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Mood trajectories following daily life events

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Abstract Little is known about the magnitude and duration of mood responses to daily negative events as a function of gender, history of mood disorder, and current substance use. Using computerized ambulatory monitoring techniques, perceived negativity of minor daily events and state affect were prospectively examined every 3 h on average for a 7-day period. Event negativity was associated with depressed mood for 6–9 h following event occurrence, and was associated with happy mood for 3–6 h. Gender and substance use moderated the relationship between event negativity and mood states concurrently, and remained influential for approximately 3 h following the event. History of mood disorder did not moderate any within- or across-day relationships between event negativity and mood. No evidence was found for mood uplifts following daily events in either within- or across-day analyses. The findings are discussed relative to assessment timing in investigations of vulnerability-stress theories.

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Introduction

Stressful events have long been implicated in the development of mood disorders (Kessler 1997; Paykel 2003) as well as in fluctuations of daily mood states (e.g., Bolger et al. 1989; DeLongis et al. 1988). Although the magnitude of events that lead to clinical syndromes has been assumed to differ from those implicated in daily mood changes, recent theory and research suggest that minor daily stressors may play an important role in the onset of depression and other mental disorders (Almedia 2005; O'Neill et al. 2004; Zautra 2003). Identifying sources of variability in reactivity to daily events may therefore provide important information for understanding vulnerability to clinical disorders as well as normal mood experience. Individual characteristics that moderate the *duration* of mood responses to daily events are of particular importance, as they may have consequences for the precision with which vulnerability-stress theories can be tested in daily life. However, despite the clinical and methodological relevance of variables that may alter stress-mood trajectories, previous research has examined only a limited number of potential moderators and has typically tested their effects within a limited time frame.

Temporal considerations

One important source of variability in emotional reactivity is within-person, or the relationship between events and mood states over time for a given individual. Daily diary

and experience sampling studies have consistently indicated that daily experiences that are perceived as negative or stressful are positively associated with negative mood states (e.g., Affleck et al. 1994; Bolger et al. 1989; DeLongis et al. 1988). However, this research has largely focused on concurrent, adjacent, or across-day relationships between negative events and mood, potentially obscuring important within-day variability. Mood responses within a given day may be instantaneous or, conversely, may persist several hours beyond the immediate experience of an event. Moreover, the full trajectory of mood responses to daily events may be characterized by an initial increase in negative mood followed by an eventual mood uplift or rebound (Marco and Suls 1993; Solomon and Corbit 1974; Solomon 1980), and some research has provided evidence of mood uplifts on an across-day basis (e.g., Bolger et al. 1989; DeLongis et al. 1988; Williams et al. 1991). The scarcity of information concerning the temporal dynamics of mood trajectories, in particular on a within-day basis, therefore constitutes an impediment for testing vulnerability-stress theories that may find supportive, nonsignificant or even contradictory findings according to relatively small changes in the timing of assessments.

An additional consideration is the potential bi-directionality of event-mood relationships in daily life (c.f., Bolger et al. 2003; Cohen et al. 2005; Nezlek and Allen 2006). One way to explore the temporal sequencing of events relative to mood is to time-lag data and control for concurrent levels of event negativity at the time of mood assessment. Bolger and colleagues (2003) note that this strategy is similar to that used in traditional panel analyses, but argue that this approach is less vulnerable to rival hypotheses because lagged analyses in diary studies are within-subject rather than between-subject. This strategy has been used in across-day analysis of diary data (Bolger and Zuckerman 1995; Nezlek and Allen 2006), and to examine the relationship between events and subsequent mood in experience sampling investigations (Peeters et al. 2003). Although this approach aids the interpretation of mood responses following discrete events, the lagging of such analyses over increasingly longer time periods is necessary to estimate the full duration, nature and magnitude of effects.

