Journal of Consulting and Clinical Psychology
2004, Vol. 72, No. 2, 341–348

0022-006X/04/$12.00 DOI: 10.1037/0022-006X.72.2.341

An Ecological Momentary Assessment of Relapse Crises in Dieting

Robert A. Carels, Olivia M. Douglass, Holly M. Cacciapaglia, and William H. O'Brien
Bowling Green State University

Much of the research on relapse crises in dieting has focused on isolated lapse events and relied heavily on retrospective self-report data. The present study sought to overcome these limitations by using ecological momentary assessment (EMA) techniques to examine situations of dietary temptation and lapse with a sample of obese, formerly sedentary, postmenopausal women ($N = 37$) during the final week of a weight-loss intervention. Mood was associated with reports of dietary lapse. Abstinence-violation effects were more strongly associated with dietary lapses than temptations. Finally, coping responses distinguished dietary temptations from lapses. Education on the factors associated with relapse crises in dieting may be imperative for weight loss success and maintenance.

From a public health perspective, the increased incidence of obesity is alarming because obesity is a risk factor for a number of serious health problems (National Heart, Lung, and Blood Institute Obesity Education Initiative Task Force Members, 1998). Despite the potential health benefits of weight-loss programs, these programs are often plagued by high rates of relapse (Jeffery et al., 2000). Although research has indicated that a number of factors are likely to contribute to successful weight loss (e.g., self-monitoring; Brownell & Kramer, 1989), the contextual, behavioral, and emotional factors that could plausibly influence relapse are poorly understood (National Heart, Lung, and Blood Institute Obesity Education Initiative Task Force Members, 1998).

Research investigating potential influences on dieting relapse has indicated that certain factors—such as affect, interpersonal stress or pressure, and specific activities—may play a key role in temptation and lapse in dieting (e.g., Cummings, Gordon, & Marlatt, 1980; Grilo, Shiffman, & Wing, 1989; Rosenthal & Marx, 1981). However, early studies relied on data collected during structured interviews that occurred 1 or 2 months following a weight-loss program (Grilo et al., 1989; Rosenthal & Marx, 1981). This methodological approach may be limited by its reliance on retrospective self-report data, which can be unreliable or biased in ways that can distort causal inference. Specifically, mood, past behaviors, preconceived notions, and self-image can bias these retrospective self-reports (e.g., see Stone & Shiffman, 1994). Also, past research has tended to focus on a single temptation or lapse episode, which may or may not be representative of other relapse crises (Grilo et al., 1989). Finally, without comparing an individual's dietary relapses to similar conditions when there is not dietary relapse, it is not possible to conclude that factors associated with a lapse are not occurring at the same frequency throughout the day.

A few published studies of relapse crises in dieters have attempted to minimize reliance on lengthy retrospective self-report data and simultaneously examine multiple relapse crises (Carels et al., 2001; Greeno, Wing, & Shiffman, 2000; Johnson, Schlundt, Barclay, Carr-Nangle, & Engler, 1995; Schlundt, Sbrocco, & Bell, 1989; Schlundt et al., 1990). Using ecological momentary assessment (EMA; i.e., repeated, real-time assessments in participant's typical environment; Stone & Shiffman, 1994) to assess dietary relapse crises in 30 overweight college dieters, we compared dietary temptation and lapse situations with moments of "minimal dietary consequence" (i.e., random assessment) across a number of contextual, behavioral, and emotional factors (Carels et al., 2001). Carels et al. (2001) determined that, compared with moments of minimal dietary consequence, increased negative mood and engagement in specific activities (e.g., socializing, interpersonal conflict) tended to promote temptation and lapse. Also, dieters reported feeling less confident in their ability to maintain their diet after dietary lapses when compared with moments of minimal dietary consequence and temptation. However, this investigation did not examine other important factors, such as coping responses, that could be associated with temptation and lapse outcomes. Additionally, the college sample was not engaged in a formal weight-loss program.

Diary research by Greeno et al. (2000) and Schlundt et al. (1989, 1990) has also yielded consistent findings regarding the role of affective and situational factors in overeating. In a study of obese women with binge eating disorder, Greeno et al. (2000) found that negative mood, low alertness, feelings of poor eating control, and cravings for sweets preceded binge episodes. Poor eating control and craving sweets also predicted binges in women without binge eating disorder. Similarly, in research with obese individuals participating in a behavioral weight-loss program, Schlundt et al. (1989) found individuals tended to overeat or eat unplanned meals in response to three situations: positive social interactions, negative emotions, and physiological cravings. In a separate study using cluster analysis to identify groups of obese women on the basis of eating patterns, emotional overeaters were also identified as a distinct group (Schlundt et al., 1990). These diary studies provided insight into the role of mood, activities, and context on lapses but did not investigate the role of other potentially important factors, such as coping and abstinence-violation effects. Also, these studies did not investigate differences between situations in which the participants successfully avoided a lapse (i.e., temptation) relative to a lapse occurrence.

The present study examined relapse crises among a sample of obese, postmenopausal women during the final week of a behav-

Robert A. Carels, Olivia M. Douglass, Holly M. Cacciapaglia, and William H. O'Brien, Department of Psychology, Bowling Green State University.

