

What's Driving the Binge in Binge Eating Disorder?: A Prospective Examination of Precursors and Consequences

Richard I. Stein, PhD¹
 Justin Kenardy, PhD^{2*}
 Claire V. Wiseman, PhD³
 Jennifer Zoler Douchis, PhD⁴
 Bruce A. Arnow, PhD⁵
 Denise E. Wilfley, PhD⁶

ABSTRACT

Objective: Previous research, mostly using retrospective reports, indicated a relation of negative affect and dietary restraint with the occurrence of binge episodes in binge eating disorder (BED). We employed Ecological Momentary Assessment (EMA) to better understand precursors and consequences of binge eating.

Method: Thirty-three females with BED carried a handheld computer for 7 days, and were periodically prompted to indicate their current emotions, hunger, and binge status.

Results: Negative mood and hunger were significantly higher at prebinge than at nonbinge times, but negative mood was even higher at postbinge. Par-

ticipants attributed binge episodes to mood more frequently than to hunger or abstinence violation.

Conclusion: The finding that negative mood is actually heightened subsequent to a binge suggests the need to further investigate what is reinforcing about a binge, including possible escape from self-awareness. Strengths of EMA technology are discussed, as well as its broad utility in BED assessment and treatment. © 2006 by Wiley Periodicals, Inc.

Keywords: binge eating disorder; Ecological Momentary Assessment; negative affect; experience sampling

(*Int J Eat Disord* 2007; 40:195–203)

Introduction

Recurrent binge episodes, marked by the consumption of a large amount of food and the experience of loss of control, are the hallmark of binge eating disorder (BED).^{1,2} Behavioral features accompanying the binge eating experience, such as eating when not physically hungry and feeling disgusted with oneself afterwards, are included among the DSM-IV research criteria for BED.³ Attitudinal dis-

turbances in eating and shape, psychiatric comorbidity, and impaired social functioning also contribute to the marked distress associated with binge eating.⁴ Yet, little is known about the mechanisms driving the binge eating in BED.

Several models of BED emphasize the role of dieting in perpetuating the disorder. According to the restraint theory of BED (for review, see Ref. 5), an obsessive desire for thinness leads to unrealistic dietary restraint, and binge eating occurs to compensate for the excessive deprivation.^{6,7} The abstinence violation effect, a cognitively-based variation of restraint theory, suggests that the inevitable violation of extreme dietary restraint activates all-or-none thinking (e.g., perfect restraint versus complete failure). These extreme thoughts heighten negative mood, disinhibit attempts to control what one eats, and lead to binge eating.⁸ Once binge eating occurs, attempts at rigid restraint are theorized to begin again, and the cycle continues. Preliminary support for the abstinence violation effect has been observed among individuals with BED as well as among nonclinical binge eaters and normal controls.⁹ However, whereas in bulimia nervosa (BN) binge eating is accompanied by dietary restraint and followed by inappropriate compensatory behavior (e.g., vomiting or excessive exercise), binge eating in BED occurs within the context of chaotic,¹⁰ less restrained eating.¹¹ Thus, the diet-

Accepted 5 September 2006

Supported by #5R29 MH51384-05 from National Institutes of Health and by Weight Watchers Foundation, Inc

Portions of the present data were presented at the Eighth New York International Conference on Eating Disorders, New York, NY, April, 1998.

*Correspondence to: Justin Kenardy, PhD, Centre of National Research on Disability and Rehabilitation Medicine, Mayne School of Medicine, University of Queensland, Herston, Queensland 4006, Australia. E-mail: j.kenardy@uq.edu.au

¹ Department of Internal Medicine, Washington University School of Medicine, St. Louis, Missouri

² School of Psychology, University of Queensland, Brisbane, Australia

³ Department of Psychiatry, Yale School of Medicine, New Haven, Connecticut

⁴ Private Practice, Naples, Florida

⁵ Department of Psychiatry and Behavioral Sciences, Stanford University, School of Medicine, Palo Alto, California

⁶ Department of Psychiatry, Washington University School of Medicine, St. Louis, Missouri

Published online 13 November 2006 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/eat.20352

© 2006 Wiley Periodicals, Inc.

binge cycle that has been hypothesized to lead to the binge eating in BN¹² appears to be operating differently in BED.

Alternative theories have focused on the role that affect may play in the maintenance of binge eating. Affect-driven models derived from BN include trade-off theory,¹³ which posits that in the face of negative mood, binge eating serves to substitute a less aversive affective condition (e.g., guilt after binge eating¹⁴) for the more aversive emotional state (e.g., depression) which preceded the binge. Alternatively, the escape from self-awareness model^{15,16} proposes that the act of binge eating serves as a means of narrowing the focus of an individual's attention toward the immediate stimuli (i.e., food) in order to block out attending to negative emotions. Another affect-related model is masking theory,^{17,18} which suggests that rather than blocking out emotions, binge eating serves as an attribution for negative affect that masks other problems. That is, negative emotions can be blamed on binge eating, which may be perceived as more controllable and/or tolerable than other aspects of one's life that may be the actual cause of distress. The majority of existing data on the role of affect in binge eating has been gathered in populations of BN or normal-weight binge eaters.¹⁹ Among participants with BN, negative mood has been found to both precede and follow a binge¹⁴; extreme negative affect (e.g., anxiety, depression, and anger) is heightened prior to a binge, and decreases during^{20,21} and following^{20,22} a binge. Consistent with trade-off theory, guilt and other less negative emotions increase following a binge.²³ In BED, evidence suggests that presence of negative mood is related to whether overeating feels out of control and is experienced as a binge.²⁴ In addition, preliminary findings among individuals with BED indicate greater distress resulting from negative mood,¹³ as compared to nonbinge eaters and individuals with nonclinical binge eating. Women with BED or a regular binge eating pattern also binge eat when feeling only moderately negative,⁹ and have a poorer mood prior to binge eating than do women without BED.^{25,26} Individuals with BED, compared to those without BED, may be less susceptible to internal hunger cues, and therefore, behave paradoxically by eating in response to distress, whereas for non-BED individuals, distress suppresses hunger,²⁷ and food consumption is likely to be associated with hunger and not distress.

