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Affect and Alcohol Use: An Ecological Momentary Assessment Study of Outpatients With Borderline Personality Disorder

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Abstract

Alcohol use may be viewed as an attempt (albeit maladaptive) to regulate negative emotional states. We examined associations between both negative and positive affects and alcohol use in outpatient women diagnosed with borderline personality disorder (BPD; *n* = 74), a prototype of emotional dysregulation, as well as a psychiatric control group of women with current depressive disorder (major depressive disorder/dysthymic disorder [MDD\DYS]; *n* = 50). Participants completed randomly prompted reports of mood and alcohol use up to six times a day over a 28-day period using electronic diaries. Mean levels of either positive or negative affects did not distinguish between drinkers and nondrinkers in either diagnostic group. However, levels of both negative and positive affects were positively associated with alcohol use at the momentary level in BPD drinkers. More robust findings were obtained with respect to within-person affective variability, which was related to alcohol use in multiple ways. BPD drinkers showed higher within-person variability for most negative affects than BPD nondrinkers; MDD\DYS drinkers in general showed less within-person variability than MDD\DYS nondrinkers for negative affects. Multilevel lagged analyses for BPD drinkers indicated that alcohol use was positively related to variability in all affects, concurrently, but fewer significant effects of affect variability on the next day's drinking or significant effects of alcohol use on the next day's affect variability were observed. Among MDD\DYS drinkers, we observed more significant associations between affect variability on next day's alcohol use and of alcohol use on next day's affect variability. We discuss theoretical and methodological issues relevant to these findings as well as implications for future research.

Keywords

borderline personality disorder; alcohol; ecological momentary assessment; multilevel modeling

Borderline personality disorder (BPD) affects 1% to 3% of the general population and is a common personality disorder in clinical settings (Lenzenweger, Lane, Loranger, & Kessler,

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2007; Trull, Jahng, Tomko, Wood, & Sher, 2010). BPD is frequently comorbid with both Axis I disorders and personality disorders (Skodol et al., 2002). In particular, BPD is highly associated with substance use disorders, especially alcohol use disorders (AUDs; Trull et al., 2000). For example, Trull et al. (in press) estimated that, on average, 16.9% of individuals with an AUD diagnosis also receive a BPD diagnosis, and 45.1% of those with BPD also receive an AUD diagnosis.

One prominent theory of the etiology of AUDs may at least partially explain this association (Sher & Grekin, 2007). The use and ultimate abuse of alcohol may represent an attempt to regulate negative emotions (Sher, 1991; Trull et al., 2000). Specifically, those who experience negative emotions more frequently and intensely, and who have trouble regulating these negative emotions, are more prone to develop alcohol use problems. The effects of alcohol may be *negatively reinforcing* in that alcohol's anxiolytic properties serve to decrease feelings of negative affect or acute distress (Baker et al., 2004) and provide some temporary relief. In addition, the belief that alcohol will alleviate negative affective states may also be powerful. Alternatively, alcohol may serve as a *positive reinforcer* by increasing positive mood states (Sher, 1991).

BPD is perhaps *the* prototype of *emotional dysregulation* (Linehan, 1993; Trull et al., 2000). Emotional dysregulation or affective instability refers to the experience of acute, extreme changes in affect or the experience of aversive affective arousal. Emotional dysregulation involves a heightened emotional sensitivity, greater and more intense emotional reactivity, and a slower return to baseline arousal (Linehan, 1993). Furthermore, emotional dysregulation appears to underlie and drive the core features of this disorder, including affective instability, impulsivity, substance use problems, interpersonal problems, and identity problems (American Psychiatric Association, 2000; Trull, Tomko, Brown, & Scheiderer, 2010). Therefore, individuals with BPD seem both biologically and psychologically motivated or predisposed to abuse alcohol (Trull et al., 2000).

Existing Data on the Negative Affect-Drinking Association

Survey studies have provided evidence consistent with the affect regulation theory of drinking (see Sher & Grekin, 2007,11 for a review). Unfortunately, most survey studies of alcohol and emotions are cross-sectional, rely on retrospective reports of both mood and drinking (Hufford, 2007) and cannot address *within-person, drinking/mood relationships over time* (Carney, Armeli, Tennen, Affleck & O'Neil, 2000). Daily diary and *ecological momentary assessment* (EMA; Stone & Shiffman, 1994) studies have been used to address some of these concerns. Daily diary/ EMA studies allow researchers to examine changing behaviors and affects while utilizing naturalistic conditions and minimizing retrospection bias.

Existing daily diary/EMA studies of drinking and emotional regulation suggest that alcohol consumption is associated with both positive and negative affect in community, collegiate, and clinical samples (e.g., Armeli, Carney, Tennen, Affleck, & O'Neill, 2000; Armeli, Conner, Cullum, & Tennen, 2010; Armeli, Tennen, Affleck, & Kranzler, 2000; Chakroun, Johnson, & Swendsen, 2010; Flynn, 2000; Litt, Cooney, & Morse, 1998; Mohr, Armeli,

Tennen, Carney, Affleck, & Hromi, 2001; Steptoe & Wardle, 1999; Todd, Armeli, Tennen, Carney, & Affleck, 2003). In fact, some studies report these relationships within the same sample, suggesting perhaps independent emotionally mediated pathways to alcohol use (e.g., Hussong, Hicks, Levy, & Curran, 2001; Mohr et al., 2001, 2005; Swendsen, Tennen, Carney, Affleck, Willard, & Hromi, 2000). Fewer studies have examined the effects of mood state on subsequent alcohol use or the effects of alcohol consumption on subsequent mood state (e.g., Armeli et al., 2010; Chakroun et al., 2010; Hussong, Gould, & Hersh, 2008; Hussong et al., 2001; Mohr et al., 2005; Todd, Armeli, & Tennen, 2009; Todd et al., 2005).

Taken together, existing diary studies suggest that some individuals use alcohol to regulate emotions but that this phenomenon is moderated by individual differences, situational, and dispositional factors. Most of these studies were conducted in nonclinical samples, and it is unclear whether the levels of affect or changes in affect were clinically significant examples of emotional dysregulation or affective instability. Finally, no study to date has examined whether *variability in affective state*, perhaps indicative of affective instability and the subsequent need to regulate emotions, is associated with alcohol use.

From our perspective, emotional dysregulation is a dynamic process best captured through indices that quantify the variability or instability of mood state (e.g., Ebner-Priemer & Trull, 2009; Trull et al., 2008). When examining relations between emotional dysregulation and behavior (e.g., alcohol use), it may be fruitful to look beyond cross-sectional concurrent associations of mean mood state with behavior to exploration of how indices of mood variation or instability are related to behavior. In our study, we address this issue by examining relations between mood variability and alcohol use as well as between alcohol use and previous, concurrent, and consequent level and variability in mood.

The primary goal of the present study was to examine the associations between both negative and positive affects and alcohol use in a clinical sample characterized by high levels of emotional dysregulation, specifically those with BPD. In addition to examining associations with mean levels of affect, we also investigated the relations between alcohol use and within-person variability in these affects (both within- and between-day). In this way, it was possible to characterize more precisely the relationship between alcohol use and variability or dysregulation in affect. We were especially interested in the relations between *within-day variability* of affects and alcohol use, given that BPD affective instability typically lasts only a few hours (American Psychiatric Association, 2000). Finally, we also collected data from a psychiatric control group comprised of patients diagnosed with current depression but not BPD. This allowed us to compare the overall pattern of findings regarding affect-alcohol use associations with those obtained from a “near-neighbor” diagnosis, in this case disorders that are associated with similarly high mean levels of negative affect.

Based on previous findings in the area of emotion, emotional regulation and alcohol use, we expected (a) no significant association between overall mean levels of negative and positive affects with drinking status for members of either diagnostic group (BPD or The major depressive disorder/dysthymic disorder [MDD/DYS]); (b) intraindividual differences in the

variance of negative affects will be more strongly associated with drinking status in the BPD group, such that BPD drinkers are characterized by significantly greater variability in negative (but not positive) affects; (c) greater *within-day* variability in negative (but not positive) affects will be positively and more strongly associated with concurrent alcohol use (and number of drinks and binge drinking) for BPD drinkers than for MDD/ DYS drinkers; and (d) greater *within-day* variability in negative (but not positive) affects will also be more strongly associated with the next day's drinking behavior, as well as drinking on the previous day for BPD drinkers.

Method

Participants

Participants were recruited from one of four local psychiatric outpatient clinics that serve community or university populations or both, and screened through chart review. Axis I and Axis II diagnostic interviews established the eligibility of participants in a larger study examining affective instability in outpatients (see Trull et al., 2008, for details). A total of 131 outpatients were entered into the study. The BPD group (n = 81) included psychiatric outpatients who met *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (*DSM–IV–TR*; American Psychiatric Association, 2000) diagnostic criteria for BPD and who endorsed the diagnostic feature of affective instability. The MDD/DYS group (n = 50) included psychiatric out-patients who met criteria for either a current *DSM–IV–TR* MDD or DYS diagnosis and who did not meet criteria either for BPD in general or for the specific feature of affective instability. There were only six men out of 81 BPD patients, and 11 men out of 50 MDD/DYS patients in the sample, which limits inference regarding the male group. In addition, one female BPD participant's EMA data on alcohol use appeared questionable.[1] Therefore, we focused the present analyses on 113 women with BPD or MDD/ DYS.