Correspondence concerning this article should be addressed to Robert A. Carels, Department of Psychology, Bowling Green State University, Bowling Green, OH 43403. E-mail: rcarels@bgnet.bgsu.edu

ioral weight-loss intervention. We used EMA techniques to compare temptations and lapses with instances of minimal dietary consequence across numerous relapse crisis events. EMA is a methodological technique used to collect repeated measurements of a phenomenon as it occurs in naturalistic settings (Stone & Shiffman, 1994). A number of research investigations have used EMA with a variety of patient populations (e.g., smokers: Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996; rheumatoid arthritis: Stone, Broderick, Porter, & Kaell, 1997; fibromyalgia: Affleck et al., 2001). A major focus of this investigation was to identify antecedents and consequences of relapse crisis by using a within-person design across several temptation and lapse events in women completing a behavioral weight-loss program. Additionally, we wanted to compare moments of temptation and lapse on important, yet understudied, factors, such as coping response and abstinence-violation effects.

Method

Participants

Participants were 37 obese, formerly sedentary, postmenopausal women in the final week of a weight-loss intervention (Table 1). Participants were recruited through local advertisements (e.g., newspaper) and fliers (e.g., distributed at women's health clinics, hospitals). Women were included in the investigation if they were (a) postmenopausal (no menstruation for at least 12 months), (b) obese (body mass index [BMI] $>$ 30 kg/m^2), (c) sedentary (not participating in a program of physical conditioning two or more times per week), (d) willing to accept random assignment, and (e) nonsmokers. Participants were excluded from participation if they had (a) past or current cardiovascular disease (e.g., myocardial infarction), (b) surgically induced menopause within the previous 6 months, (c) musculoskeletal problems that would prevent participation in moderate levels of physical activity (e.g., osteoporosis), (d) a history of insulin-dependent diabetes (self-reported), (e) resting blood pressure greater than or equal to 160/100 mmHg (assessed during screening), or (f) a life-limiting or complicated illness.

Procedure

Participants underwent a 24-session weight-loss intervention based on the LEARN program (Brownell, 2000). During the final week of the intervention, women completed EMA diaries. Women were provided with explanations for the temptation, lapse, and random-prompt sections of the diary. Women were also provided with instructions for completing each question within the diaries. Participants made several practice diary entries. Research personnel from the investigation were available to answer questions throughout the week of diary recording. Appropriate times to complete entries for each section were discussed (i.e., within the first 15 min of a temptation or lapse; right after being randomly paged), and the importance of completing entries "in the moment" was stressed throughout training. Participants carried the diaries, described above, along with pagers (for the purpose of random prompts four times a day) for 1 week. Following the week of EMA recording, participants completed a compliance and reactivity questionnaire.

Table 1
Demographic Characteristics

Demographics	*n*	%	*M*	*SD*
Income $<$ \$30,000	15	40.5		
College degree	20	54.1		
Caucasian	35	94.5		
Working full/part time	33	89.1		
Age (years)			54.7	7.9
Baseline weight (lbs)			212.0	35.2
Baseline BMI (kg/m^2)			36.4	5.5

Note. BMI = body mass index.

Intervention

The LEARN program is a comprehensive, empirically supported, lifestyle-change approach to weight management and physical activity (Brownell, 2000) and has five components: lifestyle, exercise, attitudes, relationships, and nutrition. It is designed to achieve gradual weight loss, increased physical activity, and a progressive decrease in energy and fat intake through permanent lifestyle changes. The program emphasizes (a) self-monitoring of eating behavior, (b) controlling stimuli associated with eating, (c) physical activity, (d) nutrition education, (e) modifying self-defeating thoughts and emotions associated with dieting and body image, (f) setting realistic goals, (g) relationships, (h) relapse prevention and weight maintenance, and (i) preventing, coping with, and gaining control of temptations and lapses. One half of the women were randomly assigned to receive the weight-loss intervention alone, whereas the other half received the weight-loss program as well as self-control skills training. The self-control skills training was based on Baumeister's self-control theory (Baumeister, Heatherton, & Tice, 1994). In this study, the women lost, on average, 6.2 kg (*SD* = 4.3), the equivalent to 2.4 BMI units (*SD* = 1.7).

Measures

A paper-and-pencil EMA diary was used to examine temptation and lapse in dieting (Carels et al., 2001). Separate sections were created for temptation and lapse situations, as well as random prompts.

Temptation and lapse entries. Participants were first required to record the date and time of a temptation or lapse entry when it occurred. In the case of temptations, participants then rated the intensity of their temptation using a 5-point scale (1 = *not at all*, 2 = *a little*, 3 = *somewhat*, 4 = *very*, and 5 = *extremely*). Temptations were defined as, "A sudden urge to break your diet (e.g., overeat, eat a forbidden food) in which you felt you had come close to the brink of breaking your diet." Lapses were defined as, "An incident where you felt that you broke your diet (e.g., overate, ate a forbidden food)."

Participants then completed items regarding consumptive activities that preceded the temptation or lapse. Items assessing consumptive activities included hunger ratings, level of satiety after prior eating episode, and level of satisfaction with prior eating episode (each rated on the 5-point scale described above); time of last eating episode and length of time hungry (time format); and quantity of prior eating episode (check one: snack, meal). Items also assessed participants' location (home, work, or other), presence of others ("yes" or "no"), activities (e.g., cooking [for self/for others], shopping for food, conflict with others, eating with others, exercising, eating out, eating a meal, eating a snack, watching television, socializing/attending a party, reading, or other), and mood (e.g., frustrated, nervous, bored, content, restless, in control, sad, happy, stressed, tired, relaxed, and other), preceding the temptation or lapse.