The present study gathered prospective data on the precursors and consequences of binge eating among individuals with BED. Ecological Momentary Assessment (EMA) was implemented through

the use of handheld computers to capture information about an individual's nonbinge and binge eating, binge characteristics, hunger, attributions, and affective experience in the moment among his or her usual environs.^{28,29} In addition, this technology allowed for the comparison of an individual's feelings, hunger, and food intake preceding or following both binge and nonbinge episodes, without the biases inherent in retrospective reporting. The present study improves on past research by taking a more theory-driven approach, and offering a more comprehensive analysis of the binge process, including more details of what happens at times immediately before and after a binge compared to each other and to times not associated with a binge. Thus, the overall aim of this investigation was to examine supporting evidence for the hypothesized effects of various models of binge eating prospectively, by focusing on the following: (1) emotion prior to and subsequent to a binge, (2) perceived hunger, as well as consumption of actual meals and snacks, before binge eating versus control times, and (3) participants' attributions of hunger, emotions, and abstinence violation as potential explanatory factors for binge eating.

Method

The present data collection was performed as part of the baseline assessment procedures for all females from two cohorts of BED patients prior to randomization to a comparative psychotherapy study.³⁰ The research was reviewed and approved by the Yale University Institutional Review Board.

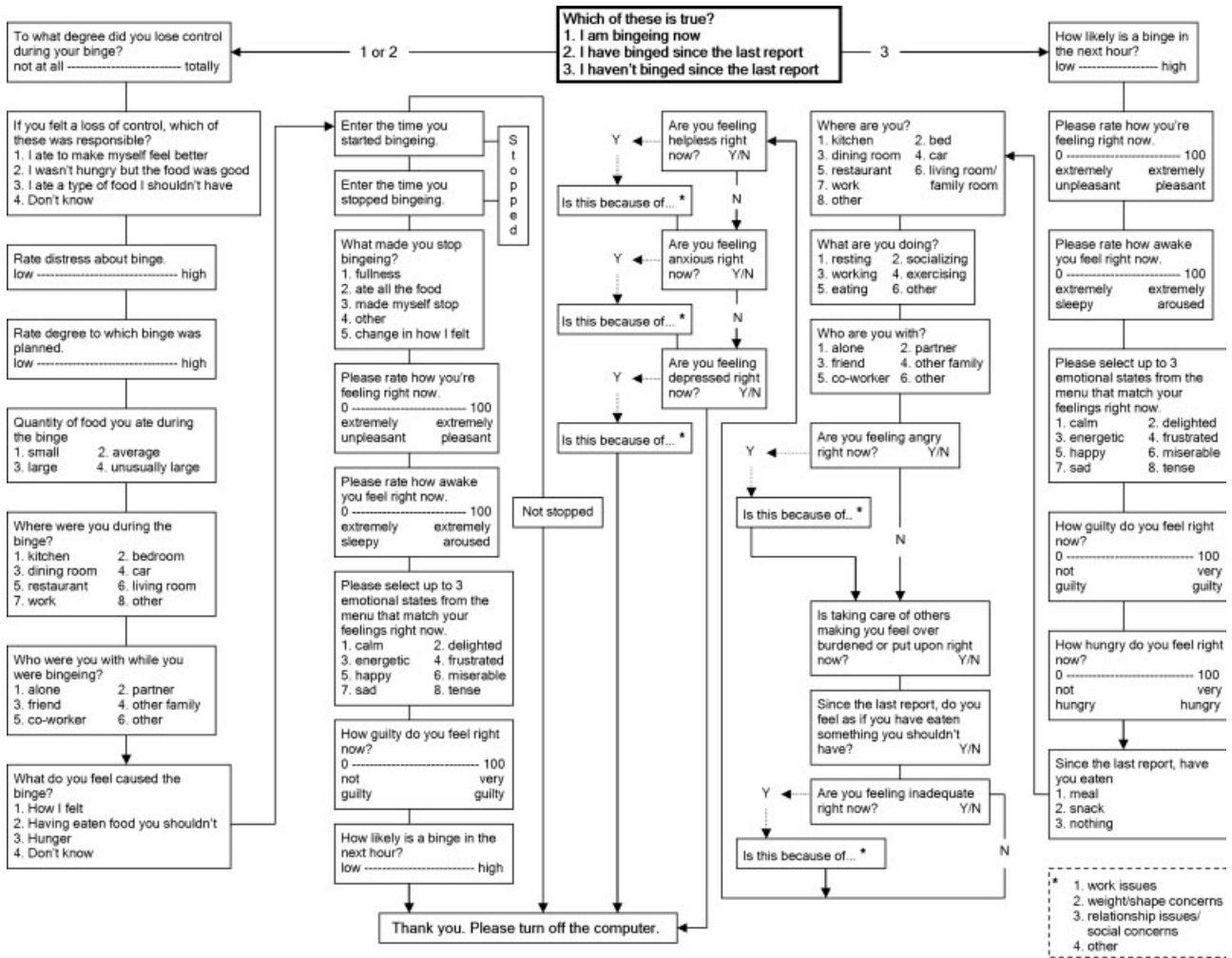
Participants

A total of 33 participants took part in the study. All participants were women, aged between 28 and 63 years ($M = 45.2$, $SD = 9.3$), who were assessed through the eating disorder examination (EDE³¹) to ensure that they met DSM-IV criteria for BED. Participants were required to be overweight, with a body mass index (BMI, calculated as $\text{weight}[\text{kg}]/\text{height}[\text{m}]^2$) of 27–48 ($M = 37.3$, $SD = 5.5$). Potential participants were excluded if they had psychiatric conditions warranting hospitalization or were actively suicidal. The ethnic breakdown of the sample was 97% Caucasian and 3% Native American. They had a mean income-range of \$40,000 to \$49,000, and a mean of 15.7 years of education.

Apparatus

Data were collected using a handheld computer, the Wizard OZ-9500 (Sharp Electronics, Mahwah, NJ). This

FIGURE 1. Full path and description of questions for experience sampling. Note: Except where indicated by response-dependent “gate” questions, each subsequent question was asked regardless of participant response to the previous question. Dotted lines indicate questions asked only if the participant responded “yes” to the previous question. The “stopped” pathway of questions was asked if the participant responded “I have binged since the last report” to the initial “gate” question; “not stopped” indicates the pathway if the participant had responded “I am bingeing now” to that initial “gate” question.



computer prompted participants, via alarm, for data entry prospectively for 7 consecutive days at six intervals during the day: 9:00 a.m., 12:00 noon, 3:00 p.m., 5:00 p.m., 7:00 p.m., and 9:00 p.m., providing a total of 42 sampling points. This model weighs 195 g, including batteries and expansion card, and it contains a built-in clock and calendar, thus allowing for time- and date-stamping of all the participants' data entries. This handheld computer has a 40-column by 8-line LCS display that accepts touch-screen data entry. Following data collection, the handheld computer was connected directly to a PC in order to download data via communication software.

Measures

Each sampling point consisted of a series of questions pertaining to participants' eating and mood. Participants

