Ecological Momentary Assessment of Responses to Dietary Lapses among Participants in a Weight Loss Program and Their Relation to Subsequent Outcomes

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Abstract

Ecological Momentary Assessment of Responses to Dietary Lapses among Participants in a Weight Loss Program and Their Relation to Subsequent Outcomes

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Behavioral weight loss programs are effective in producing moderate weight loss, but weight regain is common. Weight regain is believed to be due largely to poor adherence to the behaviors necessary for weight control, especially caloric restriction. Although most individuals attempting to lose weight and maintain weight loss experience occasional lapses in adherence, it is unclear what factors promote adherence to weight control goals after a dietary lapse. The present study thus examined individuals' attitudes toward themselves (e.g., self-critical, self-forgiving) after lapses and the relationships between these attitudes and subsequent lapse behavior using ecological momentary assessment (EMA) to determine if examination of lapses from this framework enhances understanding of lapse-relapse progression. Overweight and obese adults (n = 91) enrolled in a behavioral weight loss program completed EMA for 14 days at the beginning of treatment. Participants responded to 6 semi-random daily EMA prompts, and initiated an EMA survey whenever a dietary lapse occurred. Participants reported on their self-criticism, self-forgiveness, self-regard, and self-efficacy whenever a lapse occurred; they also reported their attribution for each lapse. Weight was measured at the beginning and end of the EMA period. Results revealed that 89% of participants experienced at least one lapse (M=6.88). Greater lapse frequency was associated with less weight loss. Participants tended to have positive self-attitudes after lapses, and variability in responses across lapses was somewhat limited. Although having a positive (e.g.,

greater self-efficacy, more positive self-regard) typical response to lapses was associated with better outcomes (i.e., fewer lapses, longer time until next lapse), having a more negative (i.e., less forgiving, more critical, more negative self-regard) in-the-moment response to lapses predicted longer time until next lapse, when examined among lapses that occurred on the same day. These results suggest that, contrary to tenets of traditional relapse prevention interventions, a harsher response to lapses may be beneficial for delaying future lapses at times. However, as having a more positive typical response was also associated with better outcomes, additional research is needed to clarify why and to what extent having a more "negative" response may confer benefit. Implications of these findings and directions for future research are discussed.

Chapter 1: Introduction

Over two-thirds of U.S. adults are overweight (BMI ≥25) or obese (BMI >30; Flegal, Carroll, Ogden, & Curtin, 2010). Overweight and obesity are associated with a number of co-morbidities, including type II diabetes, numerous types of cancers, cardiovascular disease, gallbladder disease, hypertension, asthma, and osteoarthritis (Guh et al., 2009; Must et al., 1999). A modest weight reduction of approximately 5-10% of original body weight has been shown to confer positive health benefits to and increase longevity for obese individuals (Blackburn, 1995; Goldstein, 1992).

1.1 Behavioral Weight Loss

A comprehensive program of lifestyle modification (i.e., behavioral treatment, behavioral weight control) is considered the first-line treatment for overweight and obese adults (Panel, N.O.E.I.E., 1998). Lifestyle modification programs entail three main components: diet, physical activity, and behavior therapy (i.e., a set of principles and techniques for modifying diet, exercise, and thinking habits that contribute to excess weight; Brownell, 2000; Wing, 2004). Lifestyle modification programs typically instruct patients to reduce their energy intake by 500 to 1000 kcal/day (often by reducing portion sizes and fat intake), and to engage in high levels (e.g., 30 minutes or more) of physical activity five or more days per week (Brownell, 2000). The behavioral component of lifestyle modification programs typically includes a combination of goal setting, stimulus control, self-monitoring, relapse prevention, and problem solving (Hagobian & Phelan, 2013). Lifestyle modification programs are effective in producing moderate weight loss; on average, participants achieve a weight loss of ~10 kg (~10% of initial weight) in the first 6 months of treatment (Wadden, Butryn, & Byrne, 2004).

Although lifestyle modification programs are effective in achieving weight loss, weight regain is a significant problem. Patients treated by group lifestyle modification for 20 to 30 weeks regain ~30% to 35% of their lost weight in the first year after treatment (Wadden, Butryn & Byrne, 2004). By 4-5 years after treatment, patients maintain an average weight loss of just ~1-3 kg (Anderson, Konz, Frederich, & Wood, 2001; Perri & Foreyt, 2004). Weight regain is due at least in part to failure to maintain behavior changes adopted during weight loss treatment (Hill & Wyatt, 1999).

1.2 Adherence

Adherence to the behaviors necessary for long-term weight control (e.g., eating a low-calorie diet, engaging in high levels of regular physical activity, consistent self-monitoring of body weight and food intake) is difficult. Thus, unsurprisingly, most people attempting to lose weight and maintain weight loss experience temporary lapses (i.e., "slips;" single events in which there is a reemergence of a previous habit) in adherence, and many experience full relapses (i.e., a dynamic process that ultimately results in a more permanent return to previous behaviors; Marlatt & Gordon, l985). Occasional lapses and relapses are considered a normal part of weight loss and weight loss maintenance (Wadden & the Look AHEAD Lifestyle Manual Group, 2001). Lifestyle modification programs instruct participants to anticipate dietary lapses and relapses, and teach participants behavioral skills to prevent and cope with these events (Brownell, 2000; Hagobian & Phelan, 2013). Although occasional lapses are to be expected during the weight loss and weight maintenance process, individuals may respond to lapses in very different ways. Some types of responses (e.g., identifying the factors that led to the lapse and making a plan to avoid similar lapses in the future) may

foster re-adherence to one's dietary goals, and thus result in the resumption of successful weight control behaviors. Other types of responses (e.g., feeling defeated and abandoning one's dietary goals for a period of time) may lead to additional lapses and increased caloric intake (Wadden & the Look AHEAD Lifestyle Manual Group, 2001). Responses that contribute to caloric intake may impede further weight loss, and even result in weight gain. Thus, differences in how individuals respond to lapses may be important to understanding why some individuals are ultimately successful in maintaining weight loss long-term while others experience weight regain.

1.3 Relapse Model

The theoretical framework that has been used most commonly when examining how individuals respond to behavioral lapses comes from Marlatt and Gordon's (1985) cognitive-behavioral model of relapse. Although Marlatt and Gordon's (1985) model was initially developed to explain relapse among individuals attempting to abstain from alcohol use, it has been applied to a variety of addictive disorders and health-related behaviors, including, but not limited to, smoking cessation (e.g., Curry, Marlatt, & Gordon, 1987; Shiffman et al., 1996), drug use (e.g., Carroll, 1996; McGovern, Wrisley, & Drake, 2005), pathological gambling (e.g., Bujold, Ladouceur, Sylvain, & Boisvert, 1994: Ledgerwood & Petry, 2006), obesity (e.g., Perri et al., 2001; Sternberg, 1985), eating disorders (e.g., Grilo & Shiffman, 1994), sexual offending (e.g., Wheeler, George, & Marlatt, 2006), and domestic violence (e.g., King & Polaschek, 2003).

1.3.1. Relapse Across Problematic Behaviors

There are both commonalities and differences among addictive disorders (e.g., alcoholism, smoking) and other health-related behaviors (e.g., obesity, eating disorders;

Brownell, Marlatt, Lichenstein, & Wilson, 1986). Some researchers have focused on the commonalities among addictive disorders and health-related behaviors (e.g., Brownell et al., 1986), emphasizing similarly high rates of relapse across conditions (e.g., Brandon, Vidrine, & Litvin, 2007), as well as common factors (e.g., self-efficacy, negative affect, coping strategies) involved in the relapse process (e.g., Perri, Shapiro, Ludwig, Twentyman, & McAdoo, 1984). More recently, researchers have emphasized similarities between addictive disorders and other conditions like obesity at the neurobiological level as an additional reason to conceptualize addictions and obesity similarly (e.g., Grosshans, Loeber, & Kiefer, 2011; Trinko, Sears, Guarnieri, & DiLeone, 2007; Volkow, Wang, Tomasi, & Baler, 2013; Volkow & Wise, 2005).

Other researchers, however, posit that there are critical differences between addictive disorders and obesity, and warn against using an addiction framework to understand obesity. These researchers argue, for example, that differences in the temporal pattern in the typical relapse curves for addiction and obesity suggest that different mechanisms (whether they be biological, social, or psychological) govern the relapse processes in these conditions (Wilson, 2010). Rather than supporting an addiction model of obesity, these researchers advocate a behavioral model of obesity in which the environmental factors driving the obesity epidemic, coupled with the reinforcing value of highly palatable foods, are emphasized (e.g., Brownell, 2004; Wilson, 2010).

The extent of the similarities, and the importance of the distinctions, between addictive disorders and obesity are matters that likely will not be settled soon. However, Marlatt and colleagues' (Marlatt & Gordon, 1985; Witkiewitz & Marlatt, 2004) relapse model remains at the base of many relapse prevention strategies utilized by behavioral

weight loss interventions (Hagobian & Phelan, 2013), making research concerning the validity of the model relevant to the weight control field. In addition, weight regain appears to be due largely to a failure to maintain the behaviors (e.g., reduced calorie consumption, increased energy expenditure) that produced weight loss (McGuire, Wing, Klem, Lang, & Hill, 1999), and the abandonment of these weight control behaviors presumably happens over a period of several weeks or months. As a result, it seems likely that how individuals react to early dietary violations affects subsequent weight control behaviors, even if aspects of relapse in obesity are different than relapse in the addictions. Thus, an examination of Marlatt and colleagues' (Marlatt & Gordon, 1985; Witkiewitz & Marlatt, 2004) relapse model, as well as research concerning the hypothesized relationships between lapse and relapse, is important to understanding how lapses and relapse among overweight and obese individuals attempting to lose weight and maintain weight loss have traditionally been viewed.

1.3.2 Key Components of the Relapse Model

In their cognitive-behavioral model of relapse, Marlatt and Gordon (1985) differentiate between a lapse and relapse. A lapse, or "slip," is a discrete event that is defined by the return of a previous behavior after a period of time during which the behavior was not present. Relapse, on the other hand, refers to a dynamic process (as opposed to a discrete, static outcome) that ultimately results in a more permanent return to the same intensity of a previous behavior (Donovan & Marlatt, 2005). Marlatt and Gordon's (1985) model of relapse posits that both immediate determinants (e.g., high-risk situations, self-efficacy) and covert antecedents (e.g., lifestyle factors) contribute to relapse, and outlines a specific process of relapse in which individuals' cognitive and

affective responses to situations is emphasized (Figure 1). According to the original model (Marlatt & Gordon, 1985), the process of potential relapse begins with a high-risk situation. When one is in a high-risk situation, numerous interpersonal, intrapersonal, situational, and psychological factors determine whether one is able to employ an adequate coping response to deal with the high-risk situation. If one fails to initiate an adequate coping response, and if one has a low sense of confidence in one's ability to successfully deal with the high-risk situation (i.e., if one has low self-efficacy; Bandura, 1977), one is likely to give in to temptation and engage in the behavior from which one is attempting to abstain. Giving in to this temptation is especially likely when one believes that engaging in the behavior will produce positive initial effects (i.e., when one has high positive outcome expectancies). After one has engaged in the behavior (i.e., after one lapses), one's cognitive and emotional reactions to the lapse determine the probability of one continuing to engage in the problematic behavior pattern, therefore furthering the relapse process, versus the likelihood of one regaining abstinence (Marlatt & Gordon, 1985).

In response to criticisms (e.g., Donovan, 1996; Longabaugh, Rubin, Stout, Zywiak, & Lowman, 1996; Saunders & Houghton, 1996) of Marlatt and Gordon's (1985) original model, and in an effort to synthesize empirical findings concerning the relapse process that have emerged since 1985, Witkiewitz and Marlatt (2004) proposed a re-conceptualized, dynamic relapse model (Figure 2). Many of the components of the original model are present in this newer model, and one's cognitive-affective reaction to a lapse is still believed to influence the likelihood of subsequent lapses and relapse. However, in the newer model, the factors associated with the relapse process are not

classified hierarchically and the relapse process is not presented as a causal chain, as was originally the case. Instead, Witkiewitz and Marlatt's (2004) model emphasizes the interrelationships among distal (i.e., stable predispositions that increase one's vulnerability to relapse) and proximal (i.e., immediate precipitants that actualize the probability of relapse) relapse risks, and allows for multiple configurations of these risks. Thus, in this newer model the relapse process is conceptualized in terms of a multidimensional, dynamic, complex system.

1.3.3 Lapse, Relapse, and the Abstinence Violation Effect

According to Marlatt and colleagues' models (Marlatt & Gordon, 1985; Witkiewitz & Marlatt, 2004), the primary factors that determine whether one who has lapsed will continue to lapse (i.e., to progress toward relapse) or will regain abstinence are one's explicit (i.e., subject to conscious awareness) cognitive and affective reactions to the lapse. Drawing from attribution theory (Abramson, Seligman, & Teasdale, 1978; Weiner, 1974; Weiner, 1985), the relapse models posit that one's cognitive response to a lapse is largely determined by the factors to which one attributes the lapse, or the explanation for the lapse one provides. When one lapses, one may attribute the lapse to internal or external, global or specific, stable or unstable, and perceived controllable or uncontrollable causes. According to Marlatt and Gordon (1985), individuals who attribute a lapse to global, stable, internal causal factors are likely to experience guilt and negative emotions. These emotions and guilt increase one's probability of relapse by leading one to engage in the behavior from which one is attempting to abstain (e.g., drinking, smoking a cigarette) in an attempt to escape or minimize these feelings. Marlatt and Gordon (1985) also argue that individuals who make characterological (i.e., global,

internal, stable) attributions for a lapse may experience decreased self-efficacy, which further increases their probability of relapse. In contrast, individuals who attribute a lapse to a momentary, context-specific, external cause are not expected to experience as much guilt, negative affect, or decreased self-efficacy (Marlatt & Gordon, 1985). These individuals are supposedly more likely to view their lapse as a mistake from which they can learn, and to develop more effective ways to deal with similar triggers or situations that may arise in the future (Larimer, Palmer, & Marlatt, 1999). Thus, these individuals are presumably less likely to progress from a lapse to full-blown relapse.