Moderators

The majority of studies that have examined individual differences in mood reactivity have focused on personality characteristics that influence response magnitude (e.g., Bolger and Schilling 1991; Bolger and Zuckerman 1995; Marco and Suls 1993), and have not considered whether individual characteristics also influence the duration of mood responses within a given day. However, several lines of evidence suggest that diverse clinical and individual characteristics alter the nature of mood responses following events. In particular, major depression may influence mood responses to stressful events even in non-clinical samples that are recovered from the disorder (Kendler et al. 2000; Mazure 1998; Sloan et al. 2001). Whether heightened or prolonged reactivity to daily events is also observed among individuals with a history of mood disorder is less certain, despite the clinical relevance of this issue (Cohen et al. 2005). Similarly, the use or abuse of psychoactive substances frequently precedes the onset of mood syndromes (Brook et al. 1998; Patton et al. 2002; Schuckit 1986), and its potential use as a means of regulating negative emotions (Swendsen et al. 2000) may also alter the nature or timing of mood responses to events in daily life. Finally, female gender is an important predictor of responses to both major life events (e.g., Maciejewski et al. 2001) and chronic daily strains (e.g., Nolen-Hoeksema 2001). However, knowledge of whether mood responses to daily events are more persistent for women than for men is limited, as previous investigations of this issue have been unable to prospectively examine within-day relationships between these variables due to design limitations (Almeida and Kessler 1998; Mohr et al. 2003).

Current study

Using ambulatory monitoring techniques, the objectives of the current study are to examine trajectories of depressed and happy mood responses to negative daily events and to identify variables that may moderate the relationship between events and mood over time. Ambulatory monitoring is particularly well-suited to this purpose as it permits researchers to capture the experience of minor events and mood over short periods of time, and allows for the examination of both within-day and across-day mood variation. It is hypothesized that women, substance users, and individuals with a history of mood disorder will exhibit stronger initial reactions to negative events, as well as more persistent mood responses following the experience of a negative event.

Method

Participants

As part of a larger investigation of behavior, cognition, and mood in daily life, 1,319 individuals from two French universities were screened on diverse demographic and clinical variables. One hundred sixty-nine individuals 18 and older were then selected to participate based on the

presence or absence of cognitive vulnerabilities to stress and on the frequency of recent psychoactive substance use. Eleven individuals with a current mood disorder were excluded from the current study, resulting in a sample of 158 individuals (68% women). The sample ranged in age from 18 to 26, and averaged 19.41 years ($SD = 1.35$).

Procedures

The general selection criteria and procedures are discussed in detail elsewhere (Husky et al. 2007), and were divided into three phases. During the first phase, undergraduate university students were invited to participate in a study concerning emotions, behavior and experiences in daily life. After providing written informed consent, participants completed a screening battery and were selected to have approximately equal numbers of individuals with frequent or infrequent recent substance use. High-frequency users were defined as those who consumed alcohol or cannabis over the previous month in frequencies ranging from once a week to several times per day, or who consumed other illicit substances (cocaine, heroin, ecstasy, amphetamines, and hallucinogens) at least once during this 30-day period. Low-frequency substance users were defined as individuals who consumed no more than 1 alcoholic beverage over the previous 30 days, and no additional substance. In order to examine mood responses controlling for individual levels of cognitive risk, the selection of participants in each substance use group was also counterbalanced to include high (top 30%) or low (bottom 30%) scorers on cognitive vulnerability to stressful events (sociotropy and autonomy).

Individuals were then contacted by telephone to participate in the ambulatory monitoring phase of the study by members of the research team blind to the initial selection criteria. Of the individuals contacted for this second phase, 9.6% declined to participate. The other contacted individuals were scheduled for a laboratory visit during which they were given a brief training session concerning the ambulatory monitoring phase of the study. During this session, participants were instructed to carry a hand-held Psion 'Revo' or 'Revo Plus' personal digital assistant (PDA) with them throughout the assessment week and to complete a computerized questionnaire at each signal concerning their current mood, the experience of different types of daily events, and the degree of negative impact of each event. On each of the next 7 consecutive days, five signals were administered at fixed intervals. Several different fixed-signal schedules were utilized, all of which included a signal between each of the following time periods: 8:00 am to 11:00 am; 11:00 am to 2:00 pm; 2:00 pm to 5:00 pm; 5:00 pm to 8:00 pm; and 8:00 pm to 11:00 pm. Signal schedules were randomized across participants. The duration of the electronic questionnaire administered after each signal was approximately 2 min, and each entry was time-stamped. All responses that were completed after a 10-min delay were coded as missing data for that assessment to reduce retrospective recall bias. For reasons of confidentiality, responses entered by the participants were rendered inaccessible until each PDA was returned to the research center. The start day for the study was counterbalanced across the different workdays of the week, and all participants were contacted by telephone approximately halfway through the assessment period to monitor and encourage compliance. In the final phase of the study, the Psion was returned and data were uploaded. All participants were then administered a structured clinical interview to ascertain presence or absence of lifetime DSM-IV diagnoses by psychologists blind to initial recruitment status and ambulatory monitoring data. Financial compensation was provided to participants at the end of the study.