first answered a “gate” type question that determined which pathway of questions they would answer (see Fig. 1 for a depiction of the full set and order of questions). The “gate” question inquired about current binge status (i.e., currently bingeing, completed bingeing since last data entry, or no binge eating since last data entry). Based on the response to this question, participants then entered one of two alternative question pathways: (a) questions associated with binge eating, if they had binged since the previous data entry or were currently bingeing, or (b) a different set of questions (e.g., mood and hunger), if they had not binged since the previous data entry.

The content of the questions was derived from a previous study³² of factors reported by binge eaters to be associated with binge episodes. The binge-related pathway included questions about situational variables (i.e., with whom and where binge eating had occurred), and attri-

butions for the binge. If they had not binged since the previous entry, the pathway included questions about present situational variables (where the participant was, with whom, and what she was doing). The participant was asked whether she had eaten a meal or snack since the previous data entry, and how hungry she felt. She was asked about specific emotions chosen to represent affective dimensions indicated by binge eaters as important precursors of binges.³² In addition, the participant was asked specific questions about anger, interpersonal conflict, and food “rule” breaking (i.e., abstinence violation).

Finally, certain questions were asked in both (binge and nonbinge) pathways. These included having the participant choose up to three out of eight emotions, if any, she might be feeling. The specific emotions included were chosen to reflect the main dimensions of a circumplex model of mood.³³ In addition, participants were asked to rate how pleasant they felt, how aroused they were, and how guilty they felt.

Procedure

Participants were initially screened by telephone as part of recruitment for the treatment trial, and those meeting study criteria were then invited for an assessment interview (see Ref. 30 for details). This interview included the EDE 12.0D.³¹ Those meeting research criteria for BED were included in the present study.

After obtaining the participant’s informed consent, the study procedures and use of the handheld computer were explained. Participants were then trained on the computer program, including at least one practice session, until they demonstrated competence with the procedures. Participants were instructed on the alarm and prompt times, and they were asked to try to respond to alarm prompts as immediately as possible. Participants were told to rate the size of any binges using the following guidelines: (a) “Unusually large” was equivalent to three times what others might eat in that situation, (b) “Large” was greater than what others might eat in that situation but not equivalent to three times that amount, (c) “Average” was equivalent to what others might eat in that situation, and (d) “Small” was less than what others might eat in that situation. Finally, each participant was provided with a written manual for the handheld computer and computer program.

Participants were informed that they would be compensated \$1 per data point, thus earning up to \$42. Participants were then given a handheld computer to carry with them, and the 7-day assessment period began the next day. Participants were encouraged to contact the researchers by telephone if they required help, and participants were routinely called on the first assessment day to ensure that things were running smoothly. After the week of monitoring, the participants returned the

TABLE 1. Topography of binge episodes

Descriptive Information	Frequency
Where	
Kitchen	81 (30.7) ^a
Bedroom	19 (7.2)
Dining room	10 (3.8)
Car	27 (10.2)
Restaurant	5 (1.9)
Living room	82 (31.1)
Work	27 (10.2)
Other	13 (4.9)
With whom	
No one	154 (58.3)
Partner	46 (17.4)
Friend	3 (1.1)
Other family	39 (14.8)
Coworker	14 (5.3)
Other	8 (3.0)

^aValues given inside parentheses indicate percentages.

handheld computer to the clinic, at which time they were debriefed about the nature of the study and received compensation.