Marlatt and Gordon (1985) termed a common but maladaptive cognitive-affective reaction to a lapse the abstinence violation effect (AVE). The AVE is characterized by internal attributions of blame, reduced self-efficacy, and feelings of guilt, as described above. According to Marlatt and Gordon (1985), individuals who attribute a lapse to global, stable, internal factors that are perceived to be uncontrollable (e.g., a lack of willpower, personal weaknesses) will experience a stronger AVE, while individuals who attribute a lapse to unstable, specific, external, and controllable causes (e.g., a failure to utilize effective coping skills in a specific situation) will experience a less intense AVE. According to the relapse model (Marlatt & Gordon, 1985), the intensity of the AVE influences the likelihood of a lapse escalating into a full relapse, such that individuals with a stronger AVE are expected to relapse more quickly. Although Marlatt and Gordon's (1985) theory of the AVE does not limit its occurrence to only an initial (vs. subsequent) lapse, the vast majority of research on the AVE has focused on the AVE following an initial lapse.

1.3.4 Relapse Prevention

In addition to conceptualizing a model of the relapse process, Marlatt and colleagues (Marlatt, 1978; Marlatt & Gordon, 1980) also outlined specific strategies and methods that could be used to prevent relapse. This relapse prevention model emphasizes targeting distal (e.g., lifestyle balance) and proximal (e.g., a high-risk situation) factors that may lead to a lapse, as well as specific strategies for lapse management (Dimeff & Marlatt, 1998; Marlatt & Donovan, 2005; Marlatt & Gordon, 1985). Lapse management strategies focus on stopping the lapse, and reducing the AVE to prevent a downward spiral toward full relapse (Larimer et al., 1999). Although cognitive restructuring, or reframing, is used throughout the relapse prevention model, it is especially important in combating the AVE. Patients are taught to examine their attributions for and perceptions of a lapse, and to reframe their interpretations in a more rational way (Brownell et al., 1986; Marlatt & Gordon, 1985). Rather than seeing lapses as personal failings or indicators of low willpower, for example, patients are encouraged to view lapses as mistakes or errors that signal a need for increased planning for similar future situations (Larimer et al., 1999). Using cognitive restructuring after a lapse is believed to reduce the AVE, better equipping one to respond constructively to the lapse.

1.3.5 Empirical Examination of the AVE Utilizing Retrospective Self-Reports

The proposed antecedents and consequences of the AVE have been examined in numerous studies across a variety of addictive behaviors and health-related behavior change targets (e.g., smoking cessation, alcoholism, obesity). The findings of studies that utilize retrospect reports of lapses tend to support the AVE model. In one study with participants in a smoking cessation program, for example, the strength of participants'

AVEs after an initial slip was found to be the strongest predictor of subsequent relapse versus abstinence (Curry, Marlatt, & Gordon, 1987). In a study with binge eaters, individuals who made more intense internal, global, and uncontrollable causal attributions for a binge episode experienced a subsequent binge episode sooner (Grilo & Shiffman, 1994). In a different study with obese participants enrolled in a very low calorie diet program, dieters who made more characterological (i.e., more stable, internal, global) attributions for their initial fasting lapse lost a lower percentage of excess weight. In addition, among those who dropped out of the program, those with a stronger AVE left the program sooner (Mooney, Burling, Hartman, Brenner-Liss, 1992).

Although most studies that have examined responses to lapses retrospectively have yielded results consistent with Marlatt and Gordon's (1985) model of the AVE (Brandon et al., 2007; Walters, 1996), the results of some retrospective studies have not supported the model. For example, among a sample of chronic smokers who were followed for two years after completing a smoking cessation program, no relationship was found between affective response to an initial lapse and rate of relapse (Brandon, Tiffany, Obremski, & Baker, 1990). In another study with individuals attempting to quit smoking, feeling badly after a reported lapse was actually associated with increased recovery rather than relapse, which is inconsistent with what AVE theory would predict (Borland, 1992). These discordant findings suggest that when lapses are assessed retrospectively, AVE theory may not reliably predict how individuals' responses to lapses relate to future behavior. Although it is possible that inconsistent findings are due to the limitations of retrospective self-report or the influence of other variables (e.g., inhibitory control) rather than flaws in AVE theory, the latter possibility remains.

1.3.6 Limitations of Retrospective Self-Reports

Retrospective self-reports of one's experiences after a behavioral lapse may be limited in several ways. For one, when individuals are asked to report on an event that took place several days, weeks, or even months earlier, it is likely that some degree of simple forgetting may have occurred. In addition, research has shown that autographical memory is affected by a variety of heuristics that are used in memory search and reconstruction (for a review see Schwartz & Sudman, 1994). For example, one's recall of a certain event may be influenced by events that occurred after that event, such that more recent events are used to "reconstruct" the event that is being recalled (e.g., a person who ultimately recovers from a lapse may recall his or her initial reaction to the lapse as less distressing than it was at that time). These heuristics can systematically bias recall (Gorin & Stone, 2001). One's affective state at the time of recall can also have a significant influence on one's memory or recall of an event (Teasdale & Fogarty, 1979).

Ecological momentary assessment (EMA, Stone & Shiffman, 1994) is an assessment technique that is characterized by the repeated collection of real-time data about individuals' momentary states in their natural context or environment (Stone, Shiffman, Atienza, & Nebeling, 2007). EMA is not a single method or a particular technology, but rather a variety of methods (e.g., diaries, palm-top computers, pagers, telephones, Smartphone-like devices) that are used to collect real-time, real-world data at numerous time points (Shiffman, Stone, & Hufford, 2008). The rationale for using EMA methods rests on three main benefits (Stone et al., 2007). First, because EMA techniques assess participants' states or behaviors as they are happening or shortly thereafter, EMA is thought to greatly reduce the error and biases associated with retrospective recall

(Stone & Shiffman, 1994). Second, because EMA gathers data about participants' experiences and behaviors as they go about their daily lives, findings from EMA research are believed to be more ecologically valid and generalizable to real-world experiences than findings obtained in research laboratories or clinical settings (Shiffman et al., 2008). Third, because EMA techniques collect data from participants at multiple points over a period of days or weeks, temporal relationships among variables and complex processes that occur over time can be better understood (Shiffman et al., 2008).

When examining how individuals respond to behavioral lapses, it may be especially important to utilize EMA techniques rather than retrospective assessment methods. In addition to the general limitations of retrospective self-report discussed above, some research suggests that the way one responds to a particular lapse may not be related to one's general (i.e., trait) attributional or response style. For example, Curry et al. (1987) found that, while attributions for a specific lapse predicted relapse, one's general attributional style did not. Similarly, Grilo and Shiffman (1994) found that the amount of guilt and the strength of the AVE evoked by an initial lapse were better predictors of how quickly binge eaters progressed to a second binge than was general attributional style. These findings highlight the important of assessing individuals' responses to specific lapse events, as opposed to their response style more generally, when examining the AVE and its relation to future behavior.

1.3.7 Empirical Examination of the AVE Utilizing EMA

Although studies using retrospective reports of lapses have generally obtained support for the AVE, the results of studies that collect real-time data about lapses using EMA tend not to support the hypothesized components and consequences of the AVE.

For example, in a study with smokers, lapses resulted in decreased self-efficacy and increased negative affect, guilt, self-blame, and feelings of discouragement (Shiffman et al., 1997). Although these findings suggest that individuals who lapse do experience a sense of demoralization, the observed increases in emotional distress and decreases in self-efficacy were not mediated by attributions for the lapse as AVE theory would predict. Thus, while an AVE-like, demoralized reaction to lapses does appear to occur, the results of Shiffman et al.'s (1997) study bring the relations among the components (i.e., attributions determine affective reaction) of the AVE into question.

Dieters' responses to lapses have been examined using EMA techniques in two studies conducted by Carels and colleagues (2001, 2004). In one study, Carels and colleagues (2001) used EMA to examine situations of dietary temptation (i.e., situations in which one was tempted to break one's diet but did not), dietary lapse (i.e., situations in which one broke one's diet), and minimal dietary consequence (i.e., situations of random assessment in which one was neither tempted to nor had recently broken one's diet) among a sample of overweight young adults attempting to lose weight on their own. Participants' causal attributions for dietary temptations and lapses were not assessed, limiting the conclusions regarding AVE theory that can be drawn. However, participants' affective reactions to lapses were evaluated. Compared to moments of dietary temptation, dietary lapses were associated with feeling less prepared to resist a temptation or lapse, feeling more likely to be tempted or lapse again, and feeling more like they had failed their diet (Carels et al., 2001). Interestingly, however, lapses were also negatively associated with having a desire to give up.

In a second study, Carels, Douglass, Cacciapaglia, and O'Brien (2004) utilized a similar procedure to examine situations of dietary temptation and dietary lapse in a sample of obese, postmenopausal women during the final week of a behavioral weight loss intervention. Compared with moments of temptation, lapses were associated with believing that one had failed one's diet, guilt about the temptation or lapse, responsibility for the temptation or lapse, and a reduced sense of willpower and control of future eating (Carels et al., 2004). Because the more complex components of the AVE model (e.g., the relationship between attributions for the lapse and affective response; the effect of AVE strength on subsequent lapses) cannot be examined given the limited number of variables assessed by Carels et al. (2004), it is difficult to know the extent to which these findings support or contradict the AVE model. However, based on the results of this and Carels and colleagues' earlier study (2001), it appears that dieters who experience a lapse tend to experience guilt, reduced self-efficacy, and a sense of demoralization.

In addition to characterizing responses to lapses, several studies have used EMA to examine the influence of AVE responses on subsequent behavior. In one smoking cessation study, for example, the predicted influence of the AVE on proximal outcomes (i.e., progression to a second lapse) and ultimate outcomes (i.e., progression to relapse) was examined (Shiffman et al., 1996). Although participants who felt more like giving up after an initial lapse progressed more quickly to a second lapse, feelings of wanting to give up after an initial lapse did not predict progression to relapse. Affective reactions to the lapse, self-blaming attributions, feelings of guilt, and self-efficacy after an initial lapse also did not predict progression to relapse. The only aspect of AVE theory that was found to be associated with lapse progression was internal attribution for the initial lapse;

among individuals who had a second lapse, individuals who made internal attributions for the initial lapse were more likely to have a second lapse on the same day as the first lapse (as opposed to on a later date). However, internal attributions for the initial lapse did not predict the probability of having a second lapse in general, or the likelihood or speed of progression to relapse. Thus, by and large, the hypothesized influence of the AVE on progression to relapse was not supported (Shiffman et al., 1996).

The influence of the AVE on lapse-relapse progression was further examined in a study with smokers who had achieved abstinence (Kirchner, Shiffman, & Wileyto, 2012). This study addressed limitations of previous research in that rather than focusing exclusively on the AVE after an initial lapse, the dynamic relationships between a set of AVE responses to lapses and subsequent lapse-relapse progression were examined. Results indicated that neither self-blame, guilt, nor self-efficacy after an initial lapse predicted relapse outcome. When using responses to initial lapse as covariates, however, responses to each additional lapse did predict lapse progression. In accord with AVE theory (Curry et al., 1987; Marlatt & Gordon, 1985), drops in self-efficacy after lapses were associated with accelerated progression to subsequent lapses. In contrast to AVE theory, which predicts that self-blame is a maladaptive, demoralizing response to a lapse that leads to increased risk of relapse, greater internal attributions of blame were found to be protective against lapse progression to the extent that they followed increasingly longer periods of pre-lapse abstinence (i.e., greater pre-lapse abstinence followed by elevated self-blame was prospectively associated with lower risk of or greater delay of lapse progression). Based on these results, the authors suggest that when one has had a longer period of pre-lapse abstinence, attributing a lapse to oneself may be realistic and

productive in that it may lead to renewed commitment and attempts to self-correct (Kirchner et al., 2012).

The results of these EMA studies provide partial support for certain aspects of AVE theory, but do not provide support for the overall model, or even conclusive support for particular aspects of the AVE model. Internal attributions of blame in certain circumstances were associated with increased likelihood of subsequent lapses in one study (Shiffman et al., 1996), but were shown to be protective against subsequent lapses in another study (Kirchner et al., 2012). Although lapsing was generally associated with decreased self-efficacy and increased negative affect, guilt, and discouragement (e.g., Carels et al., 2004; Shiffman et al., 1997), the relationship between these factors and attributions for the lapse, as well as these variables' relation to subsequent lapses, were inconsistent. Neither Shiffman et al. (1996) nor Kirchner et al. (2012) obtained support for the notion that self-efficacy following an initial lapse predicted lapse progression. However, controlling for initial lapse, drops in self-efficacy were associated with accelerated lapse progression in the latter study. Taken together, these studies suggest that AVE theory may not adequately describe reactions to lapses or how different variables relate to future lapse-related behaviors when assessed using ecologically valid, real-time methods of assessment.