Coping during the temptation or lapse was assessed using 14 items, rated on a 4-point scale (1 = *I did not do this*; 2 = *I did this a little*; 3 = *I did this a medium amount*; 4 = *I did this a lot*). Participants were asked to "rate your attempts to cope, if any, during the temptation or lapse" using the following items: "removed myself from the situation," "distracted myself," "talked to a group member for advice or comfort," "talked to a family member for advice or comfort," "talked to a friend for advice or comfort," "encouraged myself," "meditated/relaxed," "engaged in spiritual activities," "exercised," "thought about the benefits associated with dieting," "thought about the benefits associated with being healthy," "thought about the negatives associated with not dieting," "thought about the negatives associated with being unhealthy," and "other." Also, coping responses were summed to compute a total coping score during each temptation and lapse event.

Abstinence-violation effects were assessed by requesting participants to indicate their level of agreement with the following eight statements, rated on a 5-point scale (i.e., 1 = *strongly disagree,* 2 = *disagree,* 3 = *neutral,* 4 = *agree,* 5 = *strongly agree*). Participants were asked to "characterize your reaction to the temptation or lapse" with the following items: (a) "I am unlikely to be tempted or lapse again," (b) "I know my diet will be successful," (c) "I am worried about maintaining my diet," (d) "I feel like I failed my diet," and (e) "I feel guilty because of my temptation or lapse." In addition, participants were asked to "rate the following statement regarding your temptation/lapse" with the following three items: (a) "I am responsible for the temptation/lapse," (b) "I can control what I eat in the future," and (c) "I have willpower."

Random prompts. As with all diary entries, participants recorded the date and time of their entry. In addition, participants were asked if this was also a temptation and/or lapse ("yes" or "no"). The words *temptation*/*lapse* were replaced by the word *prompt* as required.

Compliance and reactivity. Following the week of EMA recording, participants completed a compliance and reactivity questionnaire. Compliance with the diary was rated on a 6-point scale (1 = *none,* 2 = *once during the week,* 3 = *several times during the week,* 4 = *about once a day,* 5 = *2–5 times a day,* 6 = *greater than 5 times a day*). Participants were asked "How many diary entries did you miss or skip?" and "How many diary entries did you complete longer than 15 min after the lapse, temptation, or prompt?" Reactivity (i.e., modification of typical behavior in response to the data-collection modality) was assessed with four questions. Three questions were rated on a 5-point scale (1 = *strongly disagree,* 2 = *disagree,* 3 = *neutral,* 4 = *agree,* 5 = *strongly agree*). Participants responded to the statement "compared to your normal dieting routine," (a) "I was more likely to be tempted while keeping the diary," (b) "I was more likely to lapse while keeping the diary," and (c) "I was more aware of my behavior while keeping a diary." One question (1 = *not at all,* 2 = *a little,* 3 = *somewhat,* 4 = *very,* 5 = *extremely*) asked participants "Did keeping a diary influence your eating behaviors?"

Data Analyses

Prior research suggests that the mood items may load on positive and negative mood factors (Matthews, Owens, Allen, & Stoney, 1992). Therefore, the positive and negative mood items were submitted to a factor analysis using a varimax rotation procedure. One factor emerged with high positive loadings for relaxed, happy, content, and in control (i.e., positive mood; $\alpha = .84$). A second factor emerged with high positive loadings for sad, nervous, frustrated, and restless (i.e., negative mood; $\alpha = .80$). Stressed and tired did not positively load on either factor. Therefore, positive and negative mood items were combined to form global positive and negative mood variables.

The addition of self-control-skills training had no significant effects on any intervention outcomes, including the number of lapses and temptations. Therefore, data from both treatment groups were combined. Generalized estimating equations (GEE; SAS Institute, 1997) were used to compare situations of minimal dietary consequence (i.e., random prompts) with dietary temptations and lapses on recent consumptive activities, presence of others, location, activities, mood, abstinence-violation effects, and coping (lapses vs. temptations only). GEEs were also used to compare dietary temptations and dietary lapses. GEE allows for varying numbers of observations per participant, while controlling for autocorrelation (Zeger, Liang, & Albert, 1988). GEEs use a multiple-step, maximum-likelihood approach to estimation and testing. An essential feature of this technique is that it is possible to recognize that EMA data have two random components: one due to the sampling of persons and the other due to the sampling of repeated measurements within persons.

Temptations, lapses, and random prompts were included as independent dichotomous variables. Recent consumptive activities, presence of others, location, activities, mood, abstinence-violation effects, and coping were included as dependent variables. An alpha of .05 was adjusted with the Benjamini–Hochberg procedure for controlling the false-positive rate in multiple comparisons (Benjamini & Hochberg, 1995; Thissen, Steinberg, & Kuang, 2002; Williams, Jones, & Tukey, 1999). Using the Benjamini–Hochberg procedure, the adjusted alpha is .006.

Results

Frequency of Temptations, Lapses, and Random Prompts

On average, participants reported 2.7 lapses ($SD = 1.9$; range = 0–10), 3.0 temptations ($SD = 2.8$; range = 0–13), and 19.1 random prompts ($SD = 4.7$; range = 10–28) over the 7-day recording period. Six (16.2%) participants experienced 0 lapses, 19 (51.4%) participants experienced 1–2 lapses, and 12 (32.4%) participants experienced greater than two lapses during the recording period.[1] Ten (27.1%) participants experienced 0 temptations, 14 (37.8%) participants experienced 1–2 temptations, and 13 (35.1%) participants experienced greater than 2 temptations during the recording period. Table 2 lists the means and standard deviations for all variables across lapses, temptations, and situations of minimal dietary consequence.