Results

Compliance

Compliance to the 42 (six time points over 7 days) prompts for data entry was 92.9%; mean number of completed data points was 39 (SD = 4.7), with a range from 27 to 42. Participants recorded information on 264 binge episodes (range 2–17 per participant). This allowed data to be classified into “precursor times” ($n = 172$), that is, data recorded in the sample period immediately prior to a binge, or “consequence times” ($n = 222$), that is, data recorded in the sample period immediately following a binge. The remaining data were classified as “nonbinge times”. Note that precursor and consequence times are not equal and were not available for all binge episodes reported, because (a) on some occasions, a binge followed a binge, so that precursors could also be consequences and (b) binges sometimes did not have measured consequences because the binges were too late in the day, or measured precursors because the binges were too early in the day.

Binge Characteristics

Binges were reported to have occurred most frequently in the kitchen and living room (see **Table 1**). The frequency of reports made by location and by people present was contrasted against whether the report was associated with a binge episode. Binge eating was significantly associated with location [$\chi^2(7) = 62.20, p < 0.001$], and with person present

TABLE 2. Self-rated size of binge versus standardized ratings on characteristics of binge eating episodes

	Small (N = 58)	Average (N = 71)	Large (N = 98)	Unusually Large (N = 37)	F(3,263)
Loss of control	-0.57 (0.91) ^a	-0.18 (0.90) ^a	0.21 (0.88) ^b	0.60 (0.66) ^b	17.07***
Distress	-0.53 (0.90)	0.00 (0.93) ^a	0.07 (0.87) ^a	0.62 (0.94)	13.28***
Intention to binge	-0.30 (0.91) ^a	-0.13 (0.87) ^{ab}	0.20 (0.95) ^b	0.20 (0.96) ^b	4.63**

Note: Numbers represent mean (SD). Within a given variable, means with the same alphabetic superscript do not differ at $p < 0.01$. ** $p < 0.01$, *** $p < 0.001$.

[$\chi^2(5) = 38.87, p < 0.001$]. Examination of standardized residuals indicated that binges were more likely to be reported when the person was in the kitchen ($z = 5.7, p < 0.05$) or living room ($z = 2.1, p < 0.05$), and less likely at work ($z = -5.1, p < 0.05$). Also, binges were more likely to be reported when the person was alone ($z = 5.2, p < 0.05$), and less likely when a friend ($z = -2.4, p < 0.05$) or coworker ($z = -4.0, p < 0.05$) was present. Binge eating frequency was associated with time of day [$\chi^2(2) = 21.91, p < 0.001$]: binges occurred most frequently in the evening and at night (6:00 p.m.–1:00 a.m.) [$n = 119, 45.1\%, z = 4.6, p < 0.05$] compared to the morning (5:00 a.m.–11:59 a.m.) [$n = 78, 29.5\%$] and the afternoon (12:00 noon–5:59 p.m.) [$n = 67, 25.4\%$].

Most self-identified binges were classified as “Large” or “Unusually large” (51.1%). Categories of quantity of food consumed in a binge were compared on standardized ratings of distress, loss of control, and intentionality (see **Table 2**). Examination of ANOVAs revealed that all three dependent variables differed across food quantity category, and post-hoc comparisons found that compared to “Small” or “Average” amounts of food, “Large” and “Unusually large” amounts of food were associated with significantly higher levels on distress, loss of control, and intentionality in binges.

Relation to Mood

Repeated-measures ANOVA was used to compare mean ratings of arousal, pleasantness, and guilt among reports of precursor times, consequence times, and nonbinge times. **Table 3** presents the results. As can be seen, ratings of arousal, pleasantness, and guilt differed significantly across these times. However, post-hoc comparisons revealed no significant differences on these ratings between precursor and nonbinge times. Two variables were constructed from the checklist of positive and negative emotions evaluated at each time sample. Positive mood was made up of the sum frequency of calm, delighted, energetic, and happy. Negative mood was the sum frequency of frustrated, miserable, sad, and tense. Mean positive mood and negative mood were compared among precursor, consequence, and nonbinge times. As seen in **Table 3**,

TABLE 3. Mean ratings for each participant averaged (collapsed) across reports not associated with binge eating (nonbinge times), reports immediately prior to a binge episode (precursor times), and reports immediately following a binge episode (consequence times)

	Non-Binge Times	Precursor Times	Consequence Times	F(2,60)
Pleasantness	5.03 (1.13) ^a	4.73 (1.28) ^a	3.86 (1.08)	19.50***
Arousal	5.13 (0.77) ^a	5.00 (0.97) ^a	4.27 (1.18)	12.56***
Guilt	2.26 (0.98) ^a	2.53 (1.11) ^a	4.34 (1.39)	61.22***
Positive mood	1.34 (0.49) ^a	1.10 (0.63) ^{ab}	0.83 (0.51) ^b	10.93***
Negative mood	0.37 (0.21)	0.61 (0.52)	0.91 (0.51)	17.17***
Binge likelihood	2.38 (0.80) ^a	3.95 (1.46)	2.42 (1.00) ^a	22.18***

Note: Numbers represent mean (SD). Within a given variable, means with the same alphabetic superscript do not differ at $p < 0.01$. *** $p < 0.001$.

mean positive and negative mood differed significantly across these times. Post-hoc comparisons showed that positive mood differed only between binge consequence times and nonbinge times, but neither of these were significantly different from precursor times; in contrast, negative mood differed among all three times. Thus, negative mood was significantly greater prior to a binge compared to nonbinge times, but negative mood at these precursor times was also significantly less than at binge consequence times. Reasons for a negative mood were compared between precursor and nonbinge times to examine possible binge-specific situational triggers. Four categories of situational triggers were used: work-related, weight/shape issues, relationship issues, and other. As seen in **Table 4**, negative mood was more likely to be attributed to weight/shape issues and relationship issues at binge precursor times, compared to at nonbinge times.

