absence of associations with broader trait-based risk.

Several limitations of Study 1 should be acknowledged. First, there were fewer emotion items used to compute ED-Positive than to compute ED-Negative, due to reliance on the Daily Reconstruction Method (DRM; Kahneman et al., 2004), which was not originally designed to optimize ED measurement. Second, while clinical symptoms of depression and mania were assessed, these were collected approximately one month prior to the experience-sampling period, potentially limiting sensitivity to current, state-dependent mood symptom fluctuations that may influence ED. Third, although experience-sampling is ecologically valid and widely used to assess ED, it may fail to capture sufficient emotional variability if the sampling period lacks emotionally salient or intense events, which could reduce the reliability and meaningfulness of ED estimates. To address these limitations, Study 2 was designed to better capture emotionally rich and stressful contexts—specifically during the acute phase of the COVID-19 pandemic—to test whether context might amplify emotion differentiation processes and potential links with bipolar risk dimensions.

Study 2: Experience-Sampling Approach to ED and Bipolar Risk Dimensions During an Acute Stressor

Study 2 was designed to examine the relationship between emotion differentiation (ED) and bipolar risk dimensions in emerging adults during a period of acute socioemotional stress. Based on preliminary correlational findings from Study 1, we expanded our conceptualization of bipolar disorder risk to include both trait-level indicators of bipolar risk (i.e., HPS-20) and state-based measures of current bipolar-relevant mood symptoms (i.e., DSM5-Mania, ASRM, and DSM5-Depression). To assess ED in a context of heightened emotional variability, we conducted parallel experience-sampling procedures during the COVID-19 pandemic outbreak in Spring 2020. This period was marked by unprecedented social isolation, economic instability, and abrupt disruption of academic and daily routines due to public health mandates. The pandemic provided a unique and ecologically valid context for examining how ED functions under collective and unanticipated stress. Emerging evidence has underscored the increased vulnerability of college students to mental health difficulties during this time (e.g., Cao et al., 2020; Taquet et al., 2021; Wang et al., 2020), as well as the importance of emotion differentiation in navigating stressful experiences (e.g., Nook et al., 2021; Starr et al., 2019). In addition, Study 2 incorporated a broader array of emotion items to improve the sensitivity of ED measurement and assessed current symptoms of mania and depression on average within one week of the experience-sampling period. This design enabled a more precise investigation of the associations between ED and both trait-level and state-based current dimensions of bipolar disorder risk, particularly in the context of a significant real-world stressor.

Study 2 Method

Participants

Consistent with Study 1, participants were a distinct sample of 136 American emerging adults (ages of 18-25) in their first year of college during the 2019-2020 academic year at the University of Colorado Boulder. Recruitment methods and inclusion criteria were the same as in Study 1.[7] Given the purported rise in mental health concerns during the COVID-19 pandemic, we note that participants in Study 2 reported higher levels of depression symptoms, lower levels of mania symptom severity, and reduced positive affect (PA) intensity compared to participants in Study 1. See **Table 1** for full descriptive statistics.

Bipolar Disorder Risk

Trait bipolar disorder risk was assessed using the same 20-item Hypomanic Personality Scale (HPS-20; Meads & Bentall, 2008) as in Study 1. Internal consistency for the HPS-20 in Study 2 was good (α = 0.73).

Bipolar Disorder Mood Symptoms

Current depression and mania symptoms were assessed using the same measures as in Study 1 (i.e., DSM5-Depression, DSM5-Mania, and ASRM). In addition, Study 2 included the Beck Depressive Inventory-Short Form scale (BDI-SF; Beck & Beck, 1972), a 13-item self-report inventory of depressive symptoms over the past week. Items are rated on a 4-point scale (0 to 3), with higher summed scores indicating greater depression severity. Approximately 20% of participants (n = 27) scored above