The mean age of the 113 women participants was 33.6 years old (SD = 12.04), most were White (89.2%), had family incomes of less than $25,000 (69.0%), and were single, divorced, or separated (67.3%). Approximately one-half of the sample had been previously hospitalized for psychiatric reasons (48.7%), and 53.6% were currently employed. As for current Axis I comorbid diagnoses, 74.5% had an anxiety disorder, 75.7% had a mood disorder, and 10.0% had a substance use disorder (5.5% with an AUD and 4.5% with a drug use disorder). Concerning Axis II comorbidity, 37.2%, 20.4%, and 8.8% received avoidant, obsessive–compulsive, and dependent personality disorder diagnoses, respectively.

The only significant differences between patients in the BPD and the MDD/DYS groups were as follows: (a) the BPD group had more previous psychiatric hospitalizations (M = 3.1, SE = 6.7 vs. M = 1.1, SE = 2.1; t = 2.37, p = .020); (b) the BPD group was significantly more likely to have a current anxiety disorder (81.7% vs. 61.5%; χ^2 = 5.387, p = .020), histrionic PD (9.5% vs. 0.0%; χ^2 = 3.933, p = .047), and paranoid PD (10.8% vs. 0.0%; χ^2 = 4.537, p = .033) diagnosis; and (c) as expected, the MDD/DYS group was significantly more

[1]This participant endorsed criteria for *current* alcohol dependence but did not report any momentary alcohol use during the course of the study.

likely to have a current mood disorder than the BPD group (100.0% vs. 62.5%; $\chi^2 = 19.326$, $p < .001$).

The only significant differences between drinkers and nondrinkers were observed in the BPD group: BPD drinkers were significantly younger than nondrinkers ($M = 29.6$, $SD = 11.4$ vs. $M = 38.0$, $SD = 11.1$; $t = 2.9$; $p = .005$); and BPD drinkers were more likely than nondrinkers to receive a current substance use disorder diagnosis ($\chi^2 = 5.226$, $p = .022$).

Procedures and Measures

Participants were issued an *electronic diary* (ED; Palm Zire 31 handheld computer), programmed to prompt them to record their affects, experiences, and behaviors six times a day over a 28-day period. The software program stratified the participant's personalized waking hours into six equal intervals, and then randomly selected one moment within each interval to deliver a prompt (see Trull et al., 2008, for more details).

Mood assessment—Mood items from the *Positive and Negative Affect Schedule-Extended* version (PANAS-X; Watson & Clark, 1999) were used to measure positive affect (PA; 10 items) and negative affect (NA; 10 items). We administered several additional mood items from the PANAS-X to calculate scores for the following negative affect subscales: Hostility (six items), Fear (six items), and Sadness (five items). Items were presented to each participant on the ED during each momentary assessment. For each mood item, respondents were asked to rate the extent to which they felt this way (1 = *very slightly or not at all*, 5 = *extremely*) since the last prompt. Averages of the PA and NA items were used as measures of momentary or short-term positive affect and negative affect, respectively. Items for each of the three subscales were also averaged to calculate the corresponding affect states.

Alcohol assessment—Two alcohol-related momentary experiences were assessed. *Alcohol drink* (0 = *no*, 1 = *yes*) was measured by participants' response for a question "Have you used alcohol since the last beep you answered?" at each momentary occasion. The *number of drinks* during each time interval was also reported (0 = *no drink* to 7 = *seven or more standard drinks*). To assess sequential associations of affect states and alcohol drink at momentary level, we created two binary alcohol drink variables, *alcohol drink at the previous occasion* and *alcohol drink at the following occasion*. Furthermore, we calculated two number of drinks variables, *number of drinks at the previous occasion* and *number of drinks at the following occasion*.

Daily alcohol variables—Daily alcohol variables were created based on the momentary alcohol variables: *Alcohol day* was defined as a day with one or more endorsed momentary alcohol drink assessments (0 = *nonalcohol day*, 1 = *alcohol day*).[2] Daily binge drinking was assessed based on the number of daily drinks, defined as the total number of drinks for each day and calculated by summing up the number of drinks of all the momentary assessments for a given day. If the number of daily drinks was four or more, the day was defined as *binge day* (0= *nonbinge day*, 1 = *binge day*). To assess sequential associations of affect states (and variability) and alcohol drink at daily level, we created two daily alcohol drink variables,

alcohol drink on the previous day and *alcohol drink on the following day*, and two daily binge drinking variables, *binge drinking on the previous day* and *binge drinking on the following day*, respectively.

Among the 74 women with BPD, 52 participants who reported one or more instances of alcohol use were classified as *drinkers*, and 22 participants who did not report any alcohol use were classified as *nondrinkers* (0 = *nondrinker*, 1 = *drinker*). Similarly, 25 participants out of 39 women with MDD/DYS were classified as drinkers, and the other 14 women were classified as nondrinkers. In total, there were 77 drinkers and 36 nondrinkers in the sample.

Results

Preliminary Analysis[3]

The average number of days in the study was not significantly different either between drinkers and nondrinkers, $F(1, 109) = 1.24$, $p = .27$, or between the BPD group and MDD/DYS group, $F(1, 109) = 1.79$, $p = .18$, nor was the interaction effect of drinking group by diagnostic group, $F(1, 109) = 0.01$, $p = .94$. No significant effects on the average number of assessments per day were found for drinking group, $F(1, 108) = 1.05$, $p = .31$, diagnostic group, $F(1, 108) = 2.32$, $p = .13$, their interaction, $F(1, 108) = 0.69$, $p = .41$, or alcohol day, $F(1, 3081) = 1.89$, $p = .17$. However, the average number of assessments per day significantly decreased over the course of the study, $b = -0.022$, 95% confidence interval (CI) = [−0.028, −0.015], $F(1, 3081) = 78.78$, $p < .001$.[4] Two-way interactions of days of the study by drinking group, $F(1, 3081) = 0.38$, $p = .54$, and by diagnostic group, $F(1, 3081) = 0.67$, $p = .41$, and three-way interaction of days of the study by drinking group by diagnostic group, $F(1, 3081) = 1.89$, $p = .17$, were not significant. No significant effects on the total number of assessments were found for drinking group, $F(1, 109) = 3.42$, $p = .07$, diagnostic group, $F(1, 109) = 0.01$, $p = .92$, or their interaction, $F(1, 109) = 0.64$, $p = .42$.

[2]Because participants reported their experiences since the last prompt at each momentary assessment, experiences reported at the first assessment of each day included those between the last assessment and sleep time of the previous day as well as experiences between wake–up time and the first assessment of the current day. Consequently, the alcohol use report at the first assessment of each day could represent either alcohol use from the previous day or alcohol use from the current day since wakeup. Although participants did not explicitly indicate which scenario was the case, we believe that the alcohol use reported at the first assessment of each day was primarily from the previous day. Therefore, we considered the alcohol report at the first assessment of each day as the last report of the previous day.

[3]Although the protocol was designed to prompt six random assessments a day over 28 days, the number of days in the study varied across participants, *Mdn* = 29, interquartile range (*IQR*) = 2, *M* = 28.7, *SD* = 3.0, as did the number of assessments per day, *Mdn* = 5, *IQR* = 1, *M* = 5.2, *SD* = 1.2. Some participants provided slightly more than 28 days of assessments because the last data download for them did not transpire exactly on day 28 of the study. The total number of assessments for each person ranged from 76 to 182, *Mdn* = 152, *IQR* = 25, *M* = 147.4, *SD* = 19.3, resulting in 16,702 total assessments from 113 participants. BPD drinkers had 554 total momentary reports of drinking alcohol (7.39% out of the 7,499 total assessments), 393 alcohol days (26.32% out of the 1,493 total days), and 157 binge drinking days (10.52%). MDD/DYS drinkers had 212 total momentary reports of drinking alcohol (5.77% out of 3,676 total assessments), 160 alcohol days (22.92% out of 698 total days), and 39 binge days (5.59%).

[4]Differences in average number of assessments per day may produce spurious differences in within–day variance of momentary assessments of affects. If the number of assessments for one day is less than that for another day, the average time interval between consecutive assessments of the day is longer. Because momentary affects were assessed by respondents' reports on short-term overall mood state (since the last prompt), affect scores over a longer time interval tend to be less variable than those over a shorter time interval. Therefore, we included day of the study as one of covariates of within-day variance models in the main analyses.