Materials

Between-person measures

Substance use frequency 30-day substance use frequency was assessed by a self-report questionnaire ascertaining use of 11 different psychoactive substances including tobacco, alcohol, cannabis, ecstasy, amphetamines, heroine, cocaine, LSD and other hallucinogens. For each one of these substances, respondents were asked to specify the frequency at which he or she had used the given substance during the past 30 days, with scores ranging from 1 (Never in the past 30 days) to 7 (Several times a day).

Lifetime history of mental disorders The Mini International Neuropsychiatric Interview MINI (Sheehan et al. 1998) was used to assess lifetime history of mood and other disorders using DSM-IV criteria (American Psychiatric Association 1994). The MINI is a brief structured screening interview similar to the Structured Clinical Interview for DSM-IV (SCID; First et al. 1995) and the Composite International Diagnostic Interview (CIDI; Wittchen 1994) in design and developed to be used in non-clinical populations (Lecrubier et al. 1997). The reliability and validity of the MINI have been assessed in studies of psychiatric subjects in the US and in France, showing that the MINI diagnoses had high inter-rater and test-retest reliability (Lecrubier et al. 1997; Sheehan et al. 1998). The MINI was used in the present investigation to assess the presence or absence of lifetime mood disorder (major depression, bipolar disorder).

Ambulatory repeated measures

Daily events Participants were instructed to describe in a few words the event that affected them the most since the previous signal (spanning, on average, the previous 3 h). The types of minor events assessed were based on the Inventory of Small Life Events (Zautra et al. 1986), and included the categories of family, work, education, health/illness, leisure, household, non-family social interactions, justice/crime, financial concerns, religion/spirituality, and transportation. Respondents were asked to select the category that best described the event they experienced, or to use the 'other event' category should their event not be listed. Participants were then asked to rate the impact of each event on a 7-point Likert scale ranging from 1 (No negative impact) to 7 (Extremely negative impact).

State affect Happy and depressed mood states were assessed separately in the electronic questionnaire using 7-point Likert scales that asked participants to evaluate their mood at that moment. The depressed mood scale ranged from 1 (not at all depressed) to 7 (extremely depressed), and the happy mood scale ranged from 1 (extremely happy) to 7 (extremely unhappy). For the purpose of the present investigation, depressed mood was used as the primary dependent variable as it represents the most frequent mood outcome proposed by vulnerability-stress theories. However, both happy and depressed mood were used to examine the possibility of mood rebound or uplifts. Positive and high-activation states, such as happy or joyous moods, provide an appropriate comparison to negative and low-activation states such as depressed or sad moods as they are in most cases mutually exclusive (Larsen and Diener 1992).

Statistical analysis

Data were analyzed using HLM 6.03 (Raudenbush et al. 2005) to accommodate the multilevel structure of the repeated assessments in daily life and to model between-person differences in event-mood relationships over time. At the observation level, the *i*-th mood score for person *j* was modeled as a function of event negativity at the prior assessment point and an error term:

$$\text{Mood}_{ij} = \beta_{0j} + \beta_{1j}\text{Event Negativity}_{ij} + r_{ij}$$

where β_{0j} represents the expected mood score for person *j* when the event negativity score is zero, β_{1j}Event negativity$_{ij}$ represents the expected change in mood score of person *j* as a function of prior event negativity, and r_{ij} is the error term associated with observation *i* for person *j*. The observation-level intercepts and slopes were then modeled at the person-level using the following equations:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\text{Female}_j + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}\text{Female}_j + u_{1j}$$

where γ_{00} is the overall intercept, γ_{01}Female$_j$ is the main effect of gender, γ_{10} is the main effect of event negativity, γ_{11}Female$_j$ is the cross-level interaction term for gender and event negativity or the difference between the event-mood gradient for men and women. The same equations were then used to test whether history of mood disorder and substance use moderate event negativity-mood relationships. To test whether history of mood disorder moderates event negativity-mood relationships, a dichotomous variable indicating history of mood disorder was substituted for gender, and the same procedure was followed for current substance use.