[7] For Study 2, an initial sample size of 1043 initial online survey responses were collected that included at least the first question on the survey (i.e., consent form). Similar to Study 1, survey responses were excluded if they did not provide a required study identification number (n = 4), were outside the eligible age range (n = 5), were not fluent in English (n = 0), not a first-year student (n = 194), had duplicate survey responses (n = 120), did not complete the survey past the consent and demographic questions (n = 235), failed any of the attention check items (n = 340). Three additional participants were excluded (n = 3) who had incomplete or inconsistent responding on the primary measure of trait bipolar risk (i.e., HPS-20). We also excluded participants who completed < 50% of ESM survey prompts (n = 31).

established clinical cutoffs for depression (e.g., Furlanetto et al., 2005). Internal consistency for the BDI-SF in Study 2 was good (α = 0.89), while reliability for the ASRM was lower (α = 0.53).[8]

Experience-Sampling Measures

Study 2 employed a parallel experience-sampling procedure to that used in Study 1, spanning a 2-week period during the end of participants' first year of college. This data collection coincided with the acute phase of the COVID-19 pandemic, during which lockdown restrictions were in place (i.e., April-May 2020). Experience-sampling questions included the same core items as in Study 1, with several additional emotion items described below to broaden the assessment of emotional experience. As in Study 1, participants were compensated via a $40 Amazon gift card for completing at least 50% of the total experience-sampling prompts. Participants who completed more than 85% of the prompts received an additional $10 bonus (total compensation = $50). There were no significant demographic or clinical differences between participants who completed fewer than 50% of prompts and those who met the inclusion threshold. Eligible participants included in the final analyses completed an average of *M* = 43.40 total prompts (*SD* = 6.58; range: 28-53).

Participants reported on their current emotions four times a day during the experience-sampling period, using items adapted from prior momentary assessment work (Kahneman et al., 2004). In addition to the emotion items used in Study 1, three additional items were included to capture a broader range of contextually relevant emotional experiences: *grateful/thankful*, *optimistic/hopeful* (positive emotions), and *lonely* (negative emotion). These additions were intended to more fully represent the valence and arousal dimensions of emotion and to better capture salient affective experiences such as loneliness during the COVID-19 lockdown.

As in Study 1, emotion ratings were used to compute an index of ED using intra-class correlations (ICCs) (see Footnote 4), with the additional one negative item (lonely) and two additional positive items (grateful/thankful, optimistic/hopeful). Positive and negative emotion mean intensity scores (PA and NA intensity, respectively) were computed using the same approach as in Study 1, incorporating the additional emotion items into the composite scores. PA scores ranged from 0.02-5.92 (*M* = 2.79, *SD* = 1.30), and NA ranged from 0.05-4.49 (*M* = 1.01, *SD* = 0.74). As in Study 1, PA and NA were included as covariates in subsequent analyses.

Procedure

Consistent with Study 1, participants first completed a cross-sectional Qualtrics survey during either the Fall 2019 or Spring 2020 semester. This initial survey lasted approximately 60 minutes and included the Hypomanic Personality Scale (HPS-20), current clinical symptoms (i.e., ASRM, DSM5-Mania, BDI-SF, DSM5-Depression), and other measures that are not part of the present investigation (see Supplementary Materials for full list). Participants were compensated via cash ($20), Amazon gift card ($20), or course credit (2 credits). Participants who consented to be recontacted were invited at the end of the Spring 2020 semester to complete a follow-up survey and participate in the ESM phase. The follow-up survey re-administered current symptom measures and served as the baseline for the ESM phase. Experience-sampling data collection was conducted during the end of the first year of college, at the height of the COVID-19 lockdown period. On average, ESM data collection began *M* = 7.56 days (*SD* = 6.25) after completion of the Spring 2020 survey containing current clinical symptom reports.