Relation to Hunger and Food Consumption

Mean ratings of hunger were compared between binge precursor times and nonbinge times. Using a paired *t*-test, mean hunger was found to be significantly greater at binge precursor times ($M = 4.06, SD = 1.42$) than at nonbinge times ($M = 3.54, SD = 0.85$) [$t(30) = 2.15, p < 0.05$]. The relation between the consumption of food and binge eating was examined by comparing whether food was eaten at nonbinge times versus precursor times to a binge. Food had been eaten on average at 59.1% ($SD =$

TABLE 4. Attributions for negative mood: Mean percentages for each participant averaged (collapsed) across reports not associated with binge eating (nonbinge times) versus reports immediately prior to a binge episode (precursor times)

	Nonbinge Times	Precursor Times	<i>t</i> (30)
Work-related	9.09 (9.01)	11.83 (17.84)	-0.97
Weight/shape	5.57 (9.99)	10.97 (13.77)	-2.24*
Relationships	10.04 (12.80)	17.09 (22.79)	-2.38*
Other	7.36 (6.67)	11.30 (15.32)	-1.40

Note: Numbers represent mean (SD).

* $p < 0.05$.

12.3%) of the reports not associated with binge eating as compared to 46.9% (SD = 29.2%) of times prior to binge episodes [$t(30) = 2.16, p < 0.05$].

Attribution

Participants ascribed the perceived cause of each binge reported, as follows: 47.7% of binges were attributed to how they felt; 17.4% to having broken a food rule; 14.0% to hunger; and the remaining 20.9% were attributed to causes identified as unknown. Participants also ascribed a perceived cause for any loss of control experienced for each binge: 27.3% were associated with an attempt to change mood; 20.5% with breaking of a food rule; 17.8% with the food being pleasurable; and 15.8% with causes identified as unknown. Notably, 49 (18.6%) of the self-reported binges were associated with no loss of control. No relation was found between reasons for a binge and either distress, loss of control, or intention to binge (see **Table 5**). Participants also reported reasons for the cessation of 200 of the 264 binge episodes. These were "Fullness" 26.5%, "Ate all of the food" 26.0%, "Made myself stop" 27.5%, "Change in how I felt" 5.5%, and "Other" 14.5%.

Mean ratings of likelihood of binge eating in the next hour were compared across precursor, consequence, and nonbinge times. Mean rated likelihood of binge eating was significantly higher at precursor times than at consequence and nonbinge times (see **Table 3**). To determine what influenced the increased perceived likelihood of binge eating prior to a binge, mean ratings of mood and hunger variables at the time immediately prior to the prebinge rating of binge prediction were regressed against

the prebinge rating of binge prediction. Only mean rating of hunger entered into the stepwise regression [$R^2 = 0.24, F(1,30) = 15.29, p = 0.005$].

Conclusion

The primary purpose of this prospective study was to examine the contribution of restraint and hunger as compared to affect-based factors in the experience of binge eating among patients with BED, thus allowing us to simultaneously evaluate various aspects of the primary models of BED. Major findings are as follows: (1) negative mood was significantly greater prior to a binge episode compared to nonbinge times, but significantly greater still at postbinge times; (2) hunger was significantly greater prior to a binge than at nonbinge times, and meals and snacks had less often been consumed prior to binge episodes than at nonbinge times; (3) participants attributed binge episodes to their mood more frequently than to hunger or abstinence violation.

The results support the primary explanatory theories of binge eating in BED. According to participants' own attributions for binge episodes and their self-rated mood before and after binge episodes, negative affect emerges as the clearest precursor to binge eating. Consistent with prior research,^{34,35} participants felt worse prior to a binge, but their experience of negative affect was actually highest immediately following a binge episode.

If trade-off to a less aversive emotional state is one intended purpose of a binge episode, the present data do not support that binge episodes succeed in serving this function. Indeed, even in the relative short-term, mood actually became more negative subsequent to a binge. These findings do not preclude the possibility that escape from self-awareness (i.e., shutting attention from a negative mood state immediately during the episode) or masking (i.e., providing an alternative attribution for negative affect in order to mask the actual underlying causes) may drive binge eating. Still, given that the self-defined primary purpose of the binge was to change mood, it is ironic that binge

TABLE 5. Self-rated cause of binge versus standardized ratings on binge eating episodes

	Mood ($N = 126$)	Broken Food Rule ($N = 46$)	Hunger ($N = 37$)	Don't Know ($N = 55$)	$F(3,263)$
Loss of control	0.05 (0.90)	0.01 (0.87)	-0.20 (1.01)	0.01 (1.05)	0.67
Distress	0.06 (0.94)	-0.04 (0.94)	-0.17 (0.84)	0.01 (1.02)	0.62
Intention to binge	0.08 (0.95)	-0.05 (0.86)	-0.13 (0.90)	-0.05 (1.04)	0.63

Note: Numbers represent mean (SD).

eating actually appears to worsen mood. It is unclear, therefore, aside from the reinforcing properties of food itself, how binge eating provides sufficient reinforcement value to perpetuate.