Compliance and Reactivity

Seventy percent of the participants reported skipping less than two diary entries during the week, and 53% reported completing less than two diary entries greater than 15 min after a lapse, temptation, or prompt. Eighty-eight percent of the participants disagreed or strongly disagreed with the statement "I was more likely to be tempted while keeping a diary," whereas 91% disagreed or strongly disagreed with the statement "I was more likely to lapse while keeping a diary." Only 21% of participants endorsed "Very" or "Extremely" to the question "Did keeping a diary influence your eating behaviors?" However, 77% of the participants agreed or strongly agreed with the statement "I was more aware of my behavior while keeping a diary."

Comparison of Temptations, Lapses, and Random Prompts

Recent consumptive activity, location, presence of others, mood, and activity. There were no significant differences in recent consumptive activities or location between moments of temptation, lapse, and minimal dietary consequence (see Tables 3, 4, and 5). Compared with moments of minimal dietary consequence, lapses were significantly associated with reporting greater positive mood ($p < .006$) and significantly associated with reporting greater negative mood ($p < .006$; Table 4). Compared with moments of minimal dietary consequence, lapses and temptations were less likely to occur while exercising ($p < .006$; Tables 3 and 4). There were no other significant differences in reported activities between moments of temptation and lapse or minimal dietary consequences.

[1] Participants were randomly paged four times each day. However, many participants reported that they did not receive four pages each day. Some pagers did not appear to be functioning reliably. Additionally, some participants may have, at times, been outside of the pager's geographical range. Although the majority of participants reported responding to all of the pages that they received, participants only responded to 19.1 ($SD = 4.7$) of 28 potential prompts (68.2%). Given these difficulties, we are limited in our ability to objectively assess compliance with random pages.

Table 2
Mean (and Standard Deviation) of Variables During Lapse, Temptation, and Random Prompts

Variable	Lapse	Temptation	Random prompt
Consumptive activity			
How long ago did you last eat (in minutes)?	146.1 (122.04)	180.2 (112.67)	126.6 (57.11)
How satisfied after last meal?	3.4 (0.75)	3.4 (0.70)	3.6 (0.54)
How full after last meal?	3.4 (0.75)	3.4 (0.76)	3.4 (0.51)
How long were you hungry (in minutes)?	96.3 (87.65)	81.5 (112.08)	77.7 (70.90)
How hungry?	2.4 (1.03)	2.9 (0.64)	2.6 (0.92)
Type of food: Meal (% of total entries)	83.1 (32.5)	85.9 (40.3)	77.8 (17.3)
Location (% of entries)			
Work	21.8 (31.77)	30.0 (38.12)	23.6 (20.18)
Home	46.4 (40.72)	32.5 (35.16)	46.2 (23.16)
Other	31.9 (37.45)	37.5 (39.90)	30.3 (17.50)
Mood			
Positive	10.9 (3.24)	11.3 (4.10)	9.3 (1.87)
Negative	7.7 (3.08)	7.0 (3.10)	6.1 (1.67)
Activity (% of total entries)			
Cooking	0.8 (4.49)	3.7 (19.25)	3.5 (5.80)
Shopping	8.9 (22.87)	9.3 (27.86)	2.8 (4.13)
In conflict	1.6 (8.98)	6.2 (20.75)	0.8 (2.71)
Eating with others	3.0 (10.69)	4.2 (19.34)	2.3 (3.78)
Exercise	0.0 (0.00)	0.0 (0.00)	2.3 (3.58)
Eating out	0.0 (0.00)	0.9 (4.81)	2.1 (3.52)
Eating a meal	6.6 (15.45)	9.3 (27.86)	5.9 (7.87)
Eating a snack	5.4 (14.52)	1.2 (6.42)	1.9 (4.00)
Watching TV	18.5 (29.47)	9.6 (16.55)	8.9 (9.93)
Socializing/attending a party	17.8 (31.18)	16.3 (30.23)	6.1 (6.63)
Reading	5.9 (19.43)	7.8 (26.65)	6.7 (7.21)
Others present	61.2 (43.67)	56.4 (40.42)	50.5 (26.13)
Coping			
Removed myself from situation	1.3 (0.49)	2.4 (1.13)	
Distracted myself	1.4 (0.50)	2.7 (1.00)	
Talked to a group member	1.1 (0.20)	1.0 (0.20)	
Talked to a family member	1.1 (0.29)	1.1 (0.30)	
Talked to a friend	1.1 (0.20)	1.0 (0.02)	
Encouraged myself	1.5 (0.49)	2.9 (0.83)	
Meditated/relaxed	1.1 (0.30)	1.4 (0.55)	
Engaged in spiritual activities	1.0 (0.00)	1.1 (0.33)	
Exercised	1.1 (0.27)	1.2 (0.50)	
Thought about the following			
Benefits of dieting	1.5 (0.66)	3.0 (0.90)	
Benefits of being healthy	1.5 (0.67)	2.8 (1.01)	
Negatives of not dieting	1.5 (0.55)	2.1 (0.97)	
Negatives of being unhealthy	1.3 (0.48)	2.1 (1.23)	
Coping (total)	14.6 (2.94)	20.6 (5.88)	
Abstinence-violation effect			
Unlikely to be tempted/to lapse	2.0 (0.74)	2.2 (1.03)	2.7 (0.92)
Diet will be a success	3.3 (0.54)	3.5 (0.60)	3.6 (0.54)
Worried about maintaining diet	3.2 (0.87)	3.0 (0.90)	2.8 (0.95)
Feel like I failed my diet	2.8 (1.01)	1.8 (0.84)	2.0 (0.90)
Feel guilty about lapse/temptation	3.2 (0.89)	1.9 (0.83)	2.0 (0.91)
I have willpower	3.2 (0.81)	3.6 (0.68)	3.5 (0.64)
I'm responsible for lapse/temptation	4.3 (0.51)	3.7 (0.94)	
I can control future eating	3.3 (0.65)	3.8 (0.62)	