Study 2 Results

Preliminary Analyses

We first examined the distribution of all primary variables of interest. None of these variables significantly departed from normality, based on skewness and kurtosis values within acceptable ranges (though see Footnote 8 for ASRM score distribution). Bivariate correlations among the primary study

[8] Internal consistency for ASRM in Study 2 was low (α = 0.53), which could have been due to overall low variability on the scale as most participants scored at 0 or subthreshold.

variables are presented in **Table 5**. In contrast to findings from Study 1, lower ED-General and ED-Negative scores were significantly associated with higher trait bipolar risk (HPS-20) and greater depressive symptoms (BDI-SF). Lower ED-Negative was also related to greater difficulty with mania symptoms as assessed by the DSM5-Mania subscale. Replicating patterns from Study 1, trait bipolar disorder risk (HPS-20) was positively associated with DSM5-Mania symptoms. Additionally, higher ED-Negative scores were correlated with lower mean negative affect (NA), and ED-General was positively correlated with both ED-Positive and ED-Negative, and inversely with NA. ED-Positive and ED-Negative scores were again positively correlated. Manic symptoms, measured via both ASRM and DSM5-Mania, were associated with lower depressive symptoms (BDI-SF and DSM5-Depression) and higher mean positive affect (PA). Depressive symptoms (BDI-SF and DSM5-Depression) were correlated with lower PA and higher NA, also consistent with prior research. HPS-20 scores were positively associated with both depressive symptoms (BDI-SF) and heightened affective intensity (i.e., higher PA and NA). DSM5-Mania scores were positively associated with ASRM scores and also with DSM5-Depression scores, suggesting overlap in mood symptom reporting. DSM5-Depression was also positively correlated with BDI-SF, and with increased NA and reduced PA. No other correlations were significant.

Table 5. Bivariate Correlations Between Clinical and Experience-Sampling Study Measures in Study 2

	1	2	3	4	5	6	7	8	9	10
1. HPS-20	--	0.28**	0.13	0.16	0.21*	-0.23**	-0.15	-0.21*	0.26**	0.20*
2. DSM5-Mania		--	0.19*	0.18*	0.03	-0.13	-0.03	-0.18*	0.08	0.56
3. ASRM			--	-0.25**	-0.22**	0.02	0.07	-0.06	0.24**	-0.08
4. DSM5-Depression				--	0.65**	-0.08	-0.01	-0.42	-0.23**	0.47**
5. BDI-SF					--	-0.17*	-0.07	-0.22*	-0.29**	0.62**
6. ED-General						--	0.79**	0.84**	-0.07	-0.24**
7. ED-Positive							--	0.34**	-0.06	-0.03
8. ED-Negative								--	-0.02	-0.35**
9. PA									--	-0.15
10. NA										--

Note: HPS-20 = 20-item Hypomanic Personality Scale; DSM5-Mania = DSM-5 Cross-Cutting Symptom Measure Mania Maximum Score; ASRM = Altman Self Rating Mania; DSM5-Depression = DSM-5 Cross-Cutting Symptom Measure Depression Maximum Score; BDI-SF = Beck Depression Inventory – Short Form; ED = Emotion Differentiation; ED-General = General Emotion Differentiation (i.e., ED-Positive + ED-Negative); ED-Positive = Positive Emotion Differentiation; ED-Negative = Negative Emotion Differentiation; PA = Positive Affect Mean Intensity; NA = Negative Affect Mean Intensity. *$p < .05$; **$p < .01$.

Study 2 Main Analyses: ED and Trait Bipolar Disorder Risk

We used a parallel regression approach to Study 1 to examine the relationship between emotion differentiation (ED) and trait bipolar disorder risk, as measured by the HPS-20 (see Footnote 5). Two hierarchical linear regressions were conducted: one examining global ED (ED-General) as a predictor,

and another examining ED-Positive and ED-Negative subscales. In each model, Block 1 included demographic covariates (age and gender; coded as Male = 0, Female = 1), Block 2 included mean PA and NA intensity, and Block 3 included either ED-General or valence-specific ED subscales. No significant outliers were detected using Cook's distance, and multicollinearity diagnostics indicated acceptable tolerance levels. Missing cases were deleted listwise.