1.4 Alternative Framework for Examining Responses to Lapses

As described above, attempts to explain how one's cognitive-affective response to a lapse relates to future behavior using the AVE framework proposed by Marlatt and colleagues' (Marlatt & Gordon, 1985; Witkiewitz & Marlatt, 2004) relapse model have been met with limited success. Although AVE theory has failed to adequately

characterize and explain how different types of responses to lapses affect future behavior, it seems likely that the type of cognitive-affective response one has to a lapse is one factor that relates to future behavior. Thus, continued examination of this topic from a slightly different perspective is warranted.

1.4.1 Attitude Toward the Self

One framework that may be useful in conceptualizing and trying to better understand cognitive-affective responses to a lapse is the attitude one takes toward the self, or the way in which one relates to the self, after a lapse. Eagly and Chaiken (1993) define an attitude broadly as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (p. 1). Attitudes may contain cognitive, affective, and behavioral components (Fazio & Olson, 2003). Examining individuals' attitudes toward themselves after a lapse may elucidate—in less complex but perhaps more informative ways than AVE theory—how different types of cognitive-affective responses to lapses relate to subsequent lapse behavior. Types of attitudes toward the self that seem particularly relevant to responses to lapses are being self-critical, self-forgiving, and self-compassionate.

1.4.2 Self-Criticism

One construct that may be important to understanding individuals' cognitive-affective responses to a lapse from a framework of the attitude one takes toward the self is self-criticism. Self-criticism has been conceptualized as a form of self-evaluation or self-judgment that is characterized by negative cognitive appraisals of the self, guilt, and fear of loss of approval for failing to live up to standards (Blatt, 2004; Blatt & Zuroff,

1992). Self-criticism can relate to various aspects of the self, such as one's personality, inner thoughts and feelings, physical appearance, or behavior (Gilbert, 2000).

Although self-criticism has not been widely discussed in the relapse literature, based on Marlatt and colleagues' (1985, 1987) assertion that making self-blaming attributions for a lapse leads to decreased self-efficacy, increased negative affect, and thus increased risk of relapse, it seems that AVE theory would assert that being self-critical after a lapse would be associated with greater risk of further relapse. Some findings from the self-criticism literature appear to support this claim. For example, in addition to being associated with both a number of personal and interpersonal deficits and various forms of psychopathology (Blatt, 2004; Powers, Zuroff & Topciu, 2004; Zuroff, Koestner, & Powers, 1994), self-criticism has been found to be negatively associated with goal progress (Powers, Koestner, Lacaille, Kwan, & Zuroff, 2009; Powers, Koestner, & Zuroff, 2007). This relationship appears to be mediated by self-efficacy, suggesting that self-critical individuals may have less confidence in their ability to perform the behaviors necessary to achieve their goals, thus further diminishing goal progress (Powers, Milyavskaya, & Koestner, 2012). Self-criticism has also been found to correlate negatively with self-efficacy prior to performance feedback, and to predict decreases in self-efficacy following feedback suggesting failure (Stoeber, Hutchfield, & Wood, 2008). The results of these studies suggest that being self-critical toward the self after a lapse may increase risk of future lapses.

Some research, however, suggests that self-criticism can also be constructive in certain situations. Driscoll (1989) argues, for example, that some reasons for and functions of self-criticism may be meant to self-correct. For instance, one may engage in

self-criticism in an effort to provide pressure or to force oneself to improve, or to renounce feelings of failure and maintain high standards (Driscoll, 1989). Gilbert and Irons (2005) have also suggested that self-criticism can be intended to detect errors and self-correct. This theory is supported by findings from a neuroimaging study that showed activation of brain regions involved in error processing and error resolution when individuals were asked to imagine being self-critical in a given scenario (Longe et al., 2010). Gilbert and colleagues (2004) also explored the different forms and functions of self-criticism via self-report in a sample of undergraduate women, and found that the reasons for/functions of self-criticism separated into two components: one related to desires to self-improve or self-correct, and the other related to supposed desires to "take revenge on" and "hurt" the self for failures (Gilbert, Clarke, Hempel, Miles, & Iron, 2004). The results of these studies suggest that self-criticism may sometimes be intended to help one improve the self.

Because self-criticism has not been specifically examined with regard to behavioral lapses, it is difficult to know for certain how self-criticism after a dietary lapse relates to subsequent behaviors. Some research from the self-criticism literature has found a negative association between self-criticism and goal progress (e.g., Powers et al., 2007; Powers et al., 2009) and between self-criticism and self-efficacy (e.g., Stoeber et al., 2008). Other research, however, suggests that self-criticism may serve a self-corrective purpose, and may therefore be helpful for error correction (i.e., preventing future lapses; e.g., Driscoll, 1989; Gilbert et al., 2004). Thus, it seems plausible to hypothesize that a complete lack of or a high amount of self-criticism after a lapse may

be associated with a greater likelihood of further relapse, while a moderate amount of self-criticism may be associated with goal re-adherence.

1.4.3 Self-Forgiveness

Another construct that may be important to consider when examining individuals' cognitive-affective responses to a lapse is self-forgiveness. Self-forgiveness has been defined in the psychological literature in a number of ways. Enright (1996) defines self-forgiveness as a willingness to abandon self-resentment in the face of one's own objective wrongdoing while fostering generosity, compassion, and love toward oneself. Hall and Fincham (2005) conceptualize self-forgiveness as a set of motivational changes whereby one becomes decreasingly motivated to avoid stimuli associated with the mistake or offense, decreasingly motivated to punish or retaliate against the self, and increasingly motivated to act benevolently toward the self. Wohl & Thompson (2011) define self-forgiveness more broadly as a positive attitudinal shift toward the self following an acceptance of responsibility for self-inflicted harm.

Regardless of the exact definition used, researchers have recently emphasized the importance of individuals first acknowledging and accepting responsibility for their mistake or wrongdoing prior to forgiving themselves for the mistake/wrongdoing in distinguishing between genuine self-forgiveness and "pseudo" self-forgiveness (Hall & Fincham, 2005; Wenzel, Woodyatt, & Hedrick, 2012). Genuine self-forgiveness involves accepting responsibility for one's wrongdoing while reducing the negative implications of responsibility for self-evaluation (Wenzell et al., 2012). Doing this may initiate feelings of guilt or regret, but it is argued that fully experiencing these feelings is necessary before one can truly extend forgiveness toward oneself (Hall & Fincham,

2005). Pseudo self-forgiveness entails failing to accept or minimizing one's responsibility for wrongdoing, but still excusing the behavior and its consequences (Wenzel et al., 2012). Individuals who engage in pseudo self-forgiveness are therefore essentially "letting themselves off the hook" for their transgression rather than truly forgiving themselves, as true forgiveness requires acknowledgment of wrongdoing (Wenzel et al., 2012). The difference between genuine and pseudo self-forgiveness has been largely overlooked in past empirical studies (Wenzel et al., 2012).

As with self-criticism, self-forgiveness has not been explicitly examined with regard to behavioral lapses. However, once again, based on Marlatt and colleagues' (1985, 1987) assertion that blaming oneself for a lapse increases the probability of relapse, AVE theory would presumably assert that individuals should be self-forgiving after a lapse to decrease the likelihood of further relapse. The results of numerous studies suggest that dispositional (i.e., trait) self-forgiveness is beneficial. Self-forgiveness has been found to be positively correlated with self-esteem, life satisfaction, and perceived physical health, and negatively correlated with neuroticism, depression, anxiety, and hostility (Maltby, Macaskill, & Day, 2001; Mauger et al., 1992; Ross, Kendall, Matters, Worbel, & Rye, 2004; Wilson, Milosevic, Carroll, Hart, & Hibbard, 2008). Some research also suggests that self-forgiveness for a specific instance of wrongdoing or a mistake (i.e., state self-forgiveness) may be advantageous. For example, self-forgiveness for a specific instance of procrastination has been shown to reduce future procrastination (Wohl, Pychyl, & Bennet, 2010). In addition, a brief (i.e., four-hour) self-forgiveness intervention with participants in an alcohol abuse treatment program was shown to reduce guilt and shame, and to increase participants' efficacy with regard to being able to abstain

from drinking (Scherer, Worthington, Hook, & Campana, 2011). In the latter study, the authors hypothesized that the observed increases in drinking refusal efficacy may reduce the probability of relapse due to increased hopefulness and confidence, and that the observed decreases in guilt and shame may also reduce the probability of relapse due to a lesser desire to use alcohol as a means of coping with these feelings (Scherer et al., 2011). Thus, the results of these studies suggest that self-forgiveness (both state and trait) may be beneficial for individuals' health, well-being, and behavioral change attempts.

Other studies, however, indicate that self-forgiveness may have deleterious consequences for future behavior when attempting to make behavioral changes. In one study with problem gamblers, for example, self-forgiveness mediated the relationship between level of gambling pathology and readiness to change, such that pathological gamblers were more ready to change than at-risk gamblers to the extent that they were less self-forgiving of their gambling (Squires, Sztainert, Gillen, Caouette, & Wohl, 2012). Similarly, in a study with smokers, Wohl & Thompson (2011) found that increased self-forgiveness for smoking was associated with a decreased likelihood of progressing through the behavioral stages of change toward action. Citing Carver and Scheier's (1998, 2011) model of self-regulation to explain their findings, Wohl and Thompson (2011) proposed that while self-forgiveness for a discrete, single transgression may be beneficial, self-forgiveness for self-inflicted behaviors that are chronic—like smoking—may be problematic.

According to Carver and Scheier's (1998, 2011) model of self-regulation, individuals self-regulate their actions through feedback-based processes in which a present condition (i.e., an input value) is compared to a desired condition (i.e., a reference

value). Movement toward a goal reflects the functioning of a discrepancy-reducing feedback loop; when there is a discrepancy between the input and reference value, an action is taken to change the input value (i.e., one's present condition) to bring it into conformity with the reference value (i.e., one's desired condition). Carver and Scheier (1998, 2011) propose that feelings are one consequence of the feedback process, and that negative affect arises when the rate of behavioral discrepancy reduction between the input and reference values is slower than desired or needed. Thus, with regard to goal progress, negatively-valenced affect essentially signals that one is doing worse than one needs to or would like to be doing, and presumably fuels corrective action. Because self-forgiveness dissipates negative emotions directed at the self (Wohl et al., 2010), but these emotions may be important for redirecting one's actions, Wohl and Thompson (2011) argue that self-forgiveness does not facilitate behavior change when one is still engaging in the behavior for which one is self-forgiving. It should be noted that although Herman and Polivy (2011) believe that Carver and Scheier's (1998, 2011) model of self-regulation may apply to dieters' long-term weight loss goals, they do not believe it is helpful in explaining the more proximate goal of intake in the short-term.

Additional research is needed to clarify the relationship between self-forgiveness and behavior change, as well as the role of negative affect in self-regulation more generally. However, findings from the existing self-forgiveness literature seem to suggest that while self-forgiveness for a specific, discrete event may be beneficial (e.g., Wohl et al., 2010), self-forgiveness for an ongoing self-inflicted behavior may actually impede behavior change (e.g., Squires et al., 2012; Wohl & Thompson, 2011). This may be especially true when self-forgiveness is assessed immediately after the event for which

one is forgiving the self, as individuals who report being self-forgiving soon after the event may be engaging in pseudo rather than genuine self-forgiveness. With regard to dietary lapses, being unforgiving toward the self in the immediate wake of a lapse may thus be associated with a decreased likelihood of subsequent lapses, whereas reporting being forgiving toward the self may indicate that one is "letting oneself off the hook" and be associated with increased likelihood of subsequent lapses.

1.4.4 Self-Compassion

A construct that may also be important to consider when examining individuals' cognitive-affective responses to a lapse is self-compassion. As defined by Neff (2003a), self-compassion is a healthy way of relating to oneself that consists of three distinct but interacting components: self-kindness (i.e., treating oneself with kindness and understanding during times of difficulty or failure rather than being harshly self-critical or judgmental), common humanity (i.e., seeing one's experiences as part of the larger human experience rather than seeing them as separating and isolating), and mindfulness (i.e., holding one's painful thoughts and emotions in balanced awareness rather than over-identifying with them). Self-compassion has been a burgeoning topic of research in the past decade, and has been associated with a number of indices of wellbeing and positive psychological functioning. For example, self-compassion has been shown to correlate positively with personal initiative, positive affect, optimism, conscientiousness, goal reengagement, perspective-taking, and self-improvement motivation, among other constructs (Breines & Chen, 2012; Neff, 2003b; Neff & Pommier, 2012; Neff, Rude, & Kirkpatrick, 2007). Self-compassion has also been shown to correlate negatively with

anxiety, depression, rumination, procrastination, maladaptive perfectionism, and fear of failure (Neff, 2003b; Neff, Hsieh, & Dejitterat, 2005; Williams, Stark, & Foster, 2008).