Differences in Mean Level and Variability of Affect Scores Between Drinkers and Nondrinkers

First, we compared drinkers and nondrinkers across the BPD and MDD/DYS groups in terms of their level and (within-person) variability of the five affect scores, that is, negative affect, hostility, fear, sadness, and positive affect. We fit the following multilevel model:

$$\begin{aligned}
&\text{Level 1:} \quad y_{tij} = \pi_{0ij} + e_{tij} \\
&\text{Level 2:} \quad \pi_{0ij} = \gamma_{00j} + \gamma_{01j} Day_{ij} + u_{0ij} \\
&\text{Level 3:} \quad \gamma_{00j} = \beta_{000} + \beta_{001} Drinker_j + \beta_{002} MDD_j + \beta_{003} Drinker_j MDD_j + r_{0j} \\
&\qquad\qquad \gamma_{01j} = \beta_{010}
\end{aligned}$$

where y_{tij} is a momentary assessment of negative affect, for example, at occasion *t* on day *i*, for individual *j*. This model assumes a three-level hierarchical data structure: momentary scores (level 1) are nested within days (level 2), which are, in turn, nested within individuals (level 3). The fixed factors of *Drinker* and *MDD* represent the between-person level covariates of drinking (0 = *nondrinker*; 1 = *drinker*) and diagnostic (0 = *BPD*; 1 = *MDD/DYS*) group, respectively. The fixed factor *Day* represents a daily level covariate of day of the study (0 = *first day of the study*, 1 = *second day of the study*, and so forth). The following random variables were assumed normal: $r_{00j} \sim N(0, \tau_r^k)$, $u_{0ij} \sim N(0, \tau_u^k)$, and $e_{tij} \sim N(0, \sigma_{ij}^2)$, where *k* indexes BPD nondrinkers (*k* = 1), BPD drinkers (*k* = 2), MDD/DYS nondrinkers (*k* = 3), and MDD/DYS drinkers (*k* = 4). Within-day variance σ_{ij}^2 was modeled as a log-linear model with level-3 covariates of diagnostic group, drinking group, and their interaction as well as a level-2 covariate of day of the study, modeled as:

$$\sigma_{ij}{}^2 = \sigma^2 \mathrm{e}^{(\delta_1 MDD_j + \delta_2 Drinker_j + \delta_3 MDD_j Drinker_j + \delta_4 Day_{ij})}$$

where σ^2 represents, as a reference group, the within-day variance of BPD nondrinkers on the first day of the study. As such, σ_{ij}^2 represents the within-day variability of momentary fluctuations accounted for by the factors in the previous equation.

The variance of the level-3 overall random intercept, τ_r^k, represents the mean level difference between individuals in the affective state of interest, and the variance of the level-2 daily random intercept, τ_u^k, represents day-to-day fluctuations of the affective state of interest across the four *k diagnostic-drinking status groups*.[5] Table 1 presents results from this model for negative affect, hostility, fear, sadness, and positive affect scores.

As can be seen in Table 1, no significant differences were found in *overall mean level* (Level 3, Person Effects) across the five affective states as a function of drinking group, diagnostic group, or their interaction (all $|t|$s < 1.33, df = 109, all ps > .19). No significant

[5]Without inclusion of between-person variability in the model, we cannot separate within-person variability from overall variability within each group. Inclusion of between person variability in the model is not for hypothesis testing per se between the two groups but for controlling or extracting between-person variability to get proper estimates of within-person variability.

effects of day of the study (Level 2, Day Effects) on overall mean of affect were found (all $|t|$s < 1.57, df = 16588, all ps > .12).

Variability in negative affect—For negative affect, BPD drinkers showed more between-person variability than BPD non-drinkers, $\Delta\chi^2(1) = 6.0$, $p = .01$, and more between-day and within-day variability as well, $\Delta\chi^2(1) = 34.6$, $p < .001$, and $\hat{\delta_2} = 0.16$, $z = 4.84$, $p < .001$, respectively). By contrast, no significant differences in interindividual or within-day variability in NA were found between MDD/DYS drinkers and MDD/DYS nondrinkers, $\Delta\chi^2(1) = 3.2$, $p = .07$, and $z = -1.41$, $p = .16$, respectively. Significantly less between-day variability in negative affect was found for MDD/DYS drinkers than MDD/DYS nondrinkers, $\Delta\chi^2(1) = 23.5$, $p < .001$. MDD nondrinkers did not differ from BPD nondrinkers in terms of within-day variability ($\delta_1 = -0.01$).

Variability in hostility—For hostility, no significant differences between BPD drinkers and BPD nondrinkers were found in interindividual variability, $\Delta\chi^2(1) = 1.1$, $p = .29$, or between-day variability, $\Delta\chi^2(1) = 2.4$, $p = .12$. BPD drinkers, however, showed significantly smaller within-day variability than BPD non-drinkers, $\hat{\delta_2} = -0.11$, $z = -3.53$, $p < .001$. MDD/DYS drinkers showed, relative to MDD/DYS nondrinkers, significantly less between-person variability, $\Delta\chi^2(1) = 11.3$, $p < .001$ and more within-day variability, $\delta_2 + \delta_3 = -0.19$, 95% CI [−0.27, −0.11], $z = -4.41$, $p < .001$, but no significant difference in between-day variability, $\Delta\chi^2(1) = 1.9$, $p = .17$.

Variability in fear—For fear, BPD drinkers showed, relative to BPD nondrinkers, significantly greater between-person, between-day and within-day variability, $\Delta\chi^2(1) = 8.0$, $p = .005$; $\Delta\chi^2(1) = 97.5$, $p < .001$; and $\hat{\delta_2} = 0.32$, $z = 9.76$, $p < .001$, respectively. This is in contrast to the comparison of MDD/DYS drinkers to nondrinkers, who showed no significant differences in between-person or within-day variability, $\Delta\chi^2(1) = 0.8$, $p = .37$ and $z = 0.51$, $p = .61$, respectively, and significantly *smaller* between-day variability, $\Delta\chi^2(1) = 39.6$, $p < .001$.

Variability in sadness—For sadness, BPD drinkers were not statistically different from BPD-nondrinkers in terms of between-person or within-day variability, $\Delta\chi^2(1) = 0.3$, $p = .58$ and $z = -0.56$, $p = .57$, respectively, but showed significantly greater between-day variability, $\Delta\chi^2(1) = 23.5$, $p < .001$. MDD/DYS drinkers, relative to MDD/DYS nondrinkers, showed significantly smaller between-person and between-day variability, but greater within-day variability, $\Delta\chi^2(1) = 8.0$, $p = .005$; $\Delta\chi^2(1) = 97.5$, $p < .001$; and $\hat{\delta_2} + \hat{\delta_3} = 0.17$, 95% CI = [0.08, 0.25], $z = 3.92$, $p < .001$, respectively.

Variability in positive affect—For positive affect, BPD drinkers were not found to differ from BPD nondrinkers in degree of interindividual variability, between-day variability, or within-day variability, $\Delta\chi^2(1) = 0.2$, $p = .65$; $\Delta\chi^2(1) = 0.1$, $p = .75$; and $z = 1.60$, $p = .11$, respectively. MDD/DYS drinkers were also not significantly different from MDD/DYS nondrinkers in terms of between-person variability, $\Delta\chi^2(1) = 0.7$, $p = .40$, but did demonstrate significantly greater between-day and within-day variability, $\Delta\chi^2(1) = 4.0$, $p = .046$ and $\hat{\delta_2} + \hat{\delta_3} = 0.34$, 95% CI = [0.25, 0.42], $z = 7.90$, $p < .001$, respectively.

Summary—Taken together, these results suggest that women drinkers and nondrinkers with BPD or MDD/DYS cannot be distinguished by reference to their overall mean levels of positive affect or different negative affects. However, consistent with the general hypotheses that alcohol may be involved in patterns of affective dysregulation, drinkers with BPD or MDD/DYS appeared to have different degrees of inter- and intraindividual variability relative to nondrinkers especially for negative affect (and its subscales). These differences, however, are not parallel across BPD and MDD/DYS women. BPD drinkers were more variable in the level of reported affect than BPD nondrinkers for negative affect ($\tau_r^2=0.42$ vs. $\tau_r^1=0.16$) and fear ($\tau_r^2=0.45$ vs. $\tau_r^1=0.14$). In contrast, MDD/DYS drinkers were less variable than MDD/DYS nondrinkers for hostility ($\tau_r^4=0.07$ vs. $\tau_r^3=0.35$) and sadness ($\tau_r^4=0.23$ vs. $\tau_r^3=0.89$). Regarding within-person variability in affect across or within days indicative of possible affective instability, BPD drinkers were more variable than BPD nondrinkers in terms of day-to-day variability in negative affect, fear, and sadness ($\tau_u^2=0.17$ vs. $\tau_u^1=0.10$; $\tau_u^2=0.20$ vs. $\tau_u^1=0.08$; and $\tau_u^2=0.23$ vs. $\tau_u^1=0.19$, respectively) while MDD/DYS drinkers showed *less* between-day variability in those three affective states (Table 1). In addition, BPD drinkers showed *greater* within-day variability in NA (0.21 vs. 0.18) and fear (0.23 vs. 0.17) than BPD nondrinkers, while MDD/DYS drinkers showed *greater* variability of sadness (0.40 vs. 0.34). In the case of positive affect, however, the only significant difference found was that MDD/DYS drinkers had *greater* within-day affective variability than MDD/DYS nondrinkers (0.33 vs. 0.23).