ED-General as a Predictor of Bipolar Risk

We first examined whether the ED-General score predicted HPS-20. As shown in **Table 3**, demographic variables in Block 1 were not associated with HPS-20 scores (Model 1: $F_{(2, 118)} = 0.34$, $p = .716$; $R^2 = .01$). After adding PA and NA intensity in Block 2, the model reached significance (Model 2: $F_{(4, 116)} = 4.23$, $p = .003$; $R^2 = .13$, $\Delta R^2 = .12$), with both PA and NA intensity positively predicting bipolar risk scores. Consistent with our hypothesis, the addition of ED-General in Block 3 further improved the model (Model 3: $F_{(5, 115)} = 4.45$, $p = .001$; $R^2 = .16$, $\Delta R^2 = .03$). Importantly, ED-General was a significant negative predictor of HPS-20 scores ($\beta = -0.19$, $p = .033$), indicating that lower emotion differentiation was associated with increased trait bipolar disorder risk. This effect remained robust when controlling for current mood symptoms (see Footnote 6 and Supplementary Materials).

ED-Positive and ED-Negative as Predictors of Bipolar Risk

Next, we tested whether valence-specific indices of ED predicted trait bipolar disorder risk. As shown in **Table 4**, demographic covariates in Block 1 were not predictive of HPS-20 scores (Model 1: $F_{(2, 118)} = 0.34$, $p = .716$; $R^2 = .01$). Adding PA and NA intensity in Block 2 again significantly improved the model (Model 2: $F_{(4, 116)} = 4.27$, $p = .003$; $R^2 = .13$, $\Delta R^2 = .12$), with both PA and NA associated with increased HPS-20 scores. In Block 3, the addition of ED-Positive and ED-Negative resulted in a significant overall model (Model 3: $F_{(6, 114)} = 3.68$, $p = .002$; $R^2 = .16$, $\Delta R^2 = .03$); however, neither ED-Positive ($\beta = -0.10$, $p = .300$) nor ED-Negative ($\beta = -0.14$, $p = .171$) alone uniquely predicted bipolar disorder risk scores (ΔF, $p = .103$). These findings were consistent when controlling for current mood symptoms (see Footnote 6 and Supplementary Materials). Together, these results suggest that while global emotion differentiation (ED-General) is associated with lower trait bipolar disorder risk, valence-specific differentiation (ED-Positive and ED-Negative) did not uniquely contribute to predicting trait bipolar disorder risk in this sample.

Study 2 Main Analyses: ED and Bipolar Disorder Symptom Dimensions

We next examined whether ED was associated with current bipolar disorder-relevant mood symptoms in Study 2, using parallel hierarchical linear regressions for each symptom dimension: mania (DSM5-Mania, ASRM) and depression (DSM5-Depression, BDI-SF).[9] Two sets of analyses were conducted. In the first, we tested ED-General as a predictor of symptom measures. In the second, we tested ED-Positive and ED-Negative subscales. In all models, Block 1 included demographic covariates (age and gender), Block 2 included mean PA and NA intensity, and Block 3 included the relevant ED predictor(s).

ED-General as a Predictor of Bipolar Mood Symptoms

Four separate regressions were conducted with ED-General as the Block 3 predictor. Demographic variables in Block 1 did not significantly predict any of the mood symptom outcomes (Model 1: ps > .20). When PA and NA intensity were added in Block 2, the depression symptom models were significant for both the DSM-5 Depression (Model 2: $F_{(4, 109)} = 9.04$, $p < .001$; $R^2 = .25$, $\Delta R^2 = .23$) and BDI-SF measures (Model 2: $F_{(4, 109)} = 19.59$, $p < .001$; $R^2 = .42$, $\Delta R^2 = .40$); for the mania symptom models, the DSM-5 Mania measure was significant (Model 2: $F_{(4, 109)} = 2.50$, $p = .047$; $R^2 = .08$, $\Delta R^2 = .06$), but the ASRM measure was not (Model 2: $F_{(4, 110)} = 2.29$, $p = .064$; $R^2 = .8$, $\Delta R^2 = .07$). Across Block 2 models, NA intensity predicted increased depression symptoms (BDI-SF, DSM5-Depression) and

[9] Based on Study 1 preliminary bivariate correlation findings, additional analyses were run in Study 2, with ED predicting state-level bipolar symptom measures using a subset of participants (n=113) who completed symptom measures (i.e., DSM-Mania, ASRM, DSM5-Depression, BDI-SF) during the Spring 2020 semester, an average of M=7.56 (SD=6.25) days prior to the ESM data collection period.