To address concerns about the potential bi-directionality of event-mood relationships (Cohen et al. 2005; Nezlek and Allen 2006), data were time-lagged and all models included a control for concurrent level of event negativity. The analytic strategy for both the within-day and across-day analyses involved first estimating the concurrent relationship between event negativity and mood, and then estimating a series of lagged relationships between negative events and later mood states. To examine the trajectory of within-day mood responses, the duration of time-lags were progressively increased between negative events at any given assessment (T1) and mood states experienced later in the same day (T2 through T4). Data were pooled across assessments to eliminate time of day biases, to increase statistical power, and to control for concurrent events to reduce bias associated with possible continuation of negative events. T1 through T4 therefore represent time delays between events and mood states rather than time of day per se. For example, a lagged analysis of T1 and T2 variables involves pooling across a maximum of four prospectively-linked assessment times per day (the first and second assessments, second and third assessments, third and fourth assessments, and fourth and fifth assessments).

As preliminary analyses indicated that event negativity and depressed mood were of lower severity on the last assessment of the day (T5) than on the first assessment, models analyzing only these assessment points were not performed due to inability to examine mood responses separately from variation associated with time of day. To further avoid potential confounding effects, the within-day analyses excluded models of the relationship between end-of-day events and mood on the first assessment of the following day. The relationship between event negativity on a given day and mood on the subsequent day were instead the subject of distinct across-day analyses. For

these across-day analyses, average event negativity and mood ratings were computed for each day. In order to provide a sufficient number of observations per participant, across-day analyses are restricted to models lagged across a maximum of 4 days (D2–D4).

Results

Sample descriptive statistics

Means and standard deviations for the demographic and screening variables, as well as for the daily life mood and event negativity variables are presented in Table 1. Consistent with the high-risk selection design, 40% of the sample had a history of mood disorder, and 47% were classified as recent substance users. There were no significant gender differences in either history of mood disorders χ^2 $(1, N = 158) = 1.08, p > .05$ or recent substance use χ^2 $(1, N = 158) = 1.12, p > .05$, and the share of individuals who were classified as regular substance users did not differ by history of mood disorder χ^2 $(1, N = 158) = 2.63$, $p > .05$.

The final sample of 158 participants generated a total of 3,909 valid daily life assessments of events and mood, with participants responding to an average of 71% ($SD = 18\%$) of the daily assessments within the 10-min window. To determine within- and between-group variance in the primary constructs of interest, intraclass coefficients (ICCs) were computed for depressed mood and event negativity by performing an unconditional ANOVA model with random effects and then dividing the between-group variance by the sum of between-group variance and within-group variance. The ICCs for depressed mood and event negativity were .39 and .29, respectively, indicating that 39 and 29% of their variance was between-person.

Table 1 Sample descriptive statistics

	Range	Mean	*SD*
Demographic and clinical variables			
Age	18–26	19.41	1.35
Female gender	–	68%	–
Frequent substance user	–	47%	–
History of mood disorder	–	40%	–
Ambulatory monitoring variables[a]			
Depressed mood	1–7	1.95	1.39
Happy mood	1–7	5.35	1.33
Event negativity	1–7	2.87	1.87

[a] Ambulatory monitoring variable averages are computed across all valid assessments. Participants ($n = 158$) generated a total of 3,909 valid ESM assessments