Concurrent and Lagged Effects of Alcohol Use and Affect Scores in BPD and MDD/DYS Drinkers

Next, we focused more specifically on the possible differential patterns of affect and alcohol use occasions in *drinkers* from the two diagnostic groups: 52 BPD drinkers and 25 MDD/DYS drinkers. We modeled mean affects as a function of alcohol related covariates and diagnostic group at the same three levels of inter-individual, interday, and intraday aggregation. At the momentary level, dummy variables of alcohol drink at the next occasion (*ALC_NTO*), alcohol drink at the current occasion (*ALC_O*), and alcohol drink at the previous occasion (*ALC_PRO*) were included in the model. Dummy variables of alcohol drink on the next day (*ALC_NTD*), alcohol drink on that day (*ALC_D*), and alcohol drink on the previous day (*ALC_PRD*) were included as daily level covariates. A diagnostic group variable *MDD* (0 = BPD, 1 = MDD/DYS) was also included as an individual level covariate, and cross-level interactions of momentary alcohol variables by drinking group (i.e., *ALC_NTO*×*MDD*, *ALC_O*×*MDD*, *ALC_PRO*×*MDD*) as well as by daily alcohol variables (i.e., *ALC_NTD*×*MDD*, *ALC_D*×*MDD*, *ALC_PRD*×*MDD*) were also estimated. This model can be expressed as the following three-level model:

$$
\begin{aligned}
\text{Level 1:}\quad & y_{tij}=\pi_{0ij}+\pi_{1ij}ALC\_NTO_{tij}+\pi_{2ij}ALC\_O_{tij}+\pi_{3ij}ALC\_PRO_{tij}+\pi_{4ij}+\pi_{5ij}+\pi_{6ij}+e_{tij}\\
\text{Level 2:}\quad & \pi_{0ij}=\gamma_{00j}+\mu_{0ij}\\
& \pi_{1ij}=\gamma_{01j}\\
& \pi_{2ij}=\gamma_{02j}\\
& \pi_{3ij}=\gamma_{03j}\\
& \pi_{4ij}=\gamma_{04j}ALC\_NTD_{ij}\\
& \pi_{5ij}=\gamma_{05j}ALC\_D_{ij}\\
& \pi_{6ij}=\gamma_{06j}ALC\_PRD_{ij}\\
\text{Level 3:}\quad & \gamma_{00j}=\beta_{000}+\beta_{001}MDD_j+r_{00j}\\
& \gamma_{01j}=\beta_{010}+\beta_{011}MDD_j\\
& \gamma_{02j}=\beta_{020}+\beta_{021}MDD_j\\
& \gamma_{03j}=\beta_{030}+\beta_{031}MDD_j\\
& \gamma_{04j}=\beta_{040}+\beta_{041}MDD_j\\
& \gamma_{05j}=\beta_{050}+\beta_{051}MDD_j\\
& \gamma_{06j}=\beta_{060}+\beta_{061}MDD_j
\end{aligned}
$$

In this model, y_{tij} is defined as before. Random variables were assumed to be normal, such that $r_{00j}\sim N(0,\tau_r^k)$, $u_{0ij}\sim N(0,\tau_u^k)$, and $e_{tij}\sim N(0,\sigma_{ij}^2)$, where *k* indexes diagnostic group (for BPD *k* = 1 and for MDD/DYS *k* = 2). Within-day variance σ_{ij}^2 was modeled as a log-linear model with level-3 diagnostic group variable *MDD* and level-2 covariates of alcohol drink on the next day (*ALC_NTD*), alcohol drink on the current day (*ALC_D*), and alcohol drink on the previous day (*ALC_PRD*), and their cross-level interactions. In order to control for possible confounds due to reduced reporting levels at later days of measurement, *Day* of the study was also included in the model, producing the following model of individual-level variation in affect:

$$\sigma_{ij}^2=\sigma^2 e^{(\delta_1 MDD_j+\delta_2 ALC\_NTD_{ij}+\delta_3 ALC\_NTD_{ij}MDD_j+\delta_4 ALC\_D_{ij}+\delta_5 ALC\_D_{ij}MDD_j+\delta_6 ALC\_PRD_{ij}+\delta_7 ALC\_PRD_{ij}MDD_j+\delta_8 Day_{ij})},$$

where σ^2 represents a comparison group within-day variance for BPD drinkers on the first day of the study who had no alcoholic drink on the previous, current, or the next day.

β_{020} represents the *difference of the average affect scores between occasions with current alcohol drink and those occasions without current alcohol drink for BPD drinkers*. Significance of β_{020} suggests a concurrent association of alcohol drink with the affective state under consideration. Parameter β_{010}, the *difference of the average affect scores between successive occasions, when a reported alcohol drink is forthcoming at the next assessment*, and can be interpreted as the difference in successive affective states for those about to use alcohol at the next moment. On the other hand, β_{030}, indexes the *difference of average affective states across occasions with and without an alcohol drink reported at the previous assessment occasion*. This can be interpreted as the lagged effect of the previous alcohol drink on the current affective states.[6] Similarly, β_{040}, β_{050}, and β_{060}, can be interpreted as the *lagged effect of daily average affect scores on alcohol drink of the next day, concurrent association of daily average affect scores and alcohol day, and the lagged effect of alcohol drink of the previous day on daily average affect scores on the current day*, respectively.

Table 2 presents the results of the model for the five affect scores based on drinkers in the two diagnostic groups.

Negative affect—On alcohol drink occasions, BPD drinkers showed significantly higher average momentary negative affect scores than on nondrinking occasions, $\hat{\beta}_{020} = 0.07$, $t(10488) = 2.98$, $p = .04$. MDD/DYS drinkers, however, did not, $\hat{\beta}_{020} + \beta_{021} = -0.04$, $t(10488) = -1.17$, $p = .24$, as indicated by the significant interaction of momentary concurrent association with diagnostic group, $\beta_{020} = -0.11$, $t(10488) = -2.56$, $p = .01$. An interaction of diagnostic group and daily level lagged effect of alcohol drink on negative affect scores was also found, $\hat{\beta}_{061} = 0.10$, $t(10488) = 1.98$, $p = .048$, indicating that the effect was greater for MDD/DYS drinkers than BPD drinkers. No other fixed effects were statistically significant.

Hostility—For hostility, BPD drinkers showed a significant concurrent momentary association of average hostility scores and whether or not an alcoholic drink was reported, $\hat{\beta}_{020} = 0.08$, $t(10488) = 3.00$, $p = .003$. A significant difference of average hostility scores on nondrinking occasions between BPD and MDD/ DYS drinkers was also found, $\hat{\beta}_{001} = -0.22$, $t(10488) = -2.23$, $p = .03$.

Fear—For fear, only the interaction of diagnostic group and momentary concurrent association was significant, $\hat{\beta}_{021} = -0.11$, $t(10488) = -2.15$, $p = .03$, indicating that the association of fear and concurrent alcohol use for MDD/DYS drinkers were more negative than that for BPD drinkers.

Sadness—For sadness, BPD drinkers showed significant negative lagged effect on alcohol drink, $\hat{\beta}_{010} = -0.06$, $t(10488) = -2.21$, $p = .027$, significant positive concurrent association with alcohol drink, $\hat{\beta}_{020} = 0.06$, $t(10488) = 2.02$, $p = .04$, but no significant lagged effect of alcohol drink on sadness, $\hat{\beta}_{030} = -0.05$, $t(10488) = -1.66$, $p = .10$, respectively, at the momentary level. MDD/DYS drinkers who were about to drink, in contrast, were not significantly different in moment to moment changes in sadness compared to those not about to drink, $\hat{\beta}_{010} + \hat{\beta}_{011} = -0.01$, $t(10488) = -0.21$, $p = .83$, but a significant negative concurrent association with alcohol drink, $\hat{\beta}_{020} + \hat{\beta}_{021} = -0.13$, 95% CI [−0.25, −0.18], $t(10488) = -2.26$, $p = .024$, and a significant lagged effect of alcohol drink on sadness, $\hat{\beta}_{030} + \hat{\beta}_{031} = -0.12$, $t(10488) = -2.25$, $p = .02$, respectively, at the momentary level were observed.

Positive affect—For positive affect, there was a significant momentary lagged effect on alcohol drink, $\hat{\beta}_{010} = 0.16$, $t(10488) = 5.06$, $p < .001$, and a significant concurrent association with alcohol drink, $\hat{\beta}_{020} = 0.12$, $t(10488) = 3.65$, $p < .001$, for BPD drinkers. MDD/DYS drinkers showed a significant association between momentary change in previous level of positive affect and later initiation of drinking, $\hat{\beta}_{010} + \hat{\beta}_{011} = 0.11$, $t(10488) = 2.13$, $p = .03$. No other significant fixed effects were found across all the five affect scores.

[6]Because the momentary assessments requested respondents to report short-term overall mood state and alcohol drink experience since the last prompt, the reported affect scores may not represent affective states at the drinking moment and the presented association does not guarantee a true concurrent relation in its exact meaning. In addition, because successive assessments were randomly timed, interpretation of the lagged effects estimated by the suggested model must be qualified. Nevertheless, we believe that the current model specification is a reasonable solution to investigate concurrent and lagged association of the two momentarily assessed variables in EMA data like these.