greater mania-related difficulties (DSM5-Mania). PA intensity predicted greater manic symptom severity (ASRM) and lower depression symptoms (BDI-SF). When ED-General was added in Block 3, the overall models remained significant for depression symptoms on the BDI-SF (Model 3: $F_{(5, 108)} = 7.22$, $p < .001$; $R^2 = .25$, $\Delta R^2 = .00$) and DSM-5 Depression measures (Model 3: $F_{(5, 108)} = 15.54$, $p < .001$; $R^2 = .42$, $\Delta R^2 = .00$). However, examination of individual beta weights indicated that ED-General did not significantly predict depression symptoms on the DSM-Depression measure ($\beta = 0.04$, $p = .642$) or the BDI-SF measure ($\beta = -0.02$, $p = .820$), and the ΔF tests were also non-significant ($ps > .64$). These results suggest that ED-General did not uniquely predict current mania or depression symptom severity beyond PA/NA intensity.

ED-Positive and ED-Negative as Predictors of Bipolar Mood Symptoms

We then examined whether valence-specific ED scores predicted mania and depression symptom measures. As with prior models, demographic variables in Block 1 did not predict any mood outcomes (Model 1 $ps > .20$). When PA and NA intensity were added in Block 2, the overall model was significant for depression symptoms on both the DSM5-Depression (Model 2: $F_{(4, 109)} = 9.04$, $p < .001$; $R^2 = .25$, $\Delta R^2 = .23$) and the BDI-SF measures (Model 3: $F_{(4, 109)} = 19.59$, $p < .001$; $R^2 = .42$, $\Delta R^2 = .40$), as well as for mania symptoms on the DSM5-Mania measure (Model 3: $F_{(4, 109)} = 2.50$, $p = .047$; $R^2 = .08$, $\Delta R^2 = .06$). As before, NA intensity predicted greater symptom severity across depression (BDI-SF, DSM5-Depression) and mania measures (DSM5-Mania), and PA predicted increased mania symptoms (ASRM). When ED-Positive and ED-Negative were added in Block 3, the overall models for both depression measures were significant ($ps < .001$), but neither the addition of the ED predictors (ΔF, $ps > .70$) nor the individual beta weights were significant ($ps > .50$). The overall models for mania symptoms were not significant after adding ED scores ($ps > .07$). Contrary to our hypotheses, valence-specific ED measures did not predict current bipolar disorder mood symptoms.

Study 2 Brief Discussion

In contrast to Study 1, but consistent with our hypotheses, findings from Study 2 indicated that lower global emotion differentiation (ED-General) was significantly associated with increased trait bipolar risk, as measured by the HPS-20. However, ED was not related to mania or depression mood symptom measures assessed within approximately 1 week prior to the ESM study. These results suggest that ED may be an important indicator of trait bipolar risk that may be contingent on differing environmental factors, which require further study. We note that the absence of associations between ED and mood symptoms could indicate that ED ability is less tied to current mood severity and more prominently influenced by trait levels of bipolar disorder risk tendencies. Although Study 2 improved upon Study 1 by collecting mania and depression symptoms more dimensionally and in a closer proximity to the experience-sampling study, mood symptoms are dynamic; thus, in future studies it will be critical to assess both concurrent and prospective predictive value of ED on bipolar symptoms and trait bipolar risk.

General Discussion

Although prior research has emphasized the importance of emotion differentiation (ED) in predicting clinically relevant outcomes, such as elevations in depression and anxiety symptoms, no study to our knowledge has examined how ED relates to bipolar disorder risk and mood symptomatology. Addressing this gap is critical, as bipolar disorder is characterized not only by difficulties with negative affect but also with dysregulated positive emotions—a domain often overlooked in ED research. Moreover, understanding ED's role across transdiagnostic features of affective disorders may provide deeper insight into shared and distinct emotional processes underlying mood dysregulation.