As with self-criticism and self-forgiveness, self-compassion has not been widely discussed in the relapse literature. From a theoretical standpoint, however, AVE theory would seem to suggest that treating oneself compassionately after a lapse would be associated with decreased likelihood of relapse. Some research from the self-compassion literature supports this notion, including results from one study that examined self-compassion after a dietary violation. In this study, highly restrained eaters who received a brief self-compassion intervention after eating an unhealthy food reported less distress and ate less on a subsequent sham taste test than highly restrained eaters who did not receive such an intervention (Adams & Leary, 2007). The authors explained these findings by proposing that highly restrained eaters who treat themselves with compassion following a dietary lapse may be better able to monitor and inhibit future eating because they experience less negative affect and self-critical thoughts, and are therefore less motivated to eat to cope with these negative self-referent feelings or to escape self-awareness (Adams & Leary, 2007). The idea that self-compassion reduces negative affect after a mistake or failure is supported by the results of another study, in which individuals who engaged in a brief writing task meant to induce self-compassion after recalling a past experience of failure, rejection, or humiliation reported less negative affect than participants who completed an expressive writing, factual account, or no writing task (Leary, Tate, Adams, Batts Allen, & Hancock, 2007). Importantly, individuals in this study who engaged in the self-compassion exercise were also the most likely to report that the distressing event had been their fault, but not to report corresponding negative

affect. This finding suggests that self-compassion may help people to take personal responsibility for their actions while decoupling taking responsibility from experiencing negative affect (Leary et al., 2007).

One distinction between merely treating oneself kindly after a lapse and treating oneself with self-compassion (as defined by Neff, 2003a) involves attribution of blame for the lapse. Whereas AVE theory posits that making internal, characterological attributions for lapses promotes relapse (Marlatt & Gordon, 1985), self-compassion theory encourages the acceptance of personal responsibility for wrongdoing and mistakes. It asserts that individuals ought to recognize and acknowledge their faults and failings, but that they should do so in an uncritical, non-judgmental way, with the understanding that all humans are flawed. Thus, self-compassion theory encourages the acknowledgement of personal faults and mistakes without the need to be defensive. As discussed above, some research suggests that treating oneself with self-compassion enables individuals to acknowledge their responsibility for mistakes or failures without corresponding negative affect (Leary et al., 2007). In addition, the results of some studies suggest that accepting personal responsibility for mistakes or wrongdoing in a non-judgmental, uncritical way increases self-improvement motivation (Breines & Chen, 2012).

With regard to lapses, the self-compassion research thus seems to suggest that making at least a partially internal causal attribution for a lapse, while still treating oneself with kindness and avoiding self-criticism, would be associated with decreased likelihood of relapse. Although some research (e.g., Adams & Leary, 2007) suggests that being self-compassionate after a single dietary violation is associated with less negative

affect and less consumption on a subsequent taste task, the impact of treating oneself with self-compassion after a dietary lapse in the real-world (versus in the laboratory), among obese or overweight individuals attempting to lose weight (versus undergraduate restrained eaters), without prompting (versus being encouraged to act self-compassionately) and across multiple lapse episodes (versus after a single dietary violation) is unclear.

1.5 Influence of Other Variables

Marlatt and colleagues' (1985, 2004) relapse model posits that an individual's explicit cognitive and affective responses to a lapse largely determine whether that individual will experience subsequent lapses or be able to regain abstinence. Although explicit cognitive-affective responses to lapses are presumably among the factors that influence behavior after a lapse, other variables likely also influence individuals' behavior following a lapse. For example, with regard to dietary lapses, factors like inhibitory control, emotional eating, and hedonic hunger may also affect the likelihood of continued relapse versus restored abstinence. In addition, an individual's level of psychological flexibility (i.e., his or her ability to contact the present moment and to persist in or change behavior when doing so serves valued ends; Biglan, Hayes, & Pistorello, 2008) may influence the relationship between cognitive-affective responses to lapses and subsequent behaviors such that individuals with greater psychological flexibility may be better able to re-adhere to their goals, regardless of whatever cognitive-affective response they initially experience. Although it is beyond the scope of this study to examine the role of all of the variables that are potentially associated with how

individuals' respond to lapses, it is important to recognize that factors other than one's immediate, explicit cognitive-affective response to a lapse relate to future behavior.

1.6 Proposed Study

A vast body of literature has examined individuals' responses to behavioral lapses across a variety of addictive and problematic health behaviors using the abstinence violation effect (AVE) described in Marlatt and colleagues' (1985, 2004) cognitive-behavioral model of relapse. Although this model forms the basis of the relapse prevention strategies utilized by many behavioral weight loss interventions (Hagobian & Phelan, 2013), and the AVE is presumed to be relevant to behavioral lapses in weight loss (e.g., Mooney et al., 1992), few studies have empirically examined how often participants in behavioral weight loss programs experience dietary lapses, the nature of individuals' responses to lapses, or how different types of responses to lapses relate to subsequent weight control behaviors. Hence, the degree to which the relapse prevention strategies currently used in behavioral weight loss treatments are evidence-based and aptly reflect lapse experiences is unclear. The proposed study aimed to shed light on these matters by assessing the frequency of dietary lapses, characterizing overweight and obese individuals' cognitive-affective responses to dietary lapses, and examining the relationships between different types of responses and both lapse frequency and lapse progression.

In addition, despite extensive research on the AVE across numerous domains, the theoretical structure and hypothesized consequences of the AVE have not received strong empirical support. This is especially true when studies have used real-world, real-time methods of assessment rather than retrospective self-report (Brandon et al., 2007). Thus,

it seems important to examine individuals' cognitive-affective responses to lapses from a slightly different framework, such as the attitude (e.g., self-forgiving, self-critical) one takes toward the self after a lapse, using an ecologically-valid method of assessment to determine if conceptualizing responses to lapses in this way better captures lapse experiences and elucidates their relation to subsequent behaviors. Consequently, the present study aimed to further our understanding of how individuals' attitudes toward themselves and their self-efficacy vary across time, as well as how different types of responses to lapses and reported self-efficacy relate to subsequent behavior using EMA.

1.6.1 Primary Aims

1. Characterize and determine the extent of variability in: (a) individuals' attitudes (i.e., self-forgiveness, self-criticism, self-regard) toward themselves after dietary lapses, (b) individuals' self-efficacy after dietary lapses, and (c) the internality-externality of individuals' causal attributions for dietary lapses.
2. Determine the frequency with which overweight and obese adults in a behavioral weight loss program experience dietary lapses.
    a. *Hypothesis 1:* Given the challenges associated with consistently engaging in weight control behaviors (i.e., calorie restriction, portion control), we hypothesized that a vast majority (i.e., 95%) of individuals would report experiencing at least one dietary lapse during the assessment period (i.e., two weeks).
3. Examine how individuals' reported levels of self-criticism, self-forgiveness, self-efficacy, and self-regard after dietary lapses are related to lapse progression (i.e., time between lapse episodes).

a. *Hypothesis 2:* Based on research suggesting that too much and too little self-criticism may impede behavioral change, we hypothesized that reported level of self-criticism after a dietary lapse would correlate with lapse progression according to a quadratic relationship such that levels of self-criticism at the most extreme low and high ends would be associated with more rapid progression to a subsequent lapse than moderate levels of self-criticism.

b. *Hypothesis 3:* Based on research suggesting that self-forgiveness for recurrent behaviors may impede behavioral change, we hypothesized that reported level of self-forgiveness after a dietary lapse would correlate with lapse progression in a linear manner such that greater self-forgiveness would be associated with more rapid lapse progression.

c. *Hypothesis 4*: Given research suggesting that low self-efficacy may be associated with greater risk of lapsing, we hypothesized that reported self-efficacy after a dietary lapse would correlate with lapse progression in a linear manner such that lower self-efficacy would be associated with more rapid lapse progression.

d. *Hypothesis 5*: Given theory suggesting that some negative affect may be necessary to fuel behavioral change, we hypothesized that reported self-regard after a dietary lapse would correlate with lapse progression according to a quadratic relationship such that the most negative and the most positive levels of self-regard would be associated with more rapid

progression to a subsequent lapse than more neutral (i.e., less positively- or negatively-valenced) levels of self-regard.

4. Examine the relationships between reported levels of self-criticism, self-forgiveness, self-efficacy, and self-regard across dietary lapse episodes and total number of reported dietary lapses during the data collection period (i.e., 14 days).
    a. *Hypothesis 6:* Based on research suggesting that some self-criticism may facilitate behavior change while too much or too little self-criticism may impede change, we hypothesized that reported level of self-criticism across lapse episodes would be associated with total number of reported lapses according to a quadratic relationship such that levels of self-criticism at the most extreme low and high ends would be associated with more total lapses than more moderate levels of self-criticism.
    b. *Hypothesis 7:* Based on research suggesting that self-forgiveness for recurrent behaviors may hinder behavioral change, we hypothesized that reported level of self-forgiveness across lapse episodes would be associated with total number of reported lapses in a linear manner such that greater self-forgiveness would be associated with more lapses.
    c. *Hypothesis 8:* Due to research suggesting that low self-efficacy is associated with lapses, we hypothesized that reported self-efficacy across lapse episodes would be associated with total number of reported lapses in a linear manner such that lower self-efficacy would be associated with more lapses.

d. *Hypothesis 9:* Due to research suggesting that some negative affect is necessary for behavioral change, we hypothesized that self-regard across lapse episodes would be associated with total number of reported lapses according to a quadratic relationship, such that the most negative and the most positive levels of self-regard would be associated with more total lapses than more neutral self-regard.

1.6.2 Secondary Aims

1. Examine if lapse frequency was significantly different over time (i.e., in week one versus week two of EMA data collection).
    a. *Hypothesis 10:* Due to potential reactivity to being prompted to think about lapses as well as having less experience adhering to dietary goals, we hypothesized that lapse frequency would be greater in week one than in week two.
2. Examine if self-regard and self-efficacy were different shortly after a lapse (i.e., when an EMA survey was filled out and a recent lapse was reported) versus not after a lapse (i.e., when an EMA survey was filled out and a recent lapse was not reported).
    a. *Hypothesis 11:* Based on research suggesting that many individuals experience negative affect and make self-blaming attributions after a lapse, we hypothesized that self-regard would be more negative at survey points when a lapse was reported as compared to times when a lapse was not reported.

b. *Hypothesis 12:* Due to research suggesting that many individuals experience reduced self-efficacy after a lapse, we hypothesized that self-efficacy would be lower at survey points when a lapse was reported as compared to times when a lapse was not reported.

1.6.3 Exploratory Aims

1. Examine if psychological flexibility moderated the hypothesized relationships between (a) self-criticism, self-forgiveness, self-efficacy, self-regard, and lapse progression, and (b) self-criticism, self-forgiveness, self-efficacy, self-regard, and total number of lapses.
    a. *Hypothesis 13:* Because individuals with higher psychological flexibility are presumably better able to engage in valued behaviors regardless of their momentary thoughts or feelings, we hypothesized that the relationships between individuals' attitudes, self-efficacy, lapse progression, and total number of reported lapses would be weaker for individuals with higher psychological flexibility.

Chapter 2: Methods

2.1 Participants

Overweight and obese adults from Philadelphia and the surrounding area participating in a behavioral weight loss trial completed the components of this study as part of the protocol for a larger weight loss trial. All participants enrolled in the third and fourth recruitment waves (i.e., recruitment cohorts) of the weight loss trial participated in the present study.

2.1.1 Recruitment

Participants were recruited for the behavioral weight loss trial via local radio and newspaper advertisements, website advertisements, and recruitment flyers mailed to health-care providers in the community. Potential participants were screened by phone and then in person.

2.1.2 Inclusion and Exclusion Criteria

In order to enroll in the study, participants were required to have a BMI between 27 and 50 kg/m^2, be between 18-70 years of age, and agree not to join another weight loss program for the duration of the study (i.e. three years). Participants were excluded if they were lactating, pregnant, or planning to become pregnant in the next three years; reported taking a medication or having a medical or psychiatric problem known to cause weight loss or weight gain; reported a medical or psychiatric condition that could limit their ability to comply with the program's behavioral recommendations; reported having undergone weight loss surgery; were insulin-dependent; had a current diagnosis of binge eating disorder; had a first-degree relative or other member of the household who was

currently enrolled or planned to enroll in the study; or had plans to move out of the Philadelphia area in the next three years.

2.2 Study Design

A single-group design was used. Although participants in the weight loss trial were randomly assigned to an acceptance-based (ABT) or standard behavioral (SBT) weight loss treatment condition via computer-based random allocation, treatment condition was not expected to influence participant responses to the present study's questions as data collection occurred within the first few weeks of the weight loss trial, when the treatment protocols were essentially identical. Participants in both conditions received treatment in groups of 10-14 people over the course of one year. Sessions were held weekly for the first four months, bi-weekly for the following three months, and monthly and bi-monthly for the remainder of the year, for a total of 25, 90-minute sessions. Groups were led by expert interventionists (i.e., clinical psychologists with experience administering behavioral weight-control interventions who had received specialized training in both SBT and ABT). Although treatment lasted for one year, assessments took place at baseline, 6-months, post-treatment, one-year follow-up (i.e., two years from baseline), and two-year follow-up (i.e., three years from baseline). Treatment was provided to participants free of charge, and participants received up to $360 in compensation for completing all assessments.

2.3 Procedure

Prior to the beginning of treatment, participants completed a number of neuropsychological, behavioral, and self-report assessments, including a demographics questionnaire and a measure of psychological flexibility, as part of the larger treatment

study. Immediately prior to or after the first session (for participants in wave three) or the second session (for participants in wave four), participants were trained in the EMA procedures, which took ~20 minutes.[1] During the training, participants received an EMA device (i.e., an Android Smartphone-like device), were taught how to respond to prompts and initiate surveys, and had an opportunity to ask questions about operating the device. In an attempt to counter social desirability or participant worries that certain responses to the EMA questions may be "right" or "wrong," participants were explicitly told that there were no correct or incorrect answers to the questions, and were encouraged to respond as accurately as possible based on the thoughts, feelings, or urges they were experiencing in that moment. Participants received instructional handouts about the EMA procedures, and were encouraged to contact research personnel if any questions or problems arose at any point during the EMA data collection period.