Variability in affects—Concerning degree of *between-person variability*, BPD drinkers were significantly more different from each other than were MDD/DYS drinkers in terms of negative affect, hostility, and sadness, $\Delta\chi^2(1) = 10.0$, $p = .002$; $\Delta\chi^2(1) = 13.8$, $p < .001$; and $\Delta\chi^2(1) = 5.2$, $p = .02$, respectively. For *intraindividual variability*, BPD drinkers showed greater *day-to-day* variations than MDD/DYS drinkers in negative affect, hostility, fear, and sadness, $\Delta\chi^2(1) = 63.5$, $p < .001$; $\Delta\chi^2(1) = 38.4$, $p < .001$, $\Delta\chi^2(1) = 99.2$, $p < .001$, $\Delta\chi^2(1) = 5.0$, $p = .03$. BPD drinkers also showed higher levels than MDD/DYS drinkers in terms of *within-day* variability in negative affect, hostility, fear, and positive affect $\hat{\delta_1} = -0.42$, $z = -10.28$, $p < .001$; $\hat{\delta_1} = -0.37$, $z = -8.98$, $p < .001$, $\hat{\delta_1} = -0.55$, $z = -13.65$, $p < .001$; $\hat{\delta_1} = -0.33$, $z = -8.08$, $p < .001$, respectively).

Concurrent and lagged associations with affect variability—We also found several interesting concurrent and lagged associations between within-day affective variability and alcohol drink. First, BPD drinkers showed significantly greater within-day variance on days with alcohol drink than on other days (without alcohol drink on the previous, current, or the next day of the assessments) in terms of negative affect, $\hat{\delta_4} = 0.31$, $z = 6.68$, $p < .001$, hostility, $\hat{\delta_4} = 0.29$, $z = 6.44$, $p < .001$, fear, $\hat{\delta_4} = 0.29$, $z = 6.30$, $p < .001$, sadness, $\hat{\delta_4} = 0.24$, $z = 5.16$, $p < .001$, and positive affect, $\hat{\delta_4} = 0.12$, $z = 2.64$, $p = .008$. MDD/DYS drinkers, relative to BPD drinkers, showed even greater within-day variance on alcohol days than other days in fear, $\hat{\delta_5} = 0.26$, $z = 3.06$, $p = .002$, sadness, $\hat{\delta_5} = 0.27$, $z = 3.16$, $p = .002$, and positive affect, $\hat{\delta_5} = 0.38$, $z = 4.51$, $p < .001$. In addition, MDD/DYS drinkers showed a significant lagged effect of within-day affect variability on alcohol drink on the next day for negative affect, $\hat{\delta_2} + \hat{\delta_3} = 0.46$, $z = 6.78$, $p < .001$, hostility, $\hat{\delta_2} + \hat{\delta_3} = 0.21$, $z = 3.00$, $p = .003$, fear, $\hat{\delta_2}\hat{\delta_3} = 0.47$, $z = 6.92$, $p < .001$, sadness, $\hat{\delta_2}\hat{\delta_3} = 0.30$, $z = 4.39$, $p < .001$, and positive affect, $\hat{\delta_2}\hat{\delta_3} = 0.22$, $z = 3.21$, $p = .001$. Significant lagged effects of alcohol drink on the next day's within-day affective variability were found in hostility, $\hat{\delta_6} = 0.23$, $z = 5.01$, $p < .001$, fear, $\hat{\delta_6} = 0.13$, $z = 2.71$, $p < .007$, and positive affect, $\hat{\delta_6} = 0.21$, $z = 4.65$, $p < .001$, for BPD drinkers. MDD/DYS drinkers showed significant lagged effects of alcohol drink on within-day variability in negative affect, $\hat{\delta_6} + \hat{\delta_7} = 0.34$, $z = 4.98$, $p < .001$, hostility, $\hat{\delta_6} + \hat{\delta_7} = 0.28$, $z = 4.24$, $p < .001$, fear, $\hat{\delta_6} + \hat{\delta_7} = 0.31$, $z = 4.55$, $p < .001$, and positive affect, $\hat{\delta_6} + \hat{\delta_7} = 0.15$, $z = 2.31$, $p = .02$.

Summary—In summary, BPD drinkers showed greater *within-day* affective variability on alcohol use days relative to other days for all five affect scores. In addition, BPD drinkers showed positive lagged effects of alcohol drink on *within-day* variability of hostility, fear, and positive affect, while MDD/DYS drinkers showed the same lagged effects on *within-day* variability of negative affect, hostility, fear, and positive affect. Finally, MDD/DYS drinkers showed lagged effects of *within-day* variability for all five affect scores on alcohol drink on the next day.

Supplementary Analyses

We also fit the same model using *number of drinks* and *binge drinking day* as momentary and daily level alcohol covariates instead of alcohol drink and alcohol day. Results are presented in Table 3. Fixed effects of *concurrent* positive associations of the number of drinks and level of affect were significant for all five affect scores in BPD drinkers, but this

pattern of concurrent associations was not found in MDD/DYS drinkers. BPD drinkers also showed significantly lower degrees of association between level of affect and subsequent drinking. The effect of negative affect on subsequent drinking for BPD individuals was −0.02, while the corresponding relationship for MDD individuals was 0.02, $\hat{\beta}_{010} + \hat{\beta}_{011}$, $t(10488) = 2.02$, $p = .04$. Similar differential effects as a function of diagnostic category were also found for hostility (−.02 for BPD vs. 0.02 for MDD/DYS; $t(10488) = 2.03$, $p = .04$), and fear (−0.01 for the BPD group vs. 0.05 for the MDD/DYS group, $t(10488) = 4.18$, $p < .001$). No interaction by diagnostic group involving levels of sadness on subsequent drinking was found. The effect of levels of PA on subsequent drinking was positive for both groups. The interaction involving group was significant, indicating that, for the MDD/DYS group, this effect was stronger (0.07; $\hat{\beta}_{010} + \hat{\beta}_{011} = 0.07$, $t(10488) = 4.04$, $p = .001$) than in the BPD group (0.02). For *within-day* variability, BPD drinkers showed significantly smaller within-day variance of negative affect (and its subscales) on the day before *binge day* than nonalcohol day. Other patterns were similar to the previous analyses for *number of drinks*.

Discussion

Our findings partially supported our predictions concerning relationships between affect and alcohol use in BPD and MDD/ DYS. First, as predicted, *overall mean levels* of affects did not distinguish between drinkers and nondrinkers, regardless of diagnostic group. Second, *within-person variability in affects*, including both *between- and within-day variability*, distinguished drinkers from nondrinkers in both diagnostic groups. Consistent with hypotheses, BPD drinkers, in general, were distinguished by larger within-person (between-day and within-day) variability in negative but not positive affect scores. In general, MDD/DYS drinkers compared to nondrinkers were distinguished by *smaller* between-day variability in negative affects, but MDD/DYS drinkers showed *more* within-day variability than nondrinkers in hostility and sadness (the latter being a statistically stronger association than that for the BPD group). Third, the variances of all five affects were significantly larger on drinking versus nondrinking days for BPD drinkers. However, MDD/DYS drinkers showed even stronger effects for drinking versus nondrinking days in terms of larger within-day variance for fear, sadness, and positive affect. These group differences were no longer found when we examined number of drinks per day or whether it was a binge day. Fourth, our predictions of greater within-day variability in negative affects predicting next day drinking for BPD drinkers was not supported; this was found, however, for MDD/DYS drinkers. There were significant associations between next day within-day variability in hostility, fear, and positive affect and current day drinking in the BPD drinkers; the MDD/DYS drinkers showed an even stronger relationship between next day within-day variability in fear and current day drinking.

Within the context of previous studies of the relation of alcohol use with mood, these findings highlight several issues. Although we did not find that *overall mean levels* of either positive or negative affects distinguished drinkers from nondrinkers in our participants, contrary to expectations, we did find that levels of both negative and positive affects were positively associated with alcohol use at the *momentary level* in BPD drinkers. That is, drinking episodes in our BPD participants were accompanied by higher reported levels of both negative and positive affects, on average. In contrast, mean levels of most negative

affects at the *previous assessment* were not associated with alcohol use on the subsequent occasion BPD drinkers, and alcohol use in the BPD drinking group was not significantly associated with mean level of any negative affects on the next occasion.

Our findings that higher levels *both* of negative affects and of positive affect were related to drinking reports concurrently is consistent with previous findings from community (e.g., Mohr et al., 2001) and collegiate samples (e.g., Hussong et al., 2001; Mohr et al., 2005). Although they did not measure affect per se, Mohr et al. (2001) found that days with more positive interpersonal experiences were associated with drinking in social contexts, whereas days with more negative interpersonal experiences were associated with drinking alone (and this relationship was moderated by levels of neuroticism). In a college student sample, Mohr et al. (2005) reported that positive mood was positively associated with drinking away from home, while negative mood was positively related to drinking at home. There were moderators of these effects, including drinking motives and time spent with friends. In contrast to previous studies (e.g., Hussong et al., 2001; Hussong et al., 2008; Mohr et al., 2005; Swendsen et al., 2000; Todd et al., 2009), however, we did not find that levels of negative affects, in general, were related to alcohol use on the next occasion or that alcohol use was associated with subsequent negative affect level in our BPD drinkers.