The present investigation hence aimed to assess whether ED—operationalized using a naturalistic experience-sampling method—was associated with dimensional measures of bipolar disorder risk in two samples of emerging adults experiencing different degrees of socioenvironmental stressors (i.e., pre-COVID in Study 1, and during the COVID-19 pandemic in Study 2). Our hypotheses were partially

supported. In Study 1, higher positive ED (but not negative or global ED), was significantly associated with increased manic symptoms. In contrast, Study 2 showed that lower global ED (including differentiation of positive and negative emotions) was associated with increased trait bipolar disorder risk, as measured by the HPS-20. Notably, ED was not significantly associated with current manic or depressive symptom severity in Study 2 when assessed within one week of the ESM data collection period.

Importance of Capturing Context in ED and Bipolar Disorder

The fact that findings diverged somewhat across Study 1 and Study 2 raise several potential interpretations and suggest potential avenues for future research. These results paint a nuanced picture about the role of context in understanding how differentiation of emotional experiences may shape and influence bipolar relevant risk and mood severity. They also raise several potential, and non-mutually exclusive, interpretations of contributing factors to the observed differences across studies.

First, one potential interpretation hinges on the fact that the studies differed in the *socioenvironmental context* in which they took place. Study 1 occurred during an anticipated and normative transitional stressor during the first year of college; Study 2 occurred during the COVID-19 pandemic, an unprecedented and unanticipated global stressor that introduced widespread disruption, social isolation and emotional uncertainty. These heightened external stressors in Study 2 may have amplified the salience of individual differences in ED as they related to underlying trait bipolar risk. Furthermore, it raises the question of whether ED ability varies within individuals across different socioenvironmental contexts. Although the present investigation did not systematically measure stress in parallel forms across Study 1 and 2, future evidence from experimental studies examining the links between stress and emotion differentiation (e.g., Nook et al., 2021) in bipolar-relevant populations are needed to unpack this possibility further.

Second, *measurement differences* between studies may have contributed to the divergent results. Study 2 included three additional emotion items (i.e., grateful/thankful, optimistic/hopeful, and lonely) used in its computation of ED which may have provided a more granular index of emotion differentiation. In other words, it is possible that additional emotion items in Study 2 may have amplified the ability to capture variation in ED which may have bolstered our ability to detect links between ED and trait risk scores. Although the total number of emotion items that differed between the two studies was modest, these findings raise the possibility that detecting meaningful associations between ED and trait markers of mood risk may require a more nuanced assessment of ED than has previously been examined in prior literature. It will also be critical to carefully tailor the specific emotion items assessed to the contextual setting in which the study is done (e.g., Study 2 added loneliness as a context-appropriate emotion during COVID-19) and emotions relevant to the theoretical models of affective processes driving a clinical phenomenon of interest (e.g., happy given its link to mania and depressed/blue to depression). Although this issue has not been explicitly addressed, results suggest future studies should carefully select ecologically valid and feasible emotions.

Third, *cohort differences* between clinical symptomatology of participants in the two studies may have contributed to divergent findings. For example, Study 2 participants reported higher current depressive symptoms than Study 1. It is possible that elevated mood symptoms may provide greater clinical variability to track underlying dimensions of risk for mood vulnerability.

Finally, this investigation highlights broader conceptual and methodological issues in the operationalization of ED. For example, this study and previous work has assessed ED using repeated experience-sampling ratings that average across multiple occasions over time (Thompson et al., 2021), whereas other research suggests that ED may vary over time, depending on developmental stage (e.g., Nook et al., 2018). Future work is needed to map the diversity of ways ED is operationalized with clinically relevant dimensions of mood difficulties in emerging adults. Taken together, these findings raise important issues for the field regarding the extent to which contextual factors may influence the

observed findings between ED and affective disorder dimensions and suggest important methodological considerations for future work in bipolar disorder and differentiation of emotional experiences.

Limitations and Future Directions

The present investigation makes several novel contributions. To our knowledge, it is the first to examine emotion differentiation (ED) in the context of bipolar disorder risk, and one of few to include both negative and positive ED measures. This is especially important given that previous research has largely focused on negative ED, leaving the role of positive ED relatively unexplored. Considering the well-documented disturbances in positive emotion within bipolar disorder and other forms of psychopathology (e.g., Gruber et al., 2020), further research on positive ED is essential to better understand the nuanced emotional dynamics that may underlie diverse clinical phenomena.