Prior to the first session, participants were weighed individually using a digital scale. During the first session, participants were instructed to reduce their daily energy intake to 1200-1500 kcal/day if < 250 lbs. or 1500-1800 kcal/day if ≥ 250 lbs. In order to accomplish this energy reduction, participants were advised to cut back (i.e., reduce by at least one-third) consumption of high-sugar and high-fat foods, and received a list of common high-sugar and high-fat foods. In the first (wave three) or second (wave four) session, group facilitators explained the concept of dietary lapses (i.e., eating or drinking that puts weight control efforts in jeopardy) to participants, and outlined three different

[1] The EMA protocol was delayed one week in the fourth wave of the parent study due to concerns about participants' ability to identify dietary lapses during the first week of treatment. Despite this change, analyses revealed that the difference between lapse frequency in wave three (M = 6.70, SD = 5.96) versus wave four (M = 7.07, SD = 5.78) was small and not statistically different, $t(89) = -.30$, $p = .77$, $d = .07$.

types of dietary lapses (i.e., drinking or eating a high-calorie food that you had intended to avoid, having more than you had planned on consuming, or eating/drinking at a time when you hadn't intended). To ensure participant understanding of what constituted a dietary lapse, group facilitators elicited examples of lapses from participants. Participants also received written materials with the definition of and examples of a dietary lapse. At the end of the first (wave three) or second (wave four) session, participants completed a one-item measure of the priority of adhering to their dietary and/or eating goal(s) over the following seven days.

The EMA data collection period began on the day following the first (wave three) or second (wave four) treatment session, and lasted for the following fourteen days. In order to familiarize participants with using the EMA device and the EMA procedure, participants completed a "practice" round of EMA during the week between the first and second (wave three) or second and third (wave four) treatment session (i.e., for the seven days immediately preceding the actual assessment period). This "practice" round also presumably reduced any behavioral reactivity that individuals experienced as a result of being prompted to think about and report on their lapses. Data collected from the first (i.e., the "practice") and the second (i.e., the "actual") weeks of the EMA data collection period were compared to determine if any such reactivity occurred.

As in previous studies (e.g., Smyth et al., 2007; Thomas, Doshi, Crosby, & Lowe, 2011), participants received six, semi-random prompts daily in order to ensure adequate sampling throughout waking hours. Signal times were randomly distributed around six anchor points (i.e., 9:30 am, 12:00 pm, 2:30 pm, 5:00 pm, 7:15 pm, 9:30 pm) within +/- 30 minutes of the anchor point. At each EMA report, participants provided

information about their mood, the availability of and their reactions to highly palatable foods, and any dietary lapses that had occurred since the last survey. At the last signal-contingent survey of each day, participants also provided information about any social comparisons made during that day any intentions to engage in physical activity on the following day. If participants did not respond immediately to the prompt, they were signaled every 5 minutes until they responded to the prompt or the prompt expired (i.e., after 45 minutes). Responses made within 45 minutes of a prompt were considered eligible for analysis.[2] Participants lost $1 from a potential maximum of $42 in compensation for every prompt not responded to within the 45 minute response period.

In addition to the six daily, signal-contingent surveys, participants were instructed to initiate an EMA survey whenever they experienced a dietary lapse. At each self-initiated survey point, participants provided information about their recent dietary lapse, their mood, and the availability of and their reactions to highly palatable foods. The addition of these event contingent recordings helped to ensure that recordings were not missed when a target behavior (i.e., a dietary lapse) occurred (Smyth et al., 2001). If a lapse occurred and was not recorded via a self-initiated survey, it was presumably picked up at the next random signal when the participant was asked if he or she had experienced a dietary lapse since last completing a survey. Multiple recordings of the same dietary lapse were avoided by requiring participants to record when (i.e., date and time) each

[2] While it was originally proposed that only responses made within 45 minutes of a prompt would be considered eligible for analyses, all surveys completed more than five minutes apart in time from another survey were included in analyses due to the event- and signal-contingent approach used. The criteria used to determine which surveys were eligible for compliance analyses are discussed in greater detail in the Results section.

lapse occurred. Each signal- and event-contingent EMA survey took ~1 minute to complete.

During the second (wave three) or third (wave four) treatment session (i.e., after completion of the "practice" week), the definition and three different types of dietary lapses were reviewed. Group facilitators addressed any issues or questions about dietary lapses or the EMA protocol that had arisen during the practice week of EMA completion. As during the first (wave three) or second (wave four) session, facilitators also elicited examples of lapses from several participants to ensure understanding. At the end of session, participants completed the same one-item measure assessing the priority of meeting their calorie and/or other eating goal(s) during the next seven days that was completed at the end of the first (wave three) or second (wave four) session. The official (vs. practice) EMA data collection period began on the day after the second (wave three) or third (wave four) treatment session, and lasted for seven days. EMA devices were collected at the third (wave three) or fourth (wave four) treatment session. Participants were also weighed individually at this session.

2.4 Measures

A number of measures were administered to participants as part of the weight loss trial protocol. All measures relevant to the present study's research questions are reported on here.

Priority level of dietary goals. The extent to which meeting one's calorie goal and/or other dietary goal(s) was a priority for participants was assessed with one item administered at the end of the first and the second (wave three) or second and third (wave four) treatment sessions (i.e., on the day prior to the beginning of the practice and actual

EMA data collection periods). Participants responded to the question, "How much of a priority is meeting your calorie goal and/or other eating goal(s) this next week?" by selecting one of the following options: "1 = Very low. Meeting my calorie/eating goal(s) is not what I'm focused on at this time;" "2 = Somewhat low. I'll try to meet my calorie/eating goal(s), but it's not a priority;" "3 = Somewhat high. Eating according to my calorie/eating goal(s) is one of my top priorities;" "4 = Very high. Meeting my calorie/eating goal(s) is my number one, top priority."

Dietary lapse. At each signal-contingent EMA survey point, participants were asked to indicate whether they had experienced a dietary lapse since last completing an EMA survey. A lapse was defined as "eating or drinking likely to cause weight gain, and/or put weight loss/maintenance at risk." In the event of an affirmative response, participants were asked to respond to several items assessing when the lapse occurred (i.e., date and time), the type of lapse that occurred (select one: "I ate a larger portion of a meal or snack than I intended," "I ate when I hadn't intended to eat," "I ate a type of food that I intended to avoid"), and where they were when the lapse occurred (select one: "At home," "At school," "At work," "At a restaurant, café or other eating location," "Other"). Participants responded to the same questions when initiating an EMA survey in response to experiencing a dietary lapse.

Self-criticism. At each signal- and event-contingent survey point at which a lapse was reported, participants indicated the extent to which they felt self-critical in light of their lapse (i.e., "How critical do you feel towards yourself for having a lapse?"). Participants responded using a four-point, Likert-type scale (1 = *Not at all critical;* 2 =

Slightly critical; 3 = *Very critical*; 4 = *Extremely critical*). Participants were required to respond to the question to proceed with the EMA survey.

Self-forgiveness. At each signal- and event-contingent survey point at which a lapse was reported, participants indicated the extent to which they felt self-forgiving in light of their lapse (i.e., "Thinking about your lapse, which best describes how forgiving you feel toward yourself?"). Participants responded using a four-point, Likert-type scale (1 = *Not at all forgiving*; 2 = *Slightly forgiving*; 3 = *Mostly forgiving*; 4 = *Completely forgiving*). Participants were required to respond to the question to proceed with the EMA survey.

Attribution for lapse. At each signal- and event-contingent survey point at which a lapse was reported, the internality-externality of participants' attributions for their dietary lapse was assessed with the item, "The cause/reason for my lapse was…." Participants indicated their response by selecting one of the following options: "1 = *Totally due to myself*," "2 = *Mostly due to myself*," "3 = *Slightly due to myself*," "4 = *Slightly due to other people/circumstances*," "5 = *Mostly due to other people/circumstances*," "6 = *Totally due to other people circumstances*." Participants were required to respond to the question to proceed with the EMA survey.

Self-efficacy. At each signal- and event-contingent survey point, regardless of whether a lapse had been reported, participants indicated their self-efficacy with regard to their weight control goals (i.e., "Right now, how confident do you feel in your ability to succeed in your weight control goals?"). Participants responded using a four-point, Likert-type scale (1 = *Not at all confident*; 2 = *Slightly confident*; 3 = *Very confident;* 4 = *Extremely confident*). Participants were required to respond to the question to proceed with the EMA survey.

Self-regard. At each signal- and event-contingent survey point, regardless of whether a lapse had been reported, participants indicated their opinion of themselves at that moment (i.e., "Right now, how would you describe your overall opinion about yourself?"). Participants responded using a four-point, Likert-type scale (1 = *I have a very negative opinion of myself*; 2 = *I have a somewhat negative opinion of myself*; 3 = *I have a somewhat positive opinion of myself*; 4 = *I have a very positive opinion of myself.*). Participants were required to respond to the question to proceed with the EMA survey.

Lapse timing. At each signal- and event-contingent survey point at which a lapse was reported, participants were asked to report the date and time at which the reported lapse occurred. The date and time of submission of the EMA survey was also documented via the EMA data recording software.

Psychological flexibility. The Acceptance and Action Questionnaire-II (Bond et al., 2011) was used to assess participants' psychological flexibility and experiential avoidance, and was administered to participants prior to the start of treatment. Participants responded to each of the seven items (e.g., "My painful experiences and memories make it difficult for me to live a life that I would value," "Emotions cause problems in my life") using a seven-point, Likert-type scale (1 = *never true*; 7 = *always true*). This 7-item measure has been shown to have good reliability and validity (Bond et al., 2011). Higher scores on the AAQ-II indicate less psychological flexibility.

2.5 Data Analysis

All data analyses were performed using SPSS Statistics 22.

2.5.1 Statistical Analyses

Within- and between-person variability in individuals' attitudes and attributions for lapses were examined with standard deviations (SD), mean square successive differences (MSSD; Jahng, Wood, & Trull, 2008), and ranges. Lapse frequency was assessed by examining the percentage of participants who reported at least one lapse, as well as by examining number of reported lapses (both raw frequency and frequency prorated to 14-day averages). All other hypotheses were examined using generalized estimating equations (GEEs). These models have momentary observations nested within subject, and are appropriate for use with longitudinal data with correlated responses. An autoregressive (i.e., AR(1)) working correlation matrix was used for all models. The distribution, link function, and variables included in each model are specified in Results.

2.5.2 Power Analysis

Due to the complexity of running power analyses with Poisson regression models, a formal power analyses was not conducted. As previously mentioned, however, participants for the present study were individuals enrolled in the third and fourth waves of a larger weight loss trial, and that larger weight loss study planned to recruit approximately 110 individuals for the indicated waves. In actuality, 100 individuals were recruited, 91 of whom had suitable compliance for analyses (see 3.3 Compliance). The authors recognized that the present study may not be fully powered.

2.6 Ethical Considerations

The study protocol was approved by the Institutional Review Board of Drexel University. All participants underwent informed consent prior to the start of the study. Each participant was assigned a participant number that was used to label data.

Participants' names and other personal identifying information were therefore not associated with the collected data. All data was stored in a locked filing cabinet in the laboratory, and consent forms were kept separately from participant data so that no identifying information was associated with any data file.

Each participant received an EMA device to use for the duration of the study. Devices were assigned to participants and participant responses were tracked using random identification numbers rather than participants' names. Thus, the EMA devices also contained no personal identifying information. Although participants were asked to respond to all EMA prompts in a timely manner, participants were explicitly instructed not to answer an EMA prompt if doing so would place the participant or anyone else in danger (e.g., while driving). Participants also had the option to "silence" their EMA device if they were in a situation (e.g., a work meeting) where an audio prompt would be disruptive or potentially indicate to others that they were enrolled in a research study.

Chapter 3: Results

3.1 Participant Characteristics

Although 100 individuals completed EMA, nine participants were dropped from analyses due to poor compliance (described below). Characteristics for the full sample (n = 100) and for the subsample included in subsequent analyses (n = 91) are presented in Table 1. One participant was missing baseline height and weight data. Weight at the first treatment group meeting and height from the mid-treatment assessment were used to calculate baseline BMI for this individual.

3.2 Data Preparation

Several issues with the internal code of the EMA data collection program were discovered between the third and fourth wave of data collection. In specific, it was discovered that: (1) the timestamp on EMA surveys was occasionally shifting either forward or backward several hours in time, (2) participants were not able to re-enter surveys that were prematurely exited (they instead had to initiate a new survey) and responses were not saved until the next survey was opened if the "submit" button had not been pressed, resulting in clusters of incomplete and complete surveys, and (3) semi-random prompted surveys were at times saved as user-initiated surveys. Multiple steps were taken to address these issues and maximize the integrity of the data.