Coping. Compared with lapses, temptations were associated with greater use of the coping strategies: removing oneself from the situation ($p < .006$), distracting oneself ($p < .006$), and encouraging oneself ($p < .006$). Compared with lapses, temptations were also associated with more use of the coping strategies of thinking of the benefits of dieting ($p < .006$), benefits of being healthy ($p < .006$), negatives of not dieting ($p < .006$), and negatives of being unhealthy ($p < .006$). In addition, temptations were associated with a higher total coping score (indicating greater coping effort) than lapses ($p < .006$; Table 5).

Abstinence-violation effects. Compared with moments of minimal dietary consequence, temptations were associated with feeling more likely to be tempted or more likely to lapse again ($p < .006$; Table 3). Compared with moments of minimal dietary consequence, lapses were associated with feeling (a) more likely to be tempted or to lapse again, (b) less confident the diet will be a success, (c) less willpower, (d) a greater sense of failure regarding the diet, and (e) more guilt ($p < .006$; Table 4). Compared with moments of temptation, lapses were associated with feeling a sense of failure regarding the diet, more guilt because of the temptation

Table 3
Effects of Recent Consumptive Activity, Location, Mood, Activity, and Abstinence-Violation Effects, Comparing Times of Minimal Dietary Consequence With Times of Temptation

Variable	Estimate	*SE*	*z*	*p*
Recent consumptive activity				
How long ago did you last eat (in seconds)?	−475.21	1,911.05	−0.25	.804
How satisfied after last meal?	0.10	0.08	1.22	.221
How full after last meal?	0.01	0.09	0.09	.925
How long were you hungry (in seconds)?	−2,333.80	2,489.09	−0.94	.348
How hungry?	−0.23	0.12	−1.91	.056
Snack vs. meal	−0.03	0.05	−0.69	.488
Location (% of total entries)				
Work	−0.09	0.06	−1.58	.114
Home	0.10	0.06	1.72	.085
Other	−0.01	0.07	−0.12	.903
Others present	−0.01	0.06	−0.10	.917
Mood				
Positive	1.33	0.55	2.43	.015
Negative	−1.01	0.39	−2.57	.010
Activity (% of total entries)				
Cooking	0.01	0.01	1.16	.247
Shopping	−0.01	0.02	−0.38	.702
In conflict	−0.05	0.04	−1.32	.185
Eating with others	−0.00	0.02	−0.08	.938
Exercise	0.02	0.01	3.89	.000*
Eating out	0.01	0.01	0.60	.551
Eating a meal	0.01	0.03	0.48	.633
Eating a snack	0.01	0.02	0.58	.565
Watching TV	−0.04	0.03	−1.35	.177
Socializing/attending a party	−0.09	0.03	−2.62	.009
Reading	0.01	0.03	0.45	.655
Abstinence-violation effect				
Unlikely to be tempted or to lapse	0.28	0.10	2.74	.006*
Diet will be a success	0.04	0.07	0.61	.539
Worried about maintaining diet	−0.12	0.06	−1.98	.048
Feel like I failed my diet	−0.03	0.10	−0.30	.761
Feel guilty about lapse/temptation	−0.09	0.14	−0.64	.522
I have willpower	−0.11	0.07	−1.52	.128

* $p \leq .006$.

or lapse, more responsibility for the temptation or lapse, less able to control eating in the future, and less willpower ($p < .006$; Table 5).

Discussion

Using EMA with women completing a 6-month behavioral weight-loss program, we examined in the present study cognitive, behavioral, emotional, and contextual factors that could plausibly precede and follow temptations and lapses. Although women completing a behavioral weight-loss program are likely to have acquired a number of skills for coping with dietary temptation and lapse, the women nevertheless evidenced considerable variability in their responses to these dietary events. For example, mood and abstinence-violation effects were significantly associated with reports of lapses. Coping was more strongly associated with dietary temptations than lapses.

This investigation confirms and extends prior research examining relapse crises among dieters; however, some incongruities with prior research were noted. Consistent with previous research examining relapse crises in dieters (Greeno et al., 2000; Johnson et al., 1995; Schlundt et al., 1989; Schlundt et al., 1990), greater positive and negative mood states were associated with a greater likelihood of experiencing lapses. Positive and negative moods, however, did not distinguish temptations from lapses or random prompts.

No specific location increased the likelihood of experiencing a temptation or lapse. In prior research with dieters trying to lose weight without the aid of a formal program (Carels et al., 2001) and with individuals diagnosed with binge eating disorder (Johnson et al., 1995), lapses or overeating was more likely to occur at home. Because this assessment was performed near the completion of a weight-loss program, women may have successfully limited the availability of tempting snacks and food at home.