The present pattern of findings does not rule out a role for restraint theory. Perceived hunger was significantly higher, and food had more often not been eaten, prior to a binge than at times not associated with binge eating. Negative affect preceding a binge is itself consistent with restraint-based theories, which would predict that all-or-none thinking after one breaks extreme restraint cause negative mood which, in turn, lead to more disinhibited eating and, ultimately, to binge eating. However, binge eating for reasons of “breaking of a food rule,” consistent with an abstinence-violation effect model of binge eating, did not emerge as a primary cause for binge eating. Taking our findings together, it is possible that the association found between negative affect and binge eating may be further impacted by hunger, as negative affect occurring while someone is feeling hungry or deprived may lead to a greater likelihood of binge eating.

Consistent with information that has been obtained using retrospective studies with instruments such as the EDE,³¹ we found that binges most often occurred at home in the living room or kitchen, while alone in the evening. We also found that those episodes that participants classified as large or very large were more intentional, increased the individual’s distress, and were associated with significantly higher levels of loss of control. We also learned that there was no one predominant reason participants endorsed as to why their binge ended.

One strength of the present study was that, perhaps because the technology’s novelty sparked participant interest, we found compliance to the protocol was extremely high—specifically, 92.9% over the 7 days. In addition, answering questions close to when the episode occurred may have enhanced participants’ ability to describe the characteristics of their binges.³⁶ Given the extremely private nature of binge eating behaviors, participants reluctant to explain the true nature and frequency of their binge episodes in the context of an interview-based data collection may have felt freer to enter this information in the relatively anonymous pocket computer. Thus, as others have suggested,³⁷ under-reporting that may take place when binge episodes are assessed retrospectively may be overcome with EMA technology, such that we may be able to correctly identify BED cases that might be missed with clinic-based assessment.

There are some limitations to the present study. In an effort to simplify the program to make it

“user-friendly,” many of the questions used dichotomous response choices. More information could have been gained, and more statistical power allowed, by providing participants the opportunity to respond to more questions in a continuous response format. Moreover, to reduce participant burden, we did not examine all the triggers for binge eating that have been identified in restrained eaters. There may also have been confusion in participants’ responses to questions about arousal, as the word in this context was used to assess both negative anxiety and positive excitement, which may be inconsistent with how participants typically understand or use the word. An additional limitation was the use of fixed-interval rather than random-interval sampling, which may have led to greater reactivity in participants’ responding to questions and possibly less validity. However, previous research³⁸ indicates very low likelihood of reactivity from fixed-interval sampling.

Finally, for 18.6% of the episodes self-labeled as binges, participants did not endorse any loss of control. Among all study participants, 16% had 4 or more such episodes, 42% had only 1–2 such episodes, and the remaining 42% had no such episodes, reporting loss of control with all of their binges. Post-hoc analyses indicated that episodes labeled as having no loss of control tended to be described as involving a smaller quantity of food ($p < 0.001$), less guilt ($p = 0.001$), and less distress ($p = 0.033$) compared to episodes with loss of control. However, the two types of episodes did not significantly differ in degree to which they were planned, or in how pleasant or aroused the participant felt. It is possible that some participants did not fully understand the concept of loss of control, as self-report is less accurate than investigator-based methods for assessing binge eating.³⁹ However, in addition to having been assessed with the EDE, during which the interviewer guided them in dividing overeating episodes into different categories based on size and loss of control, for the purposes of this study participants were specifically trained to identify binges based on particular criteria for size and loss of control. Given their ability to distinguish between such episodes during their training, we subsequently accepted participants’ impression of when a binge episode had occurred. Another explanation for participants not endorsing any loss of control during binge episodes may be that they actually had the experience of feeling loss of control (e.g., unable to stop eating) but did not want to label the episodes or themselves as out of control. Alternatively, participants may have had other reasons for labeling episodes as feeling like a

binge in the absence of loss of control (e.g., ate to extreme fullness; ate a large amount of a single type of food; ate when not hungry just because food was available). Finally, especially for the 16% who had several binges self-labeled with no loss of control, an explanation consistent with anecdotal reports may be that some individuals felt so resigned to the inevitability of their binge eating that they did not recognize feeling a loss of control.

One intriguing finding from the present study was that when we asked participants to predict whether they were going to binge, they were able to predict somewhat accurately if a binge would occur. Participants' ability to predict binge episodes further raises the question of the nature of loss of control, with a contradiction between not being able to control a binge, yet being able to have advance knowledge of or even plan for a binge. Clinical experience suggests that individuals with BED sometimes plan the time they will binge, such as to make sure that they are alone (e.g., at night, after other family members have gone to sleep), yet still feel out of control once they start eating at that planned time. Further data are needed to understand what it means to plan a binge, whether the experience of loss of control differs when binges are planned, and the role of ceasing to even try to prevent a binge in loss of control.

Data suggesting that eating disorder behaviors do not show reactivity to daily EMA assessment⁴⁰ indicate that EMA may be a useful method to evaluate treatment outcome. For example, pre- and post-treatment EMA measures could be obtained to assess how the antecedents and consequences of binge episodes change following intervention. Another future research direction is the use of EMA, such as the keypads used in the present study, as an intervention in itself or as an added component to intervention (e.g., as has been done for BN⁴¹). This may be especially promising given the data that binge eaters find similar timer-prompted self-monitoring to be relatively helpful,²⁵ and in light of the increasing prevalence and sophistication of computer and handheld technology. For example, investigators are testing a computer-augmented cognitive-behavioral therapy for panic disorder⁴² and a CD-ROM-based self-help treatment for BN.⁴³ Activity monitors to keep track of physical activity, handheld devices with software to monitor and analyze nutrition information, and tailored computer-made health communications or computer-delivered treatment components using clinic-based kiosks, are being used in weight loss, health care, and lifestyle interventions.^{44–46}

Given that binge eating occurs within the context of both increased negative affect and physical hun-

ger, research needs to examine aspects of each of these as causal factors in initiating and maintaining binge episodes, as well as to replicate studies indicating that BED individuals can be divided into dieting and dieting/negative affect subtypes.⁴⁷ Given the complex interplay between emotional and physical factors in the phenomena of binge eating, and the ways in which treatments are commonly targeted to address one or both of these factors, research needs to be conducted further examining aspects of binges that perpetuate them. Binge episodes may be reinforcing for both restraint-based and affect-based reasons, including relief of hunger/deprivation, escape from awareness of one's negative emotions, and/or changing one's emotional state.