Although some of the inconsistencies in findings could certainly be due to differences in samples, methods (e.g., time frame used), or measures, we believe there is a need for improved conceptualization and operationalization of *affective or emotional dysregulation* in studies evaluating affect-alcohol use relations. The affect regulation hypothesis of alcohol use implies that alcohol use is associated with the dysregulation of affect. One major premise of our study is that *variability in affect* may be a better index of affective dysregulation than mean level of affect. To this point in time, investigators have almost exclusively examined *mean* levels of affect that precede, follow, or covary with alcohol use. In our view, this approach may not fully test the association between affect and alcohol use because it is agnostic as to the *variability or instability* of affect that accompanies alcohol use. Our analyses of associations between affect variability, especially within-day variability, indicate that variability in negative affects is associated with concurrent alcohol use in both BPD and MDD/DYS outpatients and that for many (but not all) negative affects this relationship was stronger for BPD drinkers.

Overall, our findings raise several possibilities. First, these can be interpreted as consistent with the negative affect regulation hypothesis: Individuals who are experiencing variability or dysregulation in affect may be more prone to use alcohol in order to regulate their mood state (i.e., a tension-reduction or negative reinforcement model). Another possibility is these associations reflect that alcohol use leads to dysregulation of affect, either by pharmacologically (a) acutely increasing PA, (b) acutely decreasing NA, (c) setting up lasting affective perturbations (e.g., hangovers or other long-lasting affective dynamics), or (d) leading to negative interpersonal or occupational consequences that influence the variability in subsequent mood. These are not necessarily mutually exclusive. As noted previously, however, our concurrent assessments cannot resolve the temporal order of dysregulated mood and alcohol use.

It is also important to note that alcohol may not simply lower the level of NA per se, but it may be used by BPD patients when the variability or dysregulation of NA is high. In this case it is the significant oscillation of NA that may lead to alcohol use (Baker et al., 2004). This is consistent with the idea that instability in negative affect may motivate those with BPD to use alcohol in an attempt (albeit maladaptive) to regulate or lessen the fluctuation in negative affect (Trull et al., 2000). Although this model of alcohol use as an attempt to regulate negative affect would seem to predict larger variability in negative affects preceding alcohol use, this pattern was not observed for the BPD drinkers. In fact, several results suggested that smaller variances in negative affects preceded alcohol use in BPD drinkers, in contrast to MDD/DYS drinkers (who did show the expected pattern of larger variances in negative affects preceding alcohol use). One possibility suggested by these results is that the dysregulation of affect related to alcohol use in those with BPD occurs more proximally to the drinking behavior due to the nature of BPD affective instability. In our lagged analyses examining variability of affect, we used a one day frame of reference. In BPD, affective instability can occur abruptly and typically only lasts for a few hours (American Psychiatric Association, 2000). Therefore, in BPD (vs. other conditions) the emotion regulation process might be best observed in a relatively small window of time (as observed in our concurrent findings) as well as by examining relations between alcohol use and mean level of affect at the momentary level.

One pattern found in both diagnostic groups was that use of alcohol was *positively* related to the variability in many affects *the next day*. This is consistent with the literature on the pharmacological effects of alcohol. Alcohol use is known to produce both short-term and long-term affective dysregulation by affecting both brain systems underlying affective states as well as brain mechanisms associated with cognitive functioning related to affect (Sher & Grekin, 2007). Therefore, variability in affects associated with alcohol use may reflect a BPD patient's use of alcohol that subsequently and significantly lowers the within-day level of NA experienced (thereby producing more variability).

It is interesting to note that both mean levels and between-day variability in *positive affect* were associated with drinking but only among BPD drinkers. PA did not distinguish BPD drinkers from nondrinkers. However, levels of PA were positively related to drinking on the next day as well as to drinking concurrently. These findings suggest that in addition to drinking to cope with negative affect, BPD drinkers may also be motivated to drink in order to enhance positive affect. Perhaps AUD is more prevalent among those with BPD because both types of motivational pathways are active, leading to more use of alcohol. On one hand, alcohol may be used to alleviate or cope with negative affective states which may be less systematic or predictable (as indicated by greater variability in these states). In addition, BPD drinkers may be motivated to use alcohol to enhance positive mood states or to increase positive feelings. As discussed above, this interpretation is consistent with previous studies that have reported both emotionally mediated pathways to alcohol consumption within the same sample (e.g., Armeli et al., 2000; Hussong et al., 2001; Mohr et al., 2001, 2005; Swendsen et al., 2000.). Finally, although speculative, recent theory suggests that BPD symptoms and associated features (e.g., mood lability, drug and alcohol addiction) may reflect an underlying dysregulation of the endogenous opioid system (Bandelow, Schmahl,

Falkai, & Wedekind, 2010). Such an account can explain the experience of emotion dysregulation and use of alcohol in this patient group, mediated by reduced sensitivity of endorphin receptors or low levels of endogenous opioids.

There are a number of implications for our findings. First, our study demonstrates the ability of an EMA approach to characterize mood states and mood variability over time. We were able to examine associations between mood and behavior concurrently, as well as prospectively. As stated earlier, our position is that EMA approaches are uniquely suited to characterizing and evaluating time-dependent processes of mood and mood variability and to tie these processes to important clinical behaviors such as substance use. Second, although intriguing, our findings point to complexity of mood-alcohol use relations. As others have noted, many individual differences beyond diagnostic group or clinical status affect why those with levels of mood or degree of mood variability choose to use alcohol (e.g., alcohol expectancies, alcohol motives, personality traits, situations, access, etc.). Future research should incorporate assessments of these variables into EMA designs like ours to better characterize the multiple influences that may be operating. Clinical implications of our findings include devoting more attention to emotional states and emotion dysregulation that may precede or accompany alcohol use and abuse. For example, in the case of BPD attention might be directed to identify those negative interpersonal conflicts and events that may lead to increases in negative affects as well as to treatment strategies that improve patients' ability to regulate their emotional states (e.g., dialectical behavior therapy skills training for emotion regulation, distress tolerance, and mindfulness).

Limitations

Several limitations should be noted. First, until replicated, we can only generalize our findings to women who are diagnosed with BPD and who endorse clinically significant levels of affective instability. Furthermore, although a strength of our study was the multiple assessments obtained from each individual, our between subjects comparisons were based on a relatively modest sample size. Therefore, it is important not to overinterpret null findings from our between-subjects comparisons and replication will be important. Second, our EMA protocol required participants to report the number of drinks imbibed since the last prompt as opposed to recording each drink as it occurred. This may have led to some unreliability in reporting and also did not allow us to assess affective states immediately before drinking episodes. Concerning the latter, as discussed above, our data only address associations between mean levels of affect or variability in affect and alcohol use. We are not able to make strong causal inferences from these data. Future studies might use a combination of random sampling and event-contingent sampling in order to better tease apart the temporal relations between mood, mood dysregulation, and alcohol use (Shiffman, 2007). Finally, our monitoring period only covered one month in the patients' lives. Drinking behavior may change from month to month or season to season, so our assessment window was relatively narrow.

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Table 1

Estimates of Fixed Effects and Random Parameters for Models of Affect Scores as a Function of Drinkers and Nondrinkers and Diagnostic Group