In this investigation, activity did not increase the likelihood of experiencing a temptation or lapse. In prior research, Grilo et al. (1989) found that obese, Type II diabetics enrolled in a university-based weight-loss program were significantly more likely to experience a relapse during social interactions, while eating, or while watching television. Again, women completing a weight-loss program may have successfully monitored food intake while eating, watching television, or socializing.

Temptations and lapses are often associated with hunger (Carels et al., 2001; Grilo et al., 1989). In this investigation, there was no association between hunger and lapses. Again, these women may have been actively monitoring daily food intake in order to min-

Table 4
Effects of Recent Consumptive Activity, Location, Mood, General Activity, and Abstinence-Violation Effects, Comparing Times of Minimal Dietary Consequence With Times of Lapse

Variable	Estimate	*SE*	*z*	*p*
Recent consumptive activity				
How long ago did you last eat (in seconds)?	−1,194.09	1,160.97	−1.03	.304
How satisfied after last meal?	0.09	0.09	1.05	.294
How full after last meal?	−0.01	0.09	−0.14	.892
How long were you hungry (in seconds)?	−1,164.48	673.20	−1.73	.084
How hungry?	−0.10	−0.13	−0.79	.428
Snack or meal	0.06	0.05	1.16	.247
Location (% of total entries)				
Work	0.02	0.05	0.43	.670
Home	−0.05	0.07	−0.70	.482
Other	0.02	0.08	0.24	.812
Others present (yes)	0.15	0.06	2.34	.020
Mood				
Positive	0.82	0.21	3.92	.000*
Negative	−1.40	0.33	−4.29	.000*
Activity (% of total entries)				
Cooking	−0.02	0.01	−1.45	.147
Shopping	0.03	0.03	1.23	.218
In conflict	0.00	0.01	0.31	.758
Eating with others	0.01	0.02	0.70	.458
Exercise	0.02	0.01	3.89	.000*
Eating out	−0.02	0.01	−0.31	.756
Eating a meal	0.02	0.03	0.82	.411
Eating a snack	0.03	0.02	1.46	.144
Watching TV	0.12	0.04	2.67	.008
Socializing/attending a party	0.11	0.04	2.58	.009
Reading	0.01	0.04	0.26	.797
Abstinence-violation effect				
Unlikely to be tempted or to lapse	−0.41	0.10	−4.17	.000*
Diet will be a success	−0.22	0.06	−3.54	.000*
Worried about maintaining diet	0.18	0.08	2.17	.030
Feel like I failed my diet	0.95	0.15	6.27	.000*
Feel guilty about lapse/temptation	1.27	0.14	8.97	.000*
I have willpower	−0.28	0.09	−3.21	.001*

* $p \leq .006$.

imize temptations and lapses and/or may have grown accustomed to moderate levels of hunger.

To our knowledge, no previous studies have used EMA to examine the enactment of coping during dietary temptations and lapses. In all circumstances, dietary lapses were associated with diminished coping. For example, compared with dietary lapses, temptations were associated with greater cognitive coping (e.g., encouraging oneself or reminding oneself about the benefits associated with dieting) and greater behavioral coping (e.g., leaving the situation or distracting oneself). In fact, compared with temptations, dietary lapses were associated with engaging in fewer coping strategies overall. The only coping categories that did not distinguish dietary temptations from lapses were social support, meditation or relaxation, and engagement in spiritual activities. Our findings are quite consistent with research examining relapse crises in dieters (Grilo et al., 1989; Grilo, Shiffman, & Wing, 1993) and in smokers (Shiffman et al., 1996). For example, Grilo et al. found that performance of coping was a strong correlate of outcome in dietary relapse crisis, and Shiffman et al. found that participants were 12 times less likely to report coping during smoking lapses than during temptations.

In this investigation, compared with dietary temptations and moments of minimal dietary consequence, abstinence-violation effects were significantly greater following dietary lapses. A dietary lapse may have contributed to the realization that dietary lapses are formidable, likely to occur in the future, and a challenge to successful longer term maintenance. Examining moments of diminished self-efficacy and long-term dietary adherence may be an important area of research for future investigations.

In this investigation, dietary lapses were limited in number ($M = 2.7$, $SD = 1.9$) and reflected subjective experiences only. Future research might benefit from a longer diary-recording period, given that the small number of lapses reported by participants may limit the generalizability of the findings. In this investigation, a lapse was defined as "an incident where you felt that you broke your diet." Dieters needed to only believe that they had broken their diet. Despite some subtle differences, there appears to be considerable similarity in the subjective and objective determinants of lapse with dieters (Wing, Shiffman, Drapkin, & McDermott, 1995). Whether objective or subjective, lapses appear to be important events from the dieter's perspective.