Further work is also needed to examine the impact of negative affect on treatment outcome, as well as to continue testing interventions focused on impacting negative affect—such as dialectical behavior therapy (DBT)⁴⁸ and interpersonal psychotherapy (IPT).⁴⁹ Given that our participants mentioned enjoying their use of the handheld computer in the present study, the extremely high compliance we obtained with relatively small incentive payments, and the increasing prevalence and versatility of handheld electronics, there seems to be a high potential to use EMA technology for assessment and treatment purposes, as well as to discover even more targeted information about what drives binge eating.

The authors thank Ms. Jacqueline Tan and Ms. Kate Darwent for their assistance with manuscript preparation, and Ms. Jennifer Gray for her help administering the keypads.

References

1. Spitzer RL, Devlin MJ, Walsh BT, Hasin D, Wing R, Marcus M. Binge eating disorder: A multisite field trial of the diagnostic criteria. *Int J Eat Disord* 1992;11:191–203.
2. Spitzer RL, Yanovski S, Wadden T, Wing R, Marcus MD, Stunkard A, et al. Binge eating disorder: Its further validation in a multisite study. *Int J Eat Disord* 1993;13:137–153.
3. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, 4th ed. (Text Revision)*. Washington, DC: American Psychiatric Association, 2000.
4. Grilo CM. Binge eating disorder. In: Fairburn CG, Brownell KD, editors. *Eating Disorders and Obesity: A Comprehensive Handbook*, 2nd ed. New York: Guilford, 2002, pp.178–182.
5. Howard CE, Porzelius LK. The role of dieting in binge eating disorder: Etiology and treatment implications. *Clin Psychol Rev* 1999;19:25–44.
6. Davis R, Freeman RJ, Garner DM. A naturalistic investigation of eating behavior in bulimia nervosa. *J Consult Clin Psychol* 1988;56:273–279.