The mean level of depressed mood in daily life was greater for women than for men ($\gamma = 0.31$, $SE = 0.15$, $p < .05$), for individuals with a history of mood disorder than those without ($\gamma = 0.33, SE = 0.15, p < .05$), and for recent substance users than for non-substance users ($\gamma = 0.40$, $SE = 0.14$, $p < .01$). Event negativity was higher among women than men ($\gamma = 0.56$, $SE = 0.27$, $p < .01$), but did not differ by history of mood disorder ($\gamma = 0.20, SE = 0.17$, $p > .05$) or substance use status ($\gamma = 0.21$, $SE = 0.17$, $p > .05$). Average level of happy mood reported during the observation period did not significantly differ by gender ($\gamma = -0.27, SE = 0.14, p > .05$), history of mood disorder ($\gamma = -0.18$, $SE = 0.14$, $p > .05$), or substance use ($\gamma = -0.18, SE = 0.13, p > .05$).

Cross-sectional and prospective relationships between event negativity and mood states

Results of the analyses that estimated the within-day concurrent and lagged relationships between event negativity and mood states are presented in Table 2. Event negativity was positively associated with depressed mood concurrently ($\gamma = 0.21$, $SE = 0.02$, $p < .01$), at the subsequent assessment period ($\gamma = 0.06, SE = 0.02, p < .01$), and two assessment periods later ($\gamma = 0.06, SE = 0.02, p < .01$), or for up to approximately 6–9 h. Consistent with hypotheses, gender moderated the concurrent relationship between event negativity and depressed mood ($\gamma = 0.09$, $SE = 0.03$, $p < .01$) as well as the T1–T2 lagged relationship between event negativity and depressed mood ($\gamma = 0.13$, $SE = 0.03$, $p < .01$). The relationship between event negativity and both concurrent and subsequent depressed mood were stronger for women than for men, even after controlling for concurrent event negativity in the T1–T2 lagged analyses. The concurrent relationship between event negativity and depressed mood did not differ by substance use ($\gamma = 0.03$, $SE = 0.04$, $p > .05$) or history of mood disorder ($\gamma = 0.05$, $SE = 0.04$, $p > .05$), and there was no evidence that either of these variables moderated the lagged event-mood relationships.

Event negativity was inversely related to happy mood at the concurrent assessment ($\gamma = -0.21$, $SE = 0.02$, $p < .01$), and at the subsequent assessment ($\gamma = -0.07$, $SE = 0.01$, $p < .01$), or for up to approximately 3–6 h. Gender did not moderate the concurrent relationship between event negativity and happy mood ($\gamma = -0.03$, $SE = 0.03$, $p > .05$), but did moderate the T1–T2 lagged relationship ($\gamma = -0.05$, $SE = 0.03$, $p < .05$). Thus, although men and women did not differ in their initial response to event negativity, women experienced a greater decrement in happy mood following a negative event than men. Recent substance use did not moderate the concurrent relationship between event negativity and happy mood

Table 2 Within-day relationships between event negativity and mood states, gamma coefficients (standard errors)

	T1	T1–T2	T1–T3	T1–T4
Depressed mood				
No covariates	0.21 (0.02)**	0.06 (0.02)**	0.06 (0.02)**	0.03 (0.03)
Gender	0.09 (0.03)**	0.13 (0.03)**	0.06 (0.04)	0.02 (0.06)
Substance use	0.03 (0.04)	0.04 (0.03)	0.00 (0.04)	0.07 (0.05)
History of mood disorder	0.05 (0.04)	−0.02 (0.03)	0.02 (0.04)	0.02 (0.06)
Happy mood				
No covariates	−0.21 (0.02)**	−0.07 (0.01)**	−0.02 (0.02)	−0.03 (0.03)
Gender	−0.03 (0.03)	−0.05 (0.03)*	−0.04 (0.04)	−0.03 (−0.06)
Substance use	−0.06 (0.03)	−0.05 (0.03)*	−0.03 (0.03)	−0.05 (0.05)
History of mood disorder	−0.03 (0.03)	0.01 (0.03)	0.02 (0.04)	−0.01 (0.05)

Notes: * $p < .05$; ** $p < .01$. Time lag represents distance between assessments of event negativity and mood. All time-lagged relationships control for concurrent event negativity. Coefficients represent the interaction between each covariate (gender, substance use, mood disorder) and the event negativity-mood slope

($\gamma = -0.06$, $SE = 0.03$, $p > .05$), but did moderate the relationship between event negativity and happy mood assessed at the subsequent assessment period ($\gamma = -0.05$, $SE = 0.03$, $p < .05$). Specifically, substance users experienced a stronger decrement in happy mood at assessments following the experience of a negative event than individuals who were not recent substance users.