As with other research using EMA techniques, this investigation is susceptible to noncompliance and experimental reactivity. For example, in EMA research using a debriefing interview with treated alcoholics to assess compliance, delayed or omitted event-contingent and signal-contingent recording was common (Litt,

Table 5
Effects of Recent Consumptive Activity, Location, Mood, General Activity, and Abstinence-Violation Effects, Comparing Times of Lapse With Times of Temptation

Variable	Estimate	*SE*	*z*	*p*
Recent consumptive activity				
How long ago did you last eat (in seconds)?	613.59	2,249.31	0.27	.785
How satisfied after last meal?	−0.01	0.13	−0.05	.964
How full after last meal?	0.00	0.12	0.01	.990
How long were you hungry (in seconds)?	−144.79	2,635.82	−0.05	.956
How hungry?	−0.29	0.15	−1.89	.059
Snack or meal	−0.01	0.06	−0.20	.838
Location (% of total entries)				
Work	−0.11	0.08	−1.42	.156
Home	0.11	0.08	1.39	.164
Other	0.00	0.09	0.05	.959
Others present	−0.18	0.08	−2.31	.021
Mood				
Positive	0.15	0.58	0.26	.791
Negative	0.58	0.48	1.22	.224
Activity (% of total entries)				
Cooking	−0.00	0.02	−0.02	.987
Shopping	0.02	0.04	0.64	.523
In conflict	−0.06	0.05	−1.17	.243
Eating with others	0.01	0.03	0.45	.650
Exercise	−0.13	0.11	−1.17	.241
Eating out	−0.01	0.01	−1.01	.310
Eating a meal	0.04	0.03	1.36	.173
Eating a snack	0.04	0.02	1.69	.092
Watching TV	0.07	0.05	1.51	.132
Socializing/attending a party	0.02	0.06	0.35	.727
Reading	0.01	0.04	0.15	.884
Coping				
Removed myself from situation	−0.95	0.21	−4.51	.000*
Distracted myself	−1.27	0.19	−6.57	.000*
Talked to a group member	0.01	0.02	0.57	.567
Talked to a family member	−0.02	0.05	−0.35	.727
Talked to a friend	0.04	0.03	1.16	.244
Encouraged myself	−1.20	0.17	−6.92	.000*
Meditated/relaxed	−0.26	0.10	−2.48	.013
Engaged in spiritual activities	−0.09	0.06	−1.63	.104
Exercised	−0.13	0.11	−1.17	.241
Thought about the following				
Benefits of dieting	−1.20	0.16	−7.54	.000*
Benefits of being healthy	−0.95	0.21	−4.59	.000*
Negatives of not dieting	−0.63	0.18	−3.49	.001*
Negatives of being unhealthy	−0.63	0.21	−2.95	.003*
Coping (total)	−5.03	0.81	−6.18	.000*
Abstinence-violation effects				
Unlikely to be tempted or to lapse	−0.18	0.15	−1.18	.236
Diet will be a success	−0.23	0.08	−2.71	.007
Worried about maintaining diet	0.07	0.07	0.90	.370
Feel like I failed my diet	1.08	0.17	6.53	.000*
Feel guilty about lapse/temptation	1.33	0.12	10.95	.000*
I am responsible for temptation/lapse	0.56	0.20	2.85	.004*
I can control what I eat in future	−0.35	0.11	−3.20	.001*
I have willpower	−0.41	0.08	−5.20	.000*

* $p \leq .006$.

Cooney, & Morse, 1998). Similarly, paper-and-pencil EMA methods appear to be more susceptible to delayed reporting than more sophisticated hand held computers (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002). In our study, about one half of the participants reported completing more than one diary entry in excess of 15 min after the event. Although this number is relatively small compared with the overall number of diary entries, some element of retrospective recall bias is introduced. Likewise, although only 21% of the participants stated that keeping a diary influenced their eating behaviors, 77% of the participants stated that they were more aware of their behavior. This increased awareness of behavior and factors that influence behavior is a well-known phenomenon in self-monitoring research (Haynes & O'Brien, 1999). The reactivity of self-monitoring may result in participants reporting fewer lapse episodes because the diary would tend to cue them to use adaptive coping. Self-monitoring

may also tend to increase participant awareness of the factors that precede, co-occur, or follow dietary events. Of course, participants may have limited awareness of their reactivity, particularly for subtle changes in their eating patterns.

Prior research on temptation and lapse in dieting has been limited by its reliance on retrospective self-report and singular-lapse situations. Therefore, the strength of the current investigation is its inclusion of real-time, ecologically valid assessments of temptation and lapse in dieting (including moments of minimal dietary consequence). The results from this investigation provide evidence that momentary factors have a substantial influence on the experience of temptation and lapse in dieters. However, we do not know whether the number of contextual factors associated with temptation or lapses will influence long-term weight loss outcomes. Further investigation of these factors will be important.

Despite nearing the completion of a formal weight-loss program, mood, coping response, and abstinence-violation effects were significantly associated with dietary-relapse crises. Recent consumptive activities, location, and other activities were not typically associated with relapse crises. These findings suggest that weight-loss program participants may benefit from additional skills training that encourages the enactment of coping, as well as teaches participants skills that reduce abstinence-violation effects and negative moods during relapse crises. Given that the associations between mood, coping response, abstinence-violation effects, and relapse crises were evident near the end of a formal weight-loss program, these factors may require greater attention in future weight-loss treatment. Such findings are likely to have critical clinical and public health implications. Awareness of the factors associated with dietary temptation and lapse, understanding of the common cognitive and affective responses to relapse crises, and development of strategies to reduce abstinence-violation effects may be essential to achieving personal and societal goals of weight loss and maintenance.

References

Affleck, G., Tennen, H., Zautra, A., Urrows, S., Abeles, M., & Karoly, P. (2001). Women's pursuit of personal goals in daily life with fibromyalgia: A value–expectancy analysis. *Journal of Consulting and Clinical Psychology, 69,* 587–596.