Despite these notable strengths, there were several limitations of the present investigation which point to important directions for future research. First, although Study 2 occurred during the COVID-19 pandemic—a presumed socioemotional stressor—the experience-sampling procedure did not include daily assessments of self-reported stress, which could have provided a rich opportunity to examine whether ED moderated links between daily stress and bipolar disorder-relevant symptoms. Future studies should incorporate stress measures alongside ESM to explore these potential interaction effects more directly.

Second, while a major strength of the experience-sampling methodology was its ecological validity (i.e., the ability to measure ED in people's natural everyday lives), a drawback is that there was no standardization of emotion experiences across participants in their real-world lives and everyday contexts. Future work should include within-subjects emotional experiences in daily life as well as more controlled laboratory assessments.

Third, we used a short form of the bipolar disorder risk measure (HPS-20) to assess risk in two analogue and non-clinically diagnosed samples. While the HPS-20 is a valid predictor of bipolar spectrum disorders, it has been shown to capture more pathological features of hypomanic personality as compared to the original scale, and thus, may fail to detect potentially adaptive characteristics of hypomanic personality such as energetic and cheerful mood likely present in subclinical samples (e.g., Sperry et al., 2015). As the current study was an initial investigation in a non-clinically diagnosed sample, future studies that examine comparisons between high versus low scoring groups on the full 48-item version of the HPS, or that oversample high scorers on the HPS, in addition to clinically diagnosed bipolar samples, are needed. We also note that future studies should strive to disentangle the causal, and likely bidirectional nature, of the relationship between ED and bipolar spectrum risk and symptom severity.

Fourth, we note that there are some methodological discussions regarding limitations of the widely used and standard approach to computing emotion differentiation using the intra-class correlation (ICC) approach, which may be influenced by the degree of diversity versus homogeneity in participant's daily activities (e.g., Ottenstein et al., 2020). Future work should unpack the unique contributions of diverse approaches to quantify emotion differentiation for clinical and non-clinical samples moving forward.

Lastly, our sample was relatively homogeneous—composed primarily of white, female, financially privileged, American college students. This demographic limitation severely restricts the generalizability of our findings to more diverse socioenvironmental contexts. Future research should prioritize inclusion of historically marginalized groups who experience disproportionate levels of chronic life stressors such as systemic discrimination, poverty, and health disparities. Furthermore, given the relative variation in how emotions are categorized and labeled within and across cultures and languages, expansion of ED research into more diverse populations and sociocultural contexts is important to accurately reflect the breadth and depth in which humans experience emotions (Villanueva et al., 2021).

Just as emotion models have emphasized the importance of individual context and goals in evaluating the adaptivity of a specific emotion in each situation, the current investigation indicates that

links between ED and bipolar risk may vary by contexts. However, additional research is needed that directly measures ED in variable contexts and explores the potential moderation of ED and bipolar risk by contextual factors such as stress. Such work could improve our understanding of emotion functioning processes in affective disorders characterized by dysregulated positive emotion disturbance and lead to insights on targets for risk identification and prevention efforts, as well as potential skills to integrate into psychotherapy.

Additional Information

Supplementary Material

Supplementary materials are available at https://osf.io/x7usr/

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Conflict of Interest

The authors declare that they have no competing interests.

Ethical approval

Ethical approval provided by the University of Colorado Boulder IRB (Protocol #18-0483).

Data Availability

Data is available upon request by contacting the senior authors.

Author CRediT Statement

Villanueva: Conceptualization, Data collection, Data curation, Formal analysis, Writing – original draft, Writing – review and editing, Visualization. **Ibonie:** Project administration, Data collection, Writing – review and editing. **Jensen:** Conceptualization, Data curation, Writing – review and editing. **Eloy:** Conceptualization, Writing – review and editing. **Quoidbach:** Data curation, Writing – review and editing. **Bryan:** Data curation, Writing – review and editing. **D'Mello:** Conceptualization, Data curation, Formal analysis, Visualization, Writing – review and editing. **Gruber:** Conceptualization, Software, Resources, Project administration, Funding acquisition, Writing – review and editing, Supervision.

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