7. Wilfley DE, Pike KM, Striegel-Moore RH. Toward an integrated model of risk for binge eating disorder. *J Gender Cult Health* 1997;2:1–32.
8. Grilo CM, Shiffman S. Longitudinal investigation of the abstinence violation effect in binge eaters. *J Consult Clin Psychol* 1994;62:611–619.
9. Johnson WG, Schlundt DG, Barclay DR, Carr-Nangle RE, Engler LB. A naturalistic functional analysis of binge eating. *Behav Ther* 1995;26:101–118.
10. Hagan MM, Shuman ES, Oswald KD, Cocoran KJ, Proffitt JH, Blackburn K. Incidence of chaotic eating behaviors in binge-eating disorder: Contributing factors. *Behav Med* 2002;28:99–105.
11. Wilfley DE, Schwartz MB, Spurrell EB, Fairburn CG. Using the eating disorder examination to identify the specific psychopathology of binge eating disorder. *Int J Eat Disord* 2000;27:259–269.
12. Polivy J, Herman CP, Olmstead M, Jazwinski CM. Restraint and bingeing: From laboratory models to clinical practice. In: Hawkins RC, Fremouw W, Clements PF, editors. *Binge Eating: Theory, Research, and Treatment*. New York: Wiley, 1984, pp.104–122.
13. Kenardy J, Arnow B, Agras WS. The aversiveness of specific emotional states associated with binge-eating in obese subjects. *Aust N Z J Psychiatry* 1996;30:839–844.
14. Lingswiler VM, Crowther JH, Stephens MAP. Emotional and somatic consequences of binge episodes. *Addict Behav* 1989;14:503–511.
15. Heatherton TF, Baumeister RF. Binge eating as escape from self-awareness. *Psychol Bull* 1991;110:86–108.
16. Schupak-Neuberg E, Nemeroff CJ. Disturbances in identity and self-regulation in bulimia nervosa: Implications for a metaphorical perspective of “body as self”. *Int J Eat Disord* 1993;13:335–347.
17. Herman CP, Polivy J. Excess and restraint in bulimia. In: Pirke KM, Vandereycken W, Ploog D, editors. *The Psychobiology of Bulimia*. Munich: Springer Verlag, 1988.
18. Polivy J, Herman CP. Distress and eating: Why do dieters overeat? *Int J Eat Disord* 1999;26:153–164.
19. Steiger H, Gauvin L, Jabalpurwala S, Seguin JR, Stotland S. Hypersensitivity to social interactions in bulimic syndromes: Relationship to binge eating. *J Consult Clin Psychol* 1999;67:765–775.
20. Hsu LKG. Experiential aspects of bulimia nervosa: Implications for cognitive behavioral therapy. *Behav Modif* 1990;14:50–65.
21. Kaye WH, Gwirtsman HE, George DT, Weiss SR, Jimerson DC. Relationship of mood alterations to bingeing behavior in bulimia. *Br J Psychiatry* 1986;149:479–485.
22. Schlundt DG, Johnson WG. *Eating Disorders: Assessment and Treatment*. Needham Heights, MA: Allyn and Bacon, 1990.
23. Cooper JL, Morrison TL, Bigman OL, Abramowitz SI, Levin S, Krener P. Mood changes and affective disorder in the bulimic binge-purge cycle. *Int J Eat Disord* 1988;7:469–474.
24. Telch CF, Agras WS. Do emotional states influence binge eating in the obese? *Int J Eat Disord* 1996;20:271–279.
25. Deaver CM, Miltenberger RG, Smyth J, Meidinger A, Crosby R. An evaluation of affect and binge eating. *Behav Modif* 2003;27:578–599.
26. Greeno CG, Wing RR, Shiffman S. Binge antecedents in obese women with and without binge eating disorder. *J Consult Clin Psychol* 2000;68:95–102.
27. Polivy J, Herman CP. Etiology of binge eating: Psychological mechanisms. In: Fairburn C, editor. *Binge Eating*. London: Guilford, 1993.
28. Lee MI, Miltenberger RG. Functional assessment and binge eating: A review of the literature and suggestions for future research. *Behav Modif* 1997;21:159–171.
29. Stickney MI, Miltenberger RG, Wolff G. A descriptive analysis of factors contributing to binge eating. *J Behav Ther Exp Psychiatry* 1999;30:177–189.
30. Wilfley DE, Welch RR, Stein RI, Spurrell EB, Cohen LR, Saelens BE, et al. A randomized comparison of group cognitive-behavioral therapy and group interpersonal psychotherapy for the treatment of overweight individuals with binge-eating disorder. *Arch Gen Psychiatry* 2002;59:713–721.
31. Fairburn CG, Cooper Z. The eating disorder examination (12th ed.). In: Fairburn CG, Wilson GT, editors. *Binge Eating: Nature, Assessment, and Treatment*. New York: Guilford, 1993, pp. 317–360.
32. Arnow B, Kenardy J, Agras WS. Binge eating among the obese: A descriptive study. *J Behav Med* 1992;15:155–170.
33. Russell JA. A circumplex model of affect. *J Pers Soc Psychol* 1980;39:1161–1178.
34. Stickney MI, Miltenberger RG. Evaluating direct and indirect measures for the functional assessment of binge eating. *Int J Eat Disord* 1999;26:195–204.
35. Wegner KE, Smyth JM, Crosby RD, Wittrock D, Wonderlich SA, Mitchell JE. An evaluation of the relationship between mood and binge eating in the natural environment using ecological momentary assessment. *Int J Eat Disord* 2002;32:352–361.
36. Smyth J, Wonderlich S, Crosby R, Miltenberger R, Mitchell J, Rorty M. The use of ecological momentary assessment approaches in eating disorder research. *Int J Eat Disord* 2001;30:83–95.
37. LeGrange D, Gorin A, Catley D, Stone AA. Does momentary assessment detect binge eating in overweight women that is denied at interview? *Eur Eat Disord Rev* 2001;9:309–324.
38. Kenardy J, Fried L, Taylor CB, Kraemer HC. Psychological precursors of panic attacks. *Br J Psychiatry* 1992;160:668–673.
39. Wilfley DE, Schwartz MB, Spurrell EB, Fairburn CG. Assessing the specific psychopathology of binge eating disorder patients: Interview or self-report? *Behav Res Ther* 1997;35:1151–1159.
40. Stein KF, Corte CM. Ecologic momentary assessment of eating-disordered behaviors. *Int J Eat Disord* 2003;34:349–360.
41. Norton M, Wonderlich SA, Myers T, Mitchell JE, Crosby RD. The use of palmtop computers in the treatment of bulimia nervosa. *Eur Eat Disord Rev* 2003;11:231–242.
42. Kenardy J, Dow MGT, Johnston DW, Newman MG, Thompson A, Taylor CB. A comparison of delivery methods of cognitive behavioral therapy for panic disorder: An international multi-center trial. *J Consult Clin Psychol* 2003;71:1068–1075.
43. Bara-Carril N, Williams CJ, Pombo-Carril MG, Reid Y, Murray K, Aubin S. A preliminary investigation into the feasibility and efficacy of a CD-ROM-based cognitive-behavioral self-help intervention for bulimia nervosa. *Int J Eat Disord* 2004;35:538–548.
44. Kreuter MW, Caburnay CA, Chen JJ, Donlin MJ. Effectiveness of individually tailored calendars in promoting childhood immunization in urban public health centers. *Am J Public Health* 2004;94:122–127.
45. Roemmich JN, Gurgol CM, Epstein LH. Open-loop feedback increases physical activity of youth. *Med Sci Sports Exerc* 2004;36:668–673.
46. Wylie-Rosett J, Swencionis C, Ginsberg M, Cimino C, Wassertheil-Smoller S, Caban A. Computerized weight loss intervention optimizes staff time: The clinical and cost results of a controlled trial conducted in a managed care setting. *J Am Diet Assoc* 2001;101:1155–1162.
47. Grilo CM, Masheb RM, Wilson GT. Subtyping binge eating disorder. *J Consult Clin Psychol* 2001;69:1066–1072.
48. Telch CF, Agras WS, Linehan MM. Dialectical behavior therapy for binge eating disorder. *J Consult Clin Psychol* 2001;69:1061–1065.
49. Wilfley DE, MacKenzie KR, Welch RR, Ayres V, Weissman MM. *Interpersonal Psychotherapy for Group*. New York: Basic Books, 2000.