With regard to the shifting of timestamps, a function was added to the EMA data collection program for the fourth wave that recorded the time at which a survey was initiated (versus completed). As this new variable did not appear to be subject to shifting, the survey start time was used as the timestamp for all EMA surveys completed in the fourth wave. To identify and attempt to correct for time shifts that occurred in the third

wave, surveys that were erroneously timestamped were flagged based on: 1) discrepancies between the given timestamps and the sequential order in which surveys were uploaded to the server, 2) implausible timestamps for prompted surveys given the time windows for valid responses (i.e., 30 minutes prior to through 75 minutes after the prompt time anchor), and 3) discrepancies between timestamps and reported lapse time. Automatic and manual (i.e., conducted by three trained coders) adjustments were then made to flagged surveys to correct the timestamps to the believed proper time of survey completion using a set of logic rules based on valid time windows, lapse times, and survey order. A total of 513 (8.14%) of the surveys used in analyses had timestamps that were adjusted based on shifts. As these timestamps were only used to determine compliance in the present study, it is believed that the effect of the time shift errors on the findings were minimal.

With regard to clustered surveys that resulted from being unable to re-open prematurely exited surveys and surveys not being timestamped immediately if the "submit" button was not pressed, 200 (3.17%) of the surveys used in analyses were timestamped within 5 minutes of another survey. Any clustered surveys that were incomplete or that had a reported lapse were examined to determine whether, based on participants' response patterns and reported lapse time (if applicable), the timestamp appeared correct or if the automated timestamp appeared to have been delayed due to technical difficulties. The timestamps for eight (0.13%) clustered surveys were adjusted to place the survey at the reported lapse time, and the timestamps for four clustered surveys (.06%) were adjusted to place the survey at the appropriate random prompt time. All clustered surveys were used in analyses, as surveys were believed to contain valid

data and to be in the proper sequence. As a result, compliance may be slightly inflated. However, because reported lapse times rather than timestamps were used for time-dependent analyses, the effect of this error on the present study's findings are believed to be minimal. Between adjusting for time shifts and clustered surveys, the timestamps for a total of 524 (8.32%) surveys were adjusted.

Reported lapse times were also examined for potential entry errors. Among the 91 participants included in analyses =, reported lapse time was missing for 5 lapses (0.79% of lapse surveys); these lapses were anchored at the survey timestamp. The time difference between the EMA survey timestamp (adjusted when necessary) and reported lapse time was calculated for the 630 other surveys at which a lapse reported, and any surveys at which a lapse was reported into the future (i.e., after the timestamp) or more than four hours into the past were flagged for examination for potential entry error. Twenty-one lapses (3.31% of lapse surveys) had reported lapse times that were in the future. The lapse time for each of these surveys was adjusted to match the survey timestamp. Eighty-three lapse surveys (13.07% of lapse surveys) were reporting on lapses that appeared to have occurred more than four hours into the past. Participants' response patterns were visually examined, and it was determined that the reported lapse time for 40 of these surveys appeared valid. The reported timestamp for the remaining 43 appeared to have user entry errors (e.g., incorrect month, incorrect year, incorrect date, AM/PM errors with 24-hour clock). Using a set of logic rules and participants' response patterns, the lapse times for these surveys were adjusted to the presumed proper lapse time. Finally, if two lapses were reported within 20 minutes of each other, only the earlier lapse survey was used due based on the assumption that these two lapses were part of the

same lapse episode. A total of 9 lapses (1.42% of lapse surveys) were excluded due to another lapse having been reported in the previous 20 minutes. In all, 626 lapses were included in analyses.

3.3 Compliance

Due to the technical difficulties described above, all user-initiated surveys at which a lapse was not reported and that were completed within the valid time frames for responding to prompted surveys were considered when determining compliance. Any surveys that were timestamped outside of these timeframes, as well as any user-initiated surveys completed during these timeframes at which a lapse was reported, were not considered when determining compliance. Across all 100 participants, compliance to prompts averaged 80.13% (range: 15.48 to 100.00%; *SD* = 18.17). Nine participants had compliance to of < 50%. Consistent with previous EMA studies of eating behavior (e.g., Lavender et al., 2013) these individuals were dropped from subsequent analyses. For the remaining 91 participants, compliance to semi-random signals averaged 84.45% (range: 54.76 – 100.00%; *SD* = 11.81). A total of 6301 separate EMA recordings were analyzed; a lapse was reported at 626 (9.93%) of these surveys. The majority of lapses (*n* = 449; 71.73%) were reported at signal-contingent surveys, with the remaining lapses (*n* = 177, 28.27%) being reported at user-initiated surveys. The number of days that participants provided EMA recordings ranged from 7 to 17, with a mean of 13.25 (*SD* = 2.17) and a median of 14.

3.4 Primary Aims

Readers are referred to Table 2 for a summary of study findings.

3.4.1 Means and Frequencies for EMA Responses

Across all 626 lapse episodes, mean self-criticism after a lapse was 2.01 (*SD* = .69; 1 = *not at all critical,* 4 = *highly critical*), mean self-forgiveness was 2.81 (*SD* = .88; 1 = *not at all forgiving,* 4 = *completely forgiving*), mean self-efficacy was 2.64 (*SD* = .73; 1 = *not at all confident,* 4 = *extremely confident*), mean self-regard was 2.99 (*SD* = .81; 1 = *very negative opinion of myself,* 4 = *very positive opinion of myself*), and mean attribution was 1.76 (*SD* = 1.29; 1 = *totally due to myself,* 6 = *totally due to other people/circumstances*). Table 3 displays the frequency of reported responses for each of these five variables across all 91 participants and all lapse surveys.

Among the 81 individuals who reported at least one lapse, mean between-person self-criticism after a lapse was 2.03 (*SD* = .53), mean between-person self-forgiveness was 2.82 (*SD* = .73), mean between-person self-efficacy was 2.83 (*SD* = .68), mean between-person self-regard was 3.10 (*SD* = .69), and mean between-person attribution was 1.74 (*SD* = .82). These results indicate that participants, on average, reported feeling slightly self-critical after lapses, slightly-to-mostly forgiving, slightly-to-very confident, having a somewhat positive opinion of themselves, and attributing lapses primarily due to themselves (versus other people or circumstances). GEEs based upon a gamma distribution with a log response function and an AR(1) matrix structure were used to compare self-criticism, self-forgiveness, self-efficacy, self-regard, and attribution after lapses during the first versus second week of EMA. Results indicated that mean levels of each of these variables after lapses in the first versus second week were similar (*p*s > .14), with differences in estimated marginal means across the two weeks as follows: self-

criticism: 0.03, self-forgiveness: 0.02, self-efficacy: 0.08, self-regard: 0.06, attribution: 0.17.

3.4.2 Within- and Between-Person Variability in EMA Responses

Within-person variability for self-criticism, self-forgiveness, and internality-externality of attributions for dietary lapses was evaluated by calculating the mean, SD, MSSD, and range of responses to the one-item measure of each variable of interest across all lapses for each participant. Ten participants reported zero lapses and ten participants reported on self-forgiveness, self-criticism, and internality-externality of attribution for only one lapse; indices of variability in responses to lapses were not calculated for these individuals. Indices of between-person variability in self-forgiveness, self-criticism, and internality-externality of attribution for the 71 participants who reported two or more lapses was evaluated by calculating (1) the average mean and range of means for each variable, (2) the average SD and range of SDs for each variable, (3) the average MSSD and range of MSSDs for each variable, and (4) the average range of responses and range of range of responses for each variable (Table 4). As was the case across all lapses and all participants, the average participant reported being slightly critical after lapses, mostly self-forgiving, and attributing lapses mostly or totally to themselves. The frequency of response ranges for each variable across participants with two or more lapses is displayed in Table 5. Of note, a considerable proportion of participants had a range of zero or one for self-criticism (zero: 22.5%, one: 52.1%), self-forgiveness (zero: 21.1%, one: 45.1%), and attribution (zero: 28.2%, one: 14.1%).

Within-person variability for self-efficacy and self-regard was also evaluated by calculating the mean, SD, MSSD, and range of responses to the one-item measures of

each of these constructs, although variability was examined on the daily level for each participant across all surveys (lapse and non-lapse) for these variables. SD and MSSD were not computed for days on which participants completed one or no surveys. Between-person variability for self-efficacy and self-regard was assessed by determining each individual's daily mean, SD, MSSD, and range of responses for both variables, aggregating these values across days to obtain person-level values for each variable, and then calculating (1) the average mean and range of means for each variable, (2) the average SD and range of SDs for each variable across, (3) the average MSSD and range of MSSDs for each variable, and (4) the average range of responses and range of range of responses for each variable. Indices of between-person variability are displayed in Table 6. These results indicate that the average participant reported feeling very self-confident and having a somewhat positive opinion of themselves. The frequency of response ranges for each variable across participants and across all completed surveys (without first determining values on a daily level) is displayed in Table 7. Of note, many participants also had a range of zero or one for both self-efficacy (zero: 14.3%, one: 46.2%) and self-regard (zero: 19.8%, one: 40.7%).

3.4.3 Lapse Frequency

We hypothesized that a vast majority (i.e., 95%) of participants would report experiencing at least one dietary lapse during the assessment period. In actuality, 89.01% (81/91) of participants reported at least one lapse, as assessed by responding "yes" to the EMA question, "Since the last time you completed this survey, did you have a dietary

lapse?" on at least one EMA survey during the two-week assessment period.[3] The number of reported lapses per person ranged from 0 to 29, with a mean of 6.88 (*SD* = 5.85) and median of 6.00. To account for potential differences in number of EMA response days, the number of reported lapses was converted to fourteen-day lapse totals. Fourteen-day lapse totals ranged from 0 to 29, with a mean of 7.27 (*SD* = 5.95) and median of 7.00. A frequency table of raw number of lapses and fourteen day lapse totals (rounded to the nearest integer) is presented in Table 8. A frequency distribution of fourteen-day lapse totals (rounded to the nearest integer) is displayed in Figure 3.

3.4.4 Self-Criticism, Self-Forgiveness, Self-Efficacy, Self-Regard, and Lapse Progression

It was hypothesized that individuals' reported attitudes and self-efficacy after a particular lapse (e.g., lapse 1) would correlate with how much time passed until a subsequent lapse (e.g., lapse 2) occurred. In particular, it was hypothesized that both self-criticism and self-regard would correlate with time until next lapse according to a quadratic relationship (with moderate levels of each correlating with greatest time until next lapse), self-forgiveness would correlate with time until next lapse according to a negative linear relationship, and self-efficacy would correlate with time until next lapse according to a positive linear relationship. Separate GEEs based on a gamma distribution with a log response function and an AR(1) matrix structure were used to examine the relationships between reported self-criticism, self-forgiveness, self-efficacy, and self-

[3] Although it was originally proposed that only lapse frequency in the second week of the assessment period would be considered, all responses across the full two-week period were considered in analyses given that many participants reported relatively few lapses, lapse frequency did not differ between the first and second week of data collection (see Secondary Aim 1 in Results), and average values on response variables of interest did not differ between the first and second week (see Section 3.4.1).

regard at a given lapse and the time (in hours) until next lapse.[4] For each variable (i.e., self-criticism, self-forgiveness, self-efficacy, self-regard), analyses were run using both the untransformed variable and squared variables for both the between- and within-subjects effects to determine the nature (i.e., linear versus quadratic) of the relationship between each construct and time until subsequent lapse. All between-subjects variables were grand mean centered prior to squaring; within-subjects variables were centered within person prior to squaring. The distribution of the time until next lapse variable was examined for normality to determine whether to use a GEE based on a linear or gamma distribution. Due to the considerable skew of the distribution, a GEE based on a gamma distribution was used.

Only participants who reported two or more lapses were included in analyses. Across these individuals (n = 71), mean time until next lapse was 29.92 hours (SD = 33.28; range: 0.42 to 266.26). Full results from the four GEE models are presented in Table 9. No significant within-subjects (i.e., momentary) effects were observed, although the relationship momentary self-criticism and time until next lapse approached significance (p = .06).

Significant between-subjects effects were observed for both self-regard and self-efficacy, however. Participants' typical level of self-regard after lapses (i.e., their mean self-regard across all lapses) predicted time until next lapse according to a positive linear relationship (b = .20, p = .04), indicating that individuals who, on average, reported more

[4] It was originally proposed that a generalized linear model based upon a survival model would be used. However, because only surveys at which a lapse was reported (vs. all surveys) were of interest to the analyses, it was determined that a GEE in which time between lapses was used as the dependent variable would actually be more appropriate to use.

positive self-regard after lapses went longer between any two particular lapses. For participants with an average (per this sample) typical level of self-regard after lapses (i.e., mean between-subjects self-regard), average time until next lapse was 30.56 hours. Individuals with typical self-regard that was one point lower (i.e., more negative) than the sample average had an average time until next lapse of 21.37 hours, while individuals with typical self-regard one point higher (i.e., more positive) had an average time until next lapse of 32.37 hours. A significant relationship between momentary self-regard and time until next lapse was not observed, indicating that fluctuations in individuals' self-regard across lapses (e.g., reporting feeling more negative about oneself than one normally did after lapsing) was not significantly relate to time until next lapse.

Participants' typical level of self-efficacy across lapses (i.e., their mean self-efficacy across lapses) was also found to significantly predict time until next lapse according to a positive linear relationship (b = .24, p =.01), indicating that individuals who, on average, reported greater self-efficacy across lapses went longer before lapsing again following any particular lapse. For participants with mean (per this sample) typical self-efficacy, average time until next lapse was 28.67 hours. Individuals with typical self-efficacy that was one point lower than the sample mean had an average time until next lapse of 22.45 hours, while individuals with typical self-efficacy one point higher had an average time until next lapse of 36.44 hours. As with self-regard, momentary self-efficacy was not significantly related to time until next lapse.