Across-day relationships between event negativity and mood states are presented in Table 3. Results indicated a significant same-day relationship between event negativity and depressed mood ($\gamma = 0.29$, $SE = 0.03$, $p < .01$), but did not provide any evidence of across-day effects. Similarly, event negativity was inversely related to same-day happy mood ($\gamma = -0.28$, $SE = 0.03$, $p < .01$), but was not associated with happy mood ratings on the following day. The same-day relationship between event negativity and depressed mood was stronger for women than for men ($\gamma = 0.17$, $SE = 0.07$, $p < .05$), but did not vary according to history of mood disorder or recent substance use. Finally, there was no evidence of a significant within- or across-day mood rebound or uplift following the resolution of a post-event negative mood.

Discussion

Mapping mood trajectories both within- and across-days and exploring the extent to which they differ by individual characteristics may help elucidate markers of clinical vulnerability and provide information necessary for guiding the timing of assessments in investigations of vulnerability-stress theories in daily life. Although a number of prior studies have used daily process designs to examine the relationship between stressful experiences and changes in negative mood states (e.g., Affleck et al. 1994; Bolger et al. 1989; Marco and Suls 1993), these studies have not

Table 3 Across-day relationships between average event negativity and mood states, gamma coefficients (standard errors)

	D1	D1–D2	D1–D3	D1–D4
Average depressed mood				
No covariates	0.29 (0.03)**	0.01 (0.03)	0.02 (0.04)	0.00 (0.04)
Gender	0.17 (0.07)*	0.05 (0.06)	−0.01 (0.08)	−0.05 (0.08)
Substance use	0.08 (0.07)	0.04 (0.05)	0.05 (0.07)	−0.06 (0.07)
History of mood disorder	−0.04 (0.07)	−0.09 (0.06)	−0.01 (0.01)	0.01 (0.08)
Average happy mood				
No covariates	−0.28 (0.03)**	−0.01 (0.03)	0.02 (0.03)	−0.04 (0.04)
Gender	−0.08 (0.07)	−0.03 (0.05)	0.03 (0.06)	−0.04 (0.08)
Substance use	−0.07 (0.07)	−0.06 (0.07)	0.01 (0.06)	−0.02 (0.09)
History of mood disorder	0.03 (0.07)	0.09 (0.06)	0.05 (0.06)	−0.07 (0.09)

Notes: * $p < .05$; ** $p < .01$. Time lag represents distance between assessments of event negativity and mood. All time-lagged relationships control for same-day event negativity. Coefficients represent the interaction between each covariate (gender, substance use, mood disorder) and the event negativity-mood slope

typically considered additional sources of within-day and between-person variability in mood trajectories. Using computerized ambulatory monitoring, the current study examined the duration of mood responses to daily negative events, and considered whether gender, history of mood disorder, and substance use moderated these relationships. Analyses were limited to responses verified to have been provided within 10 min of the programmed signal, and all prospective analyses controlled for concurrent event negativity.

Concerning the overall duration and magnitude of mood responses, results of the within-day lagged analyses indicated that negative events continue to influence ratings of depressed and happy mood for several hours, even after adjusting for the effects of concurrent event negativity. Negative events were positively associated with negative mood ratings 6–9 h later in the day, and were negatively associated with happy mood ratings for approximately 3–6 h. Results further indicated that the effect of negative events on mood assessments did not spillover into the following day, and that within-day stress-mood relationships were characterized by quantitative but not qualitative changes in mood experience. These findings are in contrast to several previous investigations that have reported mood uplifts or rebounds following negative events (e.g., Bolger et al. 1989; Marco and Suls, 1993; Williams et al. 1991), findings that have been interpreted as consistent with opponent-process theory (Solomon 1980; Solomon and Corbit 1974). The present results suggest that mood uplifts are not part of the natural trajectory of mood responses following negative events and that alternative interpretations of previous findings should be considered. For example, Bolger and colleagues (1989) reported that married couples' moods were more positive on the day after a dispute than on days following a period of non-stressful interactions. Such increases in positive mood may be best explained by the reconciliation and increased intimacy that may follow negative interpersonal events rather than mood rebounds as proposed by opponent-process theory. Other observations of mood uplifts may reflect similar mechanisms, whereby specific negative events may increase the probability for the occurrence of subsequent positive events.