	Negative affect		Hostility		Fear		Sadness		Positive affect	
Parameter	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
					Fixed effects					
Intercept	1.54***	[1.37, 1.71]	1.50***	[1.30, 1.69]	1.49***	[1.33, 1.65]	1.76***	[1.41, 2.11]	2.05***	[1.80, 2.30]
Level 2 (day)										
Day	−0.00	[−0.00, 0.00]	0.00	[−0.00, 0.00]	−0.00	[−0.00, 0.00]	−0.00	[−0.00, 0.00]	−0.00	[−0.00, 0.00]
Level 3 (person)										
MDD[a]	0.08	[−0.25, 0.42]	−0.05	[−0.42, 0.32]	0.15	[−0.24, 0.53]	0.23	[−0.38, 0.85]	−0.09	[−0.44, 0.27]
Drinker[b]	0.12	[−0.12, 0.37]	0.00	[−0.25, 0.25]	0.16	[−0.08, 0.41]	−0.02	[−0.43, 0.38]	0.02	[−0.28, 0.31]
MDD[a] × Drinker[b]	−0.19	[−0.59, 0.21]	−0.12	[−0.54, 0.30]	−0.22	[−0.69, 0.26]	−0.16	[−0.83, 0.52]	0.19	[−0.27, 0.64]
					Random parameters					
Level 3 (between-person)										
Intercept										
BPD										
Nondrinker	0.16***	[0.09, 0.33]	0.21***	[0.12, 0.44]	0.14***	[0.08, 0.29]	0.67***	[0.40, 1.38]	0.34***	[0.20, 0.71]
Drinker	0.42***	[0.29, 0.65]	0.31***	[0.22, 0.49]	0.45***	[0.31, 0.70]	0.55***	[0.39, 0.86]	0.30***	[0.21, 0.46]
MDD/DYS										
Nondrinker	0.29**	[0.15, 0.76]	0.35**	[0.18, 0.93]	0.43**	[0.22, 1.13]	0.89**	[0.47, 2.36]	0.23**	[0.12, 0.60]
Drinker	0.12***	[0.07, 0.24]	0.07***	[0.04, 0.14]	0.27***	[0.17, 0.53]	0.23***	[0.14, 0.46]	0.34***	[0.21, 0.67]
Level 2 (between-day)										
Intercept										
BPD										
Nondrinker	0.10***	[0.09, 0.12]	0.18***	[0.16, 0.21]	0.08***	[0.07, 0.09]	0.19***	[0.16, 0.22]	0.12***	[0.11, 0.15]
Drinker	0.17***	[0.16, 0.19]	0.16***	[0.15, 0.18]	0.20***	[0.18, 0.22]	0.23***	[0.21, 0.25]	0.12***	[0.11, 0.14]
MDD/DYS										
Nondrinker	0.15***	[0.13, 0.18]	0.11***	[0.09, 0.13]	0.18***	[0.15, 0.21]	0.29***	[0.25, 0.34]	0.09***	[0.07, 0.11]
Drinker	0.09***	[0.08, 0.10]	0.09***	[0.08, 0.11]	0.09***	[0.08, 0.10]	0.19***	[0.17, 0.22]	0.11***	[0.10, 0.13]

	Negative affect		Hostility		Fear		Sadness		Positive affect	
Parameter	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Level 1 (within-day)										
Residual Exponent[c]	0.18***	[0.17, 0.20]	0.28***	[0.27, 0.30]	0.17***	[0.16, 0.19]	0.34***	[0.31, 0.36]	0.39***	[0.36, 0.41]
MDD[a] $\hat{\delta_1}$	−0.01	[−0.10, 0.08]	−0.28***	[−0.37, −0.20]	0.08	[−0.01, 0.16]	−0.00	[−0.09, 0.08]	−0.51***	[−0.59, −0.42]
Drinker[b] $\hat{\delta_2}$	0.16***	[0.09, 0.22]	−0.11***	[−0.18, −0.05]	0.32***	[0.26, 0.38]	−0.02	[−0.08, 0.05]	0.05	[−0.01, 0.12]
MDD[a] × Drinker[b] $\hat{\delta_3}$	−0.22***	[−0.32, −0.11]	−0.07	[−0.18, 0.03]	−0.30***	[−0.40, −0.19]	0.19***	[0.08, 0.29]	0.29***	[0.18, 0.39]
Day $\hat{\delta_4}$	−0.02***	[−0.02, −0.01]	−0.01***	[−0.02, −0.01]	−0.02***	[−0.02, −0.02]	−0.02***	[−0.02, −0.02]	−0.02***	[−0.02, −0.02]

Note. CI = confidence interval; MDD = major depressive disorder; DYS = dysthymic disorder; BPD = borderline personality disorder.

[a] Coded as 0 for BPD group and 1 for MDD/DYS group.

[b] Coded as 0 for nondrinkers and 1 for drinkers.

[c] The base of the exponents is *e*.

** $p < .01$.

*** $p < .001$.

Table 2

Estimates of Fixed Effects and Random Parameters for Models of Affect Scores as a Function of Alcohol Drink and Daily Alcohol Use and Diagnostic Group

	Negative affect		Hostility		Fear		Sadness		Positive affect	
Parameter	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Fixed effects										
Intercept	1.66***	[1.48, 1.84]	1.53***	[1.37, 1.69]	1.64***	[1.45, 1.83]	1.72***	[1.51, 1.93]	2.03***	[1.88, 2.19]
Level 1(moment)										
ALC_NTO	−0.00	[−0.05, 0.05]	−0.02	[−0.07, 0.04]	0.03	[−0.02, 0.08]	−0.06*	[−0.12, −0.01]	0.16***	[0.10, 0.22]
ALC_NTO × MDD[a]	0.05	[−0.03, 0.14]	0.04	[−0.05, 0.13]	0.08	[−0.02, 0.17]	0.05	[−0.07, 0.18]	−0.05	[−0.17, 0.07]
ALC_O	0.07**	[0.02, 0.12]	0.08**	[0.03, 0.14]	0.04	[−0.01, 0.09]	0.06*	[0.00, 0.12]	0.12***	[0.05, 0.18]
ALC_O × MDD[a]	−0.11*	[−0.20, −0.03]	−0.09	[−0.18, 0.00]	−0.11*	[−0.20, −0.01]	−0.19**	[−0.32, −0.06]	−0.06	[−0.19, 0.06]
ALC_PRO	−0.02	[−0.07, 0.03]	0.02	[−0.04, 0.07]	−0.03	[−0.08, 0.02]	−0.05	[−0.11, 0.01]	−0.00	[−0.07, 0.06]
ALC_PRO × MDD[a]	−0.04	[−0.12, 0.05]	−0.03	[−0.12, 0.06]	0.02	[−0.07, 0.11]	−0.07	[−0.19, 0.05]	−0.06	[−0.18, 0.06]
Level 2(day)										
ALC_NTD	−0.05	[−0.11, 0.01]	−0.05	[−0.12, 0.01]	−0.05	[−0.12, 0.02]	−0.02	[−0.10, 0.05]	0.03	[−0.03, 0.09]
ALC_NTD × MDD[a]	0.10	[−0.00, 0.19]	0.06	[−0.04, 0.16]	0.08	[−0.02, 0.18]	0.11	[−0.03, 0.24]	0.04	[−0.07, 0.14]
ALC_D	−0.02	[−0.09, 0.05]	−0.06	[−0.13, 0.00]	0.00	[−0.07, 0.07]	0.02	[−0.05, 0.10]	−0.04	[−0.10, 0.03]
ALC_D × MDD[a]	0.04	[−0.06, 0.14]	0.09	[−0.01, 0.20]	−0.03	[−0.13, 0.08]	0.06	[−0.07, 0.20]	0.07	[−0.05, 0.18]
ALC_PRD	−0.03	[−0.09, 0.04]	−0.01	[−0.08, 0.05]	−0.02	[−0.09, 0.05]	−0.01	[−0.09, 0.06]	−0.01	[−0.07, 0.05]
ALC_PRD × MDD[a]	0.10*	[0.00, 0.19]	0.06	[−0.04, 0.16]	0.02	[−0.08, 0.12]	0.05	[−0.08, 0.18]	0.03	[−0.08, 0.13]
Level 3(person)										
MDD[a]	−0.15	[−0.39, 0.08]	−0.22**	[−0.41, −0.02]	−0.08	[−0.37, 0.21]	0.04	[−0.25, 0.33]	0.09	[−0.20, 0.38]
Random parameters										
Level 3 (between-person)										
Intercept										
BPD	0.42***	[0.29, 0.65]	0.32***	[0.22, 0.49]	0.45***	[0.32, 0.70]	0.56***	[0.39, 0.86]	0.30***	[0.21, 0.47]
MDD/DYS	0.12***	[0.07, 0.24]	0.07***	[0.04, 0.14]	0.28***	[0.17, 0.55]	0.23***	[0.14, 0.46]	0.36***	[0.22, 0.70]
Level 2 (between-day)										

	Negative affect		Hostility		Fear		Sadness		Positive affect	
Parameter	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Intercept										
BPD	0.16***	[0.15, 0.18]	0.16***	[0.14, 0.17]	0.18***	[0.17, 0.20]	0.21***	[0.20, 0.24]	0.12***	[0.10, 0.13]
MDD/DYS	0.08***	[0.07, 0.09]	0.09***	[0.08, 0.10]	0.07***	[0.06, 0.09]	0.17***	[0.15, 0.20]	0.10***	[0.09, 0.12]
Level 1 (within-day)										
Residual	0.17***	[0.16, 0.19]	0.21***	[0.19, 0.22]	0.20***	[0.19, 0.22]	0.30***	[0.28, 0.33]	0.34***	[0.32, 0.36]
Exponent										
MDD[a] $\hat{\delta_1}$	−0.42***	[−0.50, −0.34]	−0.37***	[−0.45, −0.29]	−0.55***	[−0.63, −0.48]	0.05	[−0.03, 0.13]	−0.33***	[−0.41, −0.25]
ALC_NTD $\hat{\delta_2}$	−0.06	[−0.15, 0.03]	0.01	[−0.08, 0.09]	−0.23***	[−0.33, −0.14]	−0.00	[−0.09, 0.08]	0.06	[−0.03, 0.14]
ALC_NTD × MDD[a] $\hat{\delta_3}$	0.51***	[0.35, 0.67]	0.20*	[0.04, 0.36]	0.70***	[0.54, 0.86]	0.30***	[0.14, 0.46]	0.16*	[0.00, 0.32]
ALC_D $\hat{\delta_4}$	0.31***	[0.22, 0.40]	0.29***	[0.20, 0.38]	0.29***	[0.20, 0.38]	0.24***	[0.15, 0.33]	0.12**	[0.03, 0.20]
ALC_D × MDD[a] $\hat{\delta_5}$	−0.02	[−0.19, 0.15]	−0.14	[−0.30, 0.02]	0.26**	[0.09, 0.43]	0.27**	[0.10, 0.43]	0.38***	[0.21, 0.54]
ALC_PRD $\hat{\delta_6}$	0.07	[−0.02, 0.16]	0.23***	[0.14, 0.32]	0.13**	[0.04, 0.22]	0.03	[−0.05, 0.12]	0.21***	[0.12, 0.29]
ALC_PRD × MDD[a] $\hat{\delta_7}$	0.27**	[0.11, 0.43]	0.05	[−0.11, 0.21]	0.19*	[0.02, 0.35]	−0.03	[−0.18, 0.13]	−0.05	[−0.21, 0.10]
Day $\hat{\delta_8}$	−0.01***	[−0.01, −0.01]	−0.01***	[−0.02, −0.01]	−0.01***	[−0.02, −0.01]	−0.02***	[−0.02, −0.02]	−0.01***	[−0.02, −0.01]