3.4.5 Self-Criticism, Self-Forgiveness, Self-Efficacy, Self-Regard, and Lapse Frequency

It was hypothesized that individuals' attitudes and self-efficacy after lapses would relate to overall lapse frequency. In particular, it was hypothesized that both self-criticism

and self-regard would correlate with number of lapses according to a quadratic relationship, self-forgiveness would correlate with number of lapses according to a positive linear relationship, and self-efficacy would correlate with number of lapses according to a negative linear relationship.

Separate GEEs based on a negative binomial distribution with a log response function and an AR(1) matrix structure were used to examine the relationships between between-subjects self-criticism, self-forgiveness, self-efficacy, and self-regard and total number of reported lapses. A negative binomial model was chosen given that the dependent variable contained only whole integers equal to or greater than zero (i.e., count data), and because EMA data typically do not satisfy the assumptions of Poisson models (e.g., mean is equivalent to variance), which may also be utilized for count data. Separate analyses were run for each hypothesis using both the untransformed and squared between-subjects variables to determine the nature (i.e., linear versus quadratic) of the relationships between self-criticism and total number of lapses, self-forgiveness and total number of lapses, self-efficacy and total number of lapses, and self-regard and total number of lapses. All between-subjects variables were grand mean centered prior to squaring; within-subjects effects were not included in the model given that momentary observations were not expected to predict overall number of lapses.

Full results of the four GEEs are presented in Table 10. No significant relationships were observed for self-forgiveness and overall number of lapses. However, typical self-efficacy across lapses was found to predict overall number of lapses according to a negative linear relationship (b = -.40, p <.001), indicating that lower self-efficacy across lapses was associated with greater overall number of lapses. For

participants with average (per this sample) typical self-efficacy, the average number of lapses experienced was 8.06. The average number of lapses experienced was 11.85 and 5.30 for participants whose typical self-efficacy was one point lower and higher than the average between-person level of self-efficacy, respectively. Typical self-criticism across lapses also significantly predicted total number of lapses according to a curvilinear relationship (b = -.41, p = .01; see Figure 4). This finding indicates that, for participants with mean typical (i.e., between-person) self-criticism, average number of lapses was 8.53, while both less than and greater than typical self-criticism was associated with fewer lapses. For example, for individuals one point lower and one high higher in typical self-criticism, number of lapses was 5.68 and 5.66, respectively.

The relationship between typical self-regard across lapses and number of lapses approached significance (b = -.23, p = .08).

3.5 Secondary Aims

3.5.1 Lapse Frequency in the First and Second Week

We hypothesized that lapse frequency would be greater in the first versus the second week of data collection due to reactivity to the EMA protocol. A GEE based upon a binomial distribution with a logit link function and an AR(1) matrix structure was used to compare lapse frequency at the momentary level in week one versus week two.[5] Results indicated that the probability of lapsing at the momentary level was not significantly different in the first (*Estimated Marginal Mean [EMM]* = .10, *SE* = .01)

[5] It was originally proposed that a generalized estimating equation with a count response function would be used to examine lapse frequency in week one versus week two. In order to better account for potential differences in compliance across the two weeks, however, the decision was made to compare the probability of lapsing at a given survey in each week instead.

versus second week (*EMM* = .10, *SE* = .01) of data collection, Wald χ^2 (1, *N* = 6301) = .40, *p* = .53, *b* = .07, *SE* = .11, 95% CI [-.15, .29].

3.5.2 Self-Regard and Self-Efficacy at Lapse Versus Non-Lapse Surveys

We hypothesized that self-efficacy would be lower and self-regard more negative at surveys at which a lapse was versus was not reported. Separate GEE models were used for each variable, and the distributions of self-efficacy and self-regard were examined for normality to determine whether to use GEEs based on a linear or gamma distribution.[6] Because the distributions for both variables were skewed, GEEs based on a gamma distribution were used. A GEE based upon a gamma distribution with a log link function and an AR(1) matrix structure revealed that, as hypothesized, self-efficacy was lower at surveys at which a lapse was reported (*EMM* = 3.00, *SE* = .07) versus at surveys at which a lapse was not reported (*EMM* = 2.86, *SE* = .07), Wald χ^2 (1, *N* = 6270) = 27.01, *p* < .001, *b* = .05, *SE* = .01, 95% CI [.03, .07] (Figure 5). A standardized effect size similar to Cohen's *d* was calculated from the estimated marginal means. The observed effect size was .03, indicating a small effect.

A GEE based upon a gamma distribution with a log link function and an AR(1) matrix structure also revealed that, as hypothesized, self-regard was more negative at surveys at which a lapse was reported (*EMM* = 3.15, *SE* = .07) versus at surveys at which a lapse was not reported (*EMM* = 3.36, *SE* = .06), Wald χ^2 (1, *N* = 6277) = 29.89, *p* < .001, *b* = .06, *SE* = .01, 95% CI [.04, .09] (Figure 6). Again, a standardized effect size

[6] Although it was originally proposed that a mixed effects model in which all surveys were coded as a lapse or non-lapse would be used, a GEE was used instead given the non-normal distribution of the self-efficacy and self-regard variables.

was calculated from the estimated marginal means; the observed effect size was .05, indicating that this effect was small in size.

3.6 Exploratory Aims

The hypothesis that the relationships between attitudes, self-efficacy, lapse progression, and total number of lapses would be weaker for individuals with higher psychological flexibility was examined by adding psychological flexibility as a covariate to each GEE based on a gamma distribution for the relationships between attitude, self-efficacy, and lapse progression, and each GEE based on a negative binomial model for the relationships between attitude, self-efficacy, and total number of lapses.

We hypothesized that psychological flexibility (as measured by the AAQ-II at the baseline assessment) would moderate the relationships between time until next lapse and self-criticism, self-forgiveness, self-efficacy, and self-regard, such that increasing flexibility would weaken the observed relationships (i.e., attitude or self-efficacy would be less strongly associated with behavior). AAQ-II scores were thus examined as a moderator in each GEE described in section 3.4.3, although only between-subjects effects for self-criticism, self-forgiveness, self-regard, and self-efficacy were included in each model, as psychological flexibility was measured on a trait rather than momentary level. All variables were grand mean centered prior to creating interaction terms. One participant did not complete the AAQ-II; this individual was not included in analyses. Full results for each GEE are presented in Table 11. No significant interactions between psychological flexibility and self-criticism, self-forgiveness, self-regard, or self-efficacy in predicting time until next lapse were observed.

The influence of psychological flexibility on the relationships between total number of lapses and typical self-criticism, self-forgiveness, self-efficacy, and self-regard across lapse surveys were also examined by adding AAQ-II scores as a moderator to each GEE described in section 3.4.4. Full results for each GEE are presented in Table 12. No significant interactions between AAQ-II scores and typical self-forgiveness or self-regard were observed. However, a significant interaction between psychological flexibility and the linear term of self-criticism was observed (b = .05, p = .01). As shown in Figure 7, these results suggest that for individuals with high flexibility (i.e., low AAQ-II scores), the relationship between typical self-criticism and number of lapses was nearly linear, with greater criticism correlating with fewer lapses. However, as psychological flexibility decreased, this relationship became increasingly curvilinear, such that average levels of criticism (relative to individuals in this sample) were associated with the most lapses, while both higher and lower levels of criticism were associated with fewer lapses.

A significant interaction between psychological flexibility and typical self-efficacy was also observed (b = -.03, p = .03). As displayed in Figure 8, this indicates that the strength of the negative linear relationship between self-efficacy and number of lapses was moderated by an individual's level of psychological flexibility, such that this relationship became stronger as psychological flexibility decreased and was attenuated as psychological flexibility increased.

3.7 Post-Hoc Analyses

Several post-hoc analyses were performed to further understand the relationships among lapses, the response variables of interest, and lapse behavior.

3.7.1 Lapse Frequency and Concurrent Weight Loss

First, in order to assess participants' ability to meaningfully report on dietary lapse episodes, the correlation between number of reported lapses and percent weight loss over the EMA assessment period was examined. It was hypothesized that the number of reported lapses would negatively correlate with percent weight loss. In an effort to control for differences in compliance to the EMA reporting protocol, a partial correlation was run controlling for number of at least partially completed EMA surveys.

Two participants were missing weights for the end of the EMA period; these individuals were not included in analyses. The number of reported lapses variable was significantly positively skewed and the number of surveys variable was significantly negatively skewed, so data transformations were attempted. A square root transformation best approximated normality for both variables. Partial correlation revealed that, when controlling for number of surveys, there was a small to medium negative correlation between number of reported lapses and percent weight loss, $r(86) = -.23$, $p = .04$.

3.7.2 Predicting Occurrence of Subsequent Lapses on the Same Day

Primary analyses indicated that individuals' typical self-criticism and self-efficacy across lapses predicted overall number of lapses. As it is possible that individuals' momentary or typical responses to lapses are also associated with risk of lapsing again in the near future (e.g., on the same day), analyses were run to determine if momentary and typical self-criticism, self-forgiveness, self-efficacy, or self-regard at a particular lapse predicted whether or not the next reported lapse occurred on the same day.[7] As originally

[7] So that surveys completed in the early hours of the morning would be considered with surveys from the previous day, a "day" was considered to span from 4 a.m. on one calendar day to 4 a.m. on the following calendar day.

hypothesized for total number of lapses, it was expected that self-criticism and self-regard would predict same day lapse occurrence according to a quadratic relationship (with both higher and lower values of each predicting lapse occurrence), self-forgiveness would predict lapse occurrence according to a positive linear relationship, and self-efficacy would predict lapse occurrence according to a negative linear relationship.

Separate GEEs based on a negative binomial distribution with a logit link function and an AR(1) matrix structure were used to examine whether momentary or typical self-criticism, self-forgiveness, self-efficacy, and self-regard predicted whether the next lapse would occur on the same day. Both the untransformed and squared terms of both the within and between variables were included in each model to determine the nature (linear vs. quadratic) of the relationships. Between-person variables were grand mean centered prior to squaring, and within-person variables were centered within person prior to squaring. Whether or not the next lapse occurred on the same day was coded such that "0" indicated the lapse did not occur on the same day, while "1" indicated that it did occur on the same day.

With regard to how frequently multiple lapses occurred on the same day, fifty-one participants (56.04%) had at least one day on which they experienced more than one lapse, and 300 (47.92%) of the 626 total reported lapses occurred on the same day as another lapse. The maximum number of lapses reported in a single day was 6. Results of the GEEs are displayed in Table 13. Self-forgiveness and self-efficacy did not significantly predict lapse occurrence on the same day. However, momentary self-criticism significantly predicted lapse occurrence such that lower self-criticism (relative to one's typical level after lapses) was associated with increased likelihood of the next

lapse occurring on the same day (Figure 9). In addition, the squared term for typical self-regard after lapses significantly predicted lapse occurrence on the same day, indicating that both higher and lower typical (i.e., between-subjects) self-regard after lapses was associated with increased likelihood of the next lapse occurring on the same day (Figure 10).

3.7.3 Lapse Progression Among Lapses Occurring on the Same or the Following Day

Primary analyses revealed that participants' typical self-regard and self-efficacy predicted how long participants went after a given lapse before lapsing again when these relationships were examined across all days. As it is possible that participants' self-attitudes after a lapse influence lapse progression for a certain amount of time but the strength of such an effect dissipates across time, the relations between responses to lapses and the time until a following lapse were also examined: a) for lapses that occurred on the same day as another lapse (versus across numerous days), and b) for lapses that occurred on the same as or the day following another lapse. As in prior analyses, we defined a "day" as spanning from 4 a.m. on one calendar day to 4 a.m. on the following calendar day.

Separate GEEs based on a gamma distribution with a log response function and an AR(1) matrix structure were used to examine the relationships between typical and momentary self-criticism, self-forgiveness, self-efficacy, and self-regard at a given lapse and time (in hours) until next lapse, for lapses that occurred on the same day as another lapse. Similar models were also run to predict time until next lapse for lapses that occurred on the same as or the day following another lapse. Both the untransformed and squared terms of both the within and between subjects effects were included in each

model to determine the nature (linear vs. quadratic) of the relationships. All between subject variables were grand mean centered prior to squaring, and momentary variables were centered within person prior to squaring.

When considering only lapses that occurred on the same day, the amount of time between lapses ranged from .42 to 11.42 hours (M = 4.50, SD = 2.72). Results from the four GEE models for lapses occurring on the same day are presented in Table 14. Momentary self-criticism significantly predicted time until next lapse according to a positive linear relationship (b = .25, p =.04), indicating that greater criticism predicted greater time until next lapse. Momentary self-forgiveness predicted time until next lapse according to a negative linear relationship (b = -.30 p = .02), indicating that less forgiveness was associated with greater time until next lapse. There was both a significant within- and between-subject effect for self-regard. In particular, typical self-regard after lapses predicted time until next lapse according to a positive linear relationship (b = .19, p = .05), indicating that more positive typical self-regard after lapses was associated with longer time until next lapse. On the momentary level, however, self-regard predicted time until next lapse according to a negative linear relationship (b = -.44, p < .001), indicating that more negative than normal self-regard at a given lapse predicted longer time until next lapse, among lapses that occurred on the same day. Finally, typical self-efficacy predicted time until next lapse according to a positive linear relationship (b = .22, p = .05), indicating that greater typical self-efficacy across lapses was associated with longer time until next lapse, among lapses that occurred on the same day.