Baumeister, R.F., Heatherton, T.F., & Tice, D.M. (1994). *Losing control: How and why people fail at self-regulation.* San Diego, CA: Academic Press.

Benjamini, Y., & Hochberg, Y. (1995). Controlling for false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society, Series B, 57,* 289–300.

Brownell, K. D. (2000). *The LEARN program for weight management 2000.* Dallas, TX: American Health.

Brownell, K. D., & Kramer, F.M. (1989). Behavioral management of obesity. *Medical Clinics of North America, 73,* 185–201.

Carels, R. A., Hoffman, J., Collins, A., Raber, A., Cacciapaglia, H., & O'Brien, W. H. (2001). Ecological momentary assessment of temptation and lapse in dieting. *Eating Behaviors, 2,* 307–321.

Cummings, C., Gordon, J. R., & Marlatt, G.A. (1980). Relapse: Prevention and prediction. In W. Miller (Ed.), *The addictive behaviors: Treatment of alcoholism* (pp. 291–322). Elmsford, NY: Pergamon.

Greeno, G. G., Wing, R. R., & Shiffman, S. (2000). Binge antecedents in obese women with and without binge eating disorder. *Journal of Consulting and Clinical Psychology, 68,* 95–102.

Grilo, C. M., Shiffman, S., & Wing, R. R. (1989). Relapse crises and coping among dieters. *Journal of Consulting and Clinical Psychology, 57,* 488–495.

Grilo, C. M., Shiffman, S., & Wing, R. R. (1993). Coping with dietary relapse crises and their aftermath. *Addictive Behaviors, 18,* 89–102.

Haynes, S. N., & O'Brien, W. H. (1999). *Principles and practice of behavioral assessment.* New York: Kluwer Academic/Plenum.

Jeffery, R. W., Drewnowski, A., Epstein, L. H., Stunkard, A. J., Wilson, G. T., & Wing, R. R. (2000). Long-term maintenance of weight loss: Current status. *Health Psychology, 19,* 5–16.

Johnson, W. G., Schlundt, D. G., Barclay, D. R., Carr-Nangle, R.E., & Engler, L. B. (1995). A naturalistic functional analysis of binge eating. *Behavior Therapy, 26,* 101–118.

Litt, M. D., Cooney, N. L., & Morse, P. (1998). Ecological momentary assessment with treated alcoholics: Methodological problems and potential solutions. *Health Psychology, 17,* 48–52.

Matthews, K. A., Owens, J. F., Allen, M. T., Stoney, C. M. (1992). Do cardiovascular responses to laboratory stress relate to ambulatory blood pressure levels? Yes, in some people, some of the time. *Psychosomatic Medicine, 54,* 686–697.

National Heart, Lung, and Blood Institute Obesity Education Initiative Task Force Members. (1998). *Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report* (NIH publication No. 98–4083). Bethesda, MD: National Institutes of Health.

Rosenthal, B., & Marx, R. D. (1981). Determinants of initial relapse episodes among dieters. *Clinical and Bariatric Medicine, 10,* 94–97.

SAS Institute. (1997). *SAS/STAT software: Changes and enhancements through Release 6.12.* Cary, NC: Author.

Schlundt, D. G., Sbrocco, T., & Bell, C. (1989). Identification of high-risk situations in a behavioral weight loss program: Application of the relapse prevention model. *International Journal of Obesity, 13,* 223–234.

Schlundt, D. G., Taylor, D., Hill, J. O., Sbrocco, T., Pope-Cordle, J., Kasser, T., & Arnold, D. (1990). A behavioral taxonomy of obese female participants in a weight loss program. *American Journal of Clinical Nutrition, 53,* 1151–1158.

Shiffman, S., Paty, J. A., Gnys, M., Kassel, J. D., & Hickcox, M. (1996). First lapses to smoking: Within-subjects analysis of real-time reports. *Journal of Consulting and Clinical Psychology, 64,* 366–379.

Stone, A. A., Broderick, J. E., Porter, L. S., & Kaell, A. T. (1997). The experience of rheumatoid arthritis pain and fatigue: Examining momentary reports and correlates over one week. *Arthritis Care and Research, 10*(3),185–193.

Stone, A. A., & Shiffman, S. (1994). Ecological momentary assessment in behavioral medicine. *Annals of Behavioral Medicine, 16,* 199–202.

Stone, A. A., Shiffman, S., Schwartz, J. E., Broderick, J. E., & Hufford, M. R. (2002). Patient noncompliance with paper diaries. *British Medical Journal, 324,* 1193–1194.

Thissen, D., Steinberg, L., & Kuang, D. (2002). Quick and easy implementation of the Benjamin–Hochberg procedure for controlling the false positive rate in multiple comparisons. *Journal of Educational and Behavioral Statistics, 27,* 77–83.

Williams, V. S. L., Jones, L. V., & Tukey, J.W. (1999). Controlling error in multiple comparisons, with examples from state-of-art differences in educational achievement. *Journal of Educational and Behavioral Statistics, 24,* 42–69.

Wing, R. R., Shiffman, S., Drapkin, R. G., & McDermott, M. (1995). Moderate versus restrictive diets: Implications for relapse. *Behavior Therapy, 26,* 5–24.

Zeger, S. L., Liang, K., & Albert, P. S. (1988). Models for longitudinal data: A generalized estimating equation approach. *Biometrics, 44,* 1049–1060.

Received August 22, 2002
Revision received February 28, 2003
Accepted April 2, 2003 ■