Note. CI = confidence interval; ALC_NTO = alcohol drink on the next occasion; ALC_O = alcohol drink on the current occasion, ALC_PRO = alcohol drink on the previous occasion; ALC_NTD = alcohol drink on the next day; ALC_D = alcohol drink on that day, i.e., alcohol day; ALC_PRD = alcohol drink on the previous day; MDD = major depressive disorder; DYS = dysthymic disorder; BPD = borderline personality disorder.

[a] Coded as 0 for BPD group and 1 for MDD/DYS group.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3

Estimates of Fixed Effects and Random Parameters for Models of Affect Scores as a Function of the Number of Drinks and Daily Binge Drinking and Diagnostic Group

	Negative affect		Hostility		Fear		Sadness		Positive affect	
Parameter	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Fixed effects										
Intercept	1.64***	[1.46, 1.82]	1.50***	[1.34, 1.66]	1.62***	[1.43, 1.81]	1.71***	[1.50, 1.92]	2.04***	[1.89, 2.20]
Level 1 (moment)										
NDR_NTO	−0.02**	[−0.03, 0.01]	−0.02**	[−0.03, 0.01]	−0.01	[−0.02, 0.00]	−0.02**	[−0.04, 0.01]	0.02**	[0.01, 0.04]
NDR_NTO × MDD[a]	0.04**	[0.01, 0.07]	0.04**	[0.02, 0.06]	0.06***	[0.04, 0.09]	0.02	[−0.02, 0.06]	0.05*	[0.01, 0.08]
NDR_O	0.03***	[0.02, 0.04]	0.03***	[0.02, 0.05]	0.02***	[0.01, 0.03]	0.03***	[0.01, 0.04]	0.03**	[0.01, 0.04]
NDR_O × MDD[a]	−0.04**	[−0.07, 0.02]	−0.03**	[−0.06, 0.01]	−0.05**	[−0.08, 0.02]	−0.06**	[−0.10, 0.02]	−0.01	[−0.04, 0.03]
NDR_PRO	−0.00	[−0.01, 0.01]	0.00	[−0.01, 0.02]	−0.00	[−0.02, 0.01]	−0.01	[−0.03, 0.00]	−0.00	[−0.02, 0.01]
NDR_PRO × MDD[a]	−0.00	[−0.03, 0.02]	0.00	[−0.02, 0.03]	0.01	[−0.03, 0.04]	−0.00	[−0.04, 0.04]	0.00	[−0.03, 0.03]
Level 2 (day)										
BIN_NTD	−0.01	[−0.10, 0.08]	−0.03	[−0.11, 0.06]	−0.01	[−0.10, 0.08]	0.01	[−0.09, 0.12]	0.07	[−0.01, 0.16]
BIN_NTD × MDD[a]	−0.03	[−0.19, 0.12]	−0.11	[−0.26, 0.05]	−0.09	[−0.25, 0.07]	−0.07	[−0.30, 0.15]	−0.02	[−0.21, 0.16]
BIN_D	−0.04	[−0.13, 0.05]	−0.07	[−0.16, 0.02]	−0.02	[−0.11, 0.08]	0.01	[−0.09, 0.12]	−0.03	[−0.12, 0.06]
BIN_D × MDD[a]	0.08	[−0.09, 0.24]	0.01	[−0.15, 0.17]	0.04	[−0.14, 0.21]	−0.06	[−0.28, 0.17]	0.02	[−0.16, 0.21]
BIN_PRD	0.01	[−0.08, 0.10]	0.05	[−0.04, 0.14]	−0.01	[−0.10, 0.08]	0.01	[−0.09, 0.11]	−0.01	[−0.10, 0.07]
BIN_PRD × MDD[a]	−0.05	[−0.21, 0.10]	−0.12	[−0.27, 0.03]	−0.05	[−0.20, 0.11]	−0.21*	[−0.42, 0.00]	−0.00	[−0.17, 0.17]
Level 3 (person)										
MDD[a]	−0.10	[−0.33, 0.13]	−0.16	[−0.35, 0.03]	−0.06	[−0.34, 0.23]	0.11	[−0.18, 0.40]	0.11	[−0.18, 0.40]
Random parameters										
Level 3 (between-person)										
Intercept										
BPD	0.42***	[0.29, 0.65]	0.32***	[0.22, 0.49]	0.45***	[0.31, 0.70]	0.56***	[0.39, 0.86]	0.31***	[0.21, 0.47]
MDD/DYS	0.13***	[0.08, 0.25]	0.07***	[0.04, 0.14]	0.28***	[0.17, 0.55]	0.24***	[0.14, 0.47]	0.36***	[0.22, 0.71]
Level 2 (between–day)										

	Negative affect		Hostility		Fear		Sadness		Positive affect	
Parameter	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Intercept										
BPD	0.16***	[0.14, 0.17]	0.15***	[0.14, 0.17]	0.18***	[0.16, 0.20]	0.21***	[0.19, 0.23]	0.12***	[0.11, 0.13]
MDD/DYS	0.08***	[0.07, 0.09]	0.09***	[0.08, 0.10]	0.07***	[0.06, 0.09]	0.18***	[0.16, 0.21]	0.10***	[0.09, 0.12]
Level 1 (within–day)										
Residual	0.17***	[0.16, 0.19]	0.21***	[0.20, 0.23]	0.21***	[0.19, 0.22]	0.30***	[0.28, 0.33]	0.37***	[0.34, 0.39]
Exponent										
MDD[a]	−0.24***	[−0.31, 0.17]	−0.23***	[−0.30, 0.16]	−0.31***	[−0.38, 0.25]	0.19***	[0.12, 0.26]	−0.25***	[−0.32, 0.18]
BIN_NTD	−0.20**	[−0.33, 0.07]	−0.18**	[−0.31, 0.05]	−0.37***	[−0.50, 0.24]	−0.08	[−0.21, 0.04]	−0.02	[−0.14, 0.11]
BIN_NTD × MDD[a]	0.41**	[0.13, 0.68]	−0.36*	[−0.64, 0.08]	0.64***	[0.37, 0.91]	0.47***	[0.19, 0.74]	0.44**	[0.17, 0.71]
BIN_D	0.36***	[0.23, 0.48]	0.30***	[0.17, 0.42]	0.37***	[0.25, 0.50]	0.24***	[0.12, 0.36]	0.11	[−0.02, 0.23]
BIN_D × MDD[a]	0.11	[−0.16, 0.39]	−0.48***	[−0.76, 0.20]	0.41**	[0.14, 0.69]	0.23	[−0.04, 0.50]	0.05	[−0.23, 0.32]
BIN_PRD	0.06	[−0.06, 0.18]	0.44***	[0.32, 0.57]	−0.12	[−0.24, 0.00]	0.19**	[0.07, 0.31]	−0.01	[−0.13, 0.12]
BIN_PRD × MDD[a]	0.32*	[0.07, 0.57]	−0.52***	[−0.78, 0.27]	0.46***	[0.21, 0.71]	−0.10	[−0.35, 0.15]	0.32*	[0.07, 0.57]
Day	−0.01***	[−0.01, 0.00]	−0.01***	[−0.01, 0.01]	−0.01***	[−0.01, 0.01]	−0.02***	[−0.02, 0.01]	−0.01***	[−0.02, 0.01]

Note. CI = confidence interval; NDR_NTO = number of drinks on the next occasion; NDR_O = number of drinks on current occasion; NDR_PRO = number of drinks on the previous occasion; BIN_NTD = daily binge drinking on the next day; BIN_D = daily binge drinking on that day; BIN_PRD = daily binge drinking on the previous day; MDD = major depressive disorder; DYS = dysthymic disorder; BPD = borderline personality disorder.

[a] Coded as 0 for BPD group and 1 for MDD/DYS group.

* $p < .05$.

** $p < .01$.

*** $p < .001$.