The findings also provide important indications of individual differences in within-day relationships between event negativity and mood states. Consistent with hypotheses, women had stronger initial depressed mood responses to negative events, as well as more persistent mood responses than men. Initial happy mood responses to negative events did not differ by gender, but women did experience a more pronounced decrement in happy mood at the subsequent assessment than men. Given that lagged analyses controlled for concurrent event negativity, these differences were therefore not simply due to gender differences in event exposure and may be consistent with women's greater tendency to ruminate on negative moods than men (e.g., Nolen-Hoeksema et al. 1999; Nolen-Hoeksema et al. 1993). This finding also complements previous diary research on heightened emotional reactivity to daily events among women (e.g., Almeida and Kessler 1998; Mohr et al. 2003), and extends it by suggesting that it is not only the initial magnitude of mood responses to daily events that differ between men and women, but also the persistence of within-day mood responses. The gender difference in findings for happy mood also underscores the importance of looking beyond initial post-event mood responses in daily process studies.

Although substance use did not moderate the concurrent or lagged within-day relationships between event negativity and depressed mood, it did modify the relationship between event negativity and subsequent happy mood. Previous research has tended to focus on substance use as it pertains to *negative* emotions in daily life (e.g., Swendsen et al. 2000), however this result suggests that decrements in positive mood may be an important component of the stress-mood profile among substance users that warrants future investigation. Finally, history of mood disorder did not moderate the initial magnitude or duration of mood responses to daily stress. Although research has suggested that major life events play a more important role in the onset of a first depression than in subsequent episodes (Kendler et al. 2000), results of the current study do not suggest that similar mechanisms are active in decreasing immediate emotional reactivity to minor daily events among individuals with a history of mood disorder.

The present findings have several implications for research designs. For example, while tests of vulnerability-stress theories in women may find significant mood effects several hours after the experience of negative event, their examination in men may be only observable over a shorter duration. Moreover, as gender did not influence immediate happy mood responses to negative events but did influence reactivity over time, results underscore the importance of examining progressively time-lagged relationships. Investigations that do not control for concurrent events in time-lagged analyses may likely observe that mood responses last over longer durations than those reported in the present study. However, it is also probable that enduring mood responses would be increasingly dissociated from events that induced initial negative affect, and therefore result in reduced power for linking mood responses with specific event qualities or event-related cognitions.

An important strength of the current investigation is its use of computerized ambulatory monitoring techniques that decrease retrospective recall bias and permit precise estimates of the timing of assessments. These features

allow the temporal patterning of relationships between negative events and mood states in ways that are inaccessible to standard laboratory-based protocols and yet are vital for understanding the persistence of mood responses to daily events. However, the results should be interpreted relative to the specific methodological parameters of the current study. The intensive nature of experience sampling investigations requires researchers to make a number of decisions that often involve tradeoffs between participant burden and amount of detail collected. Single-item mood measures, for example, may reduce participant burden in experience sampling studies, but may do so at the expense of determining reliability as distinct from measurement error (Wilhelm and Schoebi 2007). The current study also utilized a fixed signal schedule that varied slightly across participants to minimize hour-of-day effects. Although fixed signal schedules may reduce participant burden and are useful for longitudinal analyses (Bolger et al. 2003), the ideal timing of intervals between assessments of mood and negative events has yet to be established empirically. Finally, the evaluation of negative events was based on participants' own subjective evaluations, and the focus on depressed mood states may potentially be more susceptible to social desirability biases than other indicators of negative mood such as sadness. Future tests of vulnerability-stress theories may nonetheless benefit from establishing empirically-based rationales for the timing of assessments for variables that fluctuate rapidly in daily life.

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