With regard to lapses that occurred on either the same day as or the day following another lapse, sixty-four participants (70.33%) reported experiencing at least one lapse that occurred on the same day as or on the day following another lapse, and 524 (83.71%) of the 626 total reported lapses occurred on the same day as or on the day following another lapse. The amount of time between lapses that occurred on the same or the following day as another lapse ranged from .42 to 40.61 hours (M = 14.53, SD = 9.60). Results from the four GEE models are presented in Table 15. A pattern of results similar to that obtained when examining relationships among only lapses that occurred on the same day was observed; however, momentary self-criticism was no longer a significant predictor of time until next lapse. Additionally, the relationships between typical self-efficacy and typical self-regard and time until next lapse approached significance.

Given the smaller sample size available for examining the relationships among self-attitudes after lapses and lapse progression only among lapses that occurred on the same day as or on the day following another lapse, the moderating effect of psychological flexibility on these relationships was not examined.

Chapter 4: Discussion

The current study sought to assess the frequency with which overweight and obese individuals receiving behavioral weight loss treatment experienced dietary lapses during the early weeks of treatment. The study also sought to characterize individuals' their self-efficacy and attitudes toward themselves—namely, their self-forgiveness, self-criticism, and self-regard—after lapses, and to examine the influence of these responses on future lapse behavior (i.e., total number of lapses, lapse progression).

4.1 Main Findings

4.1.1 Lapse Frequency and Validity of Lapse Reports

Overall, results suggest that the majority of overweight and obese adults participating in a behavioral weight loss program experience at least one dietary lapse during the early weeks of treatment, and many individuals experience several lapses. In the present study, approximately 89% of participants reported at least one lapse over a two-week period, with the mean number of lapses experienced during that period being approximately seven. Participant characteristics (e.g., age) and program intensity (e.g., self-guided dieters versus formal weight loss program) have varied across past EMA studies of dietary lapses, limiting the ability to make meaningful comparisons. However, the lapse frequency observed in this study is similar to that observed in one prior EMA investigation of dietary lapses (Carels et al., 2004), and slightly lower than that observed in several others studies (Carels et al., 2001; McKee, Ntoumanis, & Taylor, 2014). As likelihood of lapsing at a given EMA survey did not differ across the two assessment weeks, reactivity to the EMA protocol appeared to have been minimal. The finding that the majority of lapses were reported at semi-randomly prompted surveys (i.e., signal-

contingent surveys) suggests that participants may have often waited until the next prompted survey to report a dietary lapse, rather than initiating a survey immediately after a lapse occurred. This findings raises the possibility that retrospective biases or simple forgetting may have influenced participants' responses about their cognitive-affective response to lapses in some cases, although the more immediate assessment made possible by EMA still provides improvement over even more delayed retrospective reports.

Notably, controlling for number of EMA surveys at least partially completed, there was a negative relationship between number of reported lapses and percent weight lost over the EMA period. This finding suggests that participants were able to meaningfully report on lapses, as more frequent dietary violations (e.g., eating more than planned) would be expected to negatively influence weight loss success. Although the strength of the relationship between lapse frequency and weight loss was rather weak, lapse severity (i.e., caloric intake during dietary lapses) was not assessed. As lapse severity may vary widely across lapse episodes, and one prior study found that less than 2% of dietary lapses were objectively large in size (Latner, McLeod, O'Brien, & Johnston, 2013), the limited strength of the relationship may be due to variability in lapse severity. Alternatively, the modest correlation between lapse frequency and percent weight loss may indicate that individuals experienced difficulty recognizing and/or reporting on all lapses experienced. Because the present study occurred at the beginning of weight loss treatment when participants were just learning what their dietary goals were and how to assess intake in relation to these goals, some participants may have been

uncertain of whether certain eating episodes qualified as lapses. This difficulty may have resulted in overeating episodes and other lapses going unreported.

Another alternative explanation for the modest relationship between lapse frequency and weight loss concerns compensatory behaviors. Participants may have adjusted their subsequent calorie intake and/or increased their activity level in response to a dietary lapse. Such adjustments to participants' energy balance would presumably reduce the impact of lapses on weight change. Future research may benefit from assessing lapse severity, ability to recognize lapses (e.g., with case examples), and efforts to "make up" for lapses by adjusting subsequent food intake or adjusting activity to further elucidate the relationships among lapse frequency and weight change.

4.1.2 Characterization of Attitudes Toward the Self, Self-Efficacy, and Lapse Attributions

In general, participants reported feeling small amounts of self-criticism after lapses, moderate levels of self-forgiveness (i.e., between "slightly" and "mostly" forgiving), moderate amounts of self-efficacy (i.e., between "slightly" and "very" confident), and having a somewhat positive opinion of themselves. In addition, self-efficacy was found to be lower and self-regard more negative at surveys where a lapse was reported (compared to surveys where no lapse was reported). Previous work has not examined self-criticism and self-forgiveness after dietary lapses. However, the findings that participants experienced moderate levels of self-efficacy after lapses and that self-efficacy was lower after lapses are consistent with previous research (Carels et al., 2004; Carels, 2001). Although research has not examined self-regard using the same assessment item used in this study, the finding that self-regard was more negative at surveys where a lapse was reported is also consistent with other work demonstrating that individuals tend

to report more negative self-relevant cognitions (e.g., feeling like a failure) after lapses (Carels et al., 2001; Carels et al., 2004). Additionally, consistent with previous studies suggesting that individuals typically feel a high degree of responsibility for lapses (Carels et al., 2004), participants attributed most lapses primarily to themselves (versus to other people or circumstances).

Although there was some variability in the amount of self-criticism and self-forgiveness participants experienced after a lapse, many participants had little or no variation in their levels of these variables. The same was true for self-regard and self-efficacy across all EMA surveys. These findings suggest that most individuals have characteristic manners of responding to dietary lapses, as well as relatively stable levels of self-efficacy and self-regard, at least across a short period of time (i.e., 2 weeks). Although this finding may initially appear to suggest that EMA is not needed to assess cognitive-affective responses to lapses and that measurement of typical responses to lapses or trait response styles administered at a single time point would be sufficient to understand participants' responses to lapses, results also indicated that deviations from one's typical response do occur and can have implications for future lapse behavior. Thus, although variability in cognitive-affective responses was quite limited, momentary assessment of responses appears beneficial for understanding the implications of fluctuations in cognitive-affective responses on behavior. Compared to self-attitudes and self-efficacy, greater variation in responses was observed for individuals' attributions for lapses, suggesting that individuals' perceptions of the causes of dietary in-adherence are related to the particular circumstances in which the lapse occurred.

4.1.3 Self-Attitudes, Self-Efficacy, and Lapse Occurrence

Consistent with prior research highlighting the role of self-efficacy in weight control (Latner et al., 2013; Linde, Rothman, Baldwin, & Jeffery, 2006; Palmeira et al., 2007; Warziski, Sereika, Styn, Music, & Burke, 2008), greater typical self-efficacy across lapses was associated with fewer lapses. Interestingly, both more negative and more positive typical self-regard (vs. more neutral self-regard) across lapses predicted an increased likelihood of lapsing again on the same day once a lapse had occurred. Having a highly positive opinion of the self may place one at greater risk of lapsing once a lapse has occurred because it reflects that one has not experienced the negative affect necessary to self-regulate behavior in line with one's goals (Carver & Scheier, 1998, 2011); that is, it may suggest that one has not internalized and learned from one's "slip." At the same time, however, having a highly negative opinion of the self may also place an individual at greater risk of lapsing because one may feel discouraged or helpless, and hence also be unable to regulate behavior in line with one's goals.

The finding that both low and high typical levels of self-criticism were associated with fewer overall lapses was not hypothesized, but may reflect differences in the types of self-criticism that individuals were reporting on when responding to the item assessing self-criticism. Gilbert and colleagues (2004) have suggested that there is a type of self-criticism that is meant to self-correct, and another that is meant to punish the self. Differences in participants' conceptualizations of self-criticism and the type of self-criticism they were thus reporting on may explain the curvilinear relationship observed; for example, both low levels of "punishing" self-criticism and high levels of "self-correcting" self-criticism may have been associated with few lapses.

Controlling for self-criticism experienced across lapses, when individuals experienced less self-criticism than what was typical for them after a given lapse, they were at increased risk of lapsing again on that same day. Consistent with theoretical conceptions of the potentially beneficial functions of self-criticism (Driscoll, 1989; Gilbert et al., 2004; Gilbert & Irons, 2005), this finding may indicate that when individuals experience lower than normal self-criticism, they do not perform the self-corrections necessary to avoid violating their dietary goals in the future (e.g., assess how lapsing conflicts with weight loss goals), and thus are more susceptible to experiencing another lapse.

Self-forgiveness was not strongly related to lapse frequency and was not a strong predictor of lapses occurring on the same day. This general lack of findings for a relationship between self-forgiveness and lapse occurrence may indicate that an individuals' amount of self-forgiveness for a lapse is simply not strongly related to future lapse behavior. Alternatively, assessment of self-forgiveness in the present study may have been confounded by not assessing the degree to which participants viewed dietary lapses as mistakes or wrongdoings. The act of self-forgiveness is only possible when an individual perceives that he or she has done something wrong and accepts responsibility for this wrongdoing (Hall & Fincham, 2005; Wenzel, et al., 2012). As participants may not have always viewed their lapse as a mistake or wrongdoing (for example, instead viewing it as an expected event or even a satisfactory choice) but were forced to respond to the question assessing self-forgiveness to complete the EMA survey, responses may not have always been meaningful or tapped into the intended construct.

4.1.4 Self-Attitudes, Self-Efficacy, and Lapse Progression

When examined across all lapses, only individuals' typical self-regard and self-efficacy predicted time until next lapse, with more positive self-regard and greater self-efficacy predicting longer time until next lapse. To our knowledge, no studies have previously examined these variables in relation to lapse progression. However, the finding that greater self-efficacy predicts longer time until next lapse is consistent with previous research suggesting that greater self-efficacy is associated with better weight loss outcomes (Latner et al., 2013; Linde et al., 2006; Palmeira et al., 2007; Warziski et al., 2008). The finding that individuals with more positive self-regard after lapses tended to go longer before lapsing again is also consistent with a self-compassion or AVE theory framework, both of which would seem to suggest that maintaining a positive view of the self after lapses would delay additional lapses (Adams & Leary, 2007; Curry et al., 1987; Marlatt & Gordon, 1985).

Interestingly, when the relationships between self-attitudes, self-efficacy, and lapse progression were examined only among lapses that occurred near in time (e.g., on the same day), a somewhat different picture of the factors associated with longer delay until a subsequent lapse appeared. Although having greater typical self-efficacy and more positive typical self-regard across lapses remained predictive of longer time until next lapse, being less forgiving, more critical, and having a more negative view of one's self than was typical for individuals also appeared to be adaptive in delaying a subsequent lapse. Consistent with prior theoretical and empirical work suggesting that self-forgiveness for an ongoing maladaptive behavior may hinder behavior change (Wohl & Thompson, 2011; Squires et al., 2011), while self-criticism and negative affect may assist

in self-correction (e.g., Driscoll, 1989; Gilbert et al., 2004; Carver & Scheier, 1997, 2011), these findings suggest that having a more "negative" reaction to a particular lapse may actually be beneficial for delaying further lapses. As the beneficial effects of a more negative in-the-moment response were only observed among lapses occurring on the same or the next day as another lapse, however, and having more positive overall self-regard and greater self-efficacy across lapses also predicted longer time until next lapse, additional research is needed to clarify when and to what extent having a more "negative" response may actually be helpful for preventing dietary lapses.

4.1.5 The Role of Psychological Flexibility

Psychological flexibility did not appear to influence most of the relationships between self-attitudes, self-efficacy, and future lapse behavior. However, psychological flexibility moderated the relationship between self-efficacy and number of lapses, such that the strength of the negative linear relationship between self-efficacy and number of lapses was attenuated as flexibility increased. This suggests that beliefs about one's ability to be successful with weight control were less influential on behavior (i.e., lapses) among individuals with greater flexibility, as would be expected based on the theoretical conception of psychological flexibility (e.g., Biglan et al., 2008).

Psychological flexibility also moderated the relationship between typical self-criticism and number of lapses, such that the aforementioned curvilinear relationship between self-criticism and number of lapses was even more robust among individuals with lower flexibility, and nearly linear among individuals with higher flexibility. It is unclear why increasing self-criticism would predict fewer lapses according to a nearly linear relationship among individuals with high psychological flexibility, while the nature

of this relationship would become more curvilinear with decreasing flexibility. Additional research is needed to clarify the relationship between typical self-criticism, lapse frequency, and psychological flexibility.

4.2 Strengths and Limitations

This study had several strengths. Use of EMA to examine responses to lapses and lapse behavior overcomes many of the limitations of retrospective self-reports, such as recall of past events being influenced by current affective state or systematic cognitive biases. The use of an event- and signal-contingent EMA protocol helped to ensure that events of interest (i.e., lapses) were not missed, while also allowing for random sampling of variables of interest (e.g., self-efficacy). Use of a sample of overweight and obese individuals receiving behavioral weight loss treatment to examine lapse behavior was also a strength, as individuals had concrete dietary and weight loss goals toward which they were working. Additionally, improved understanding of factors that promote re-adherence after lapses holds great potential for improving program outcomes, which is critical given the high rates of weight regain observed among participants who have undergone behavioral weight loss treatment. In addition, this was the first study to examine self-attitudes after lapses, and to examine the potential influence of psychological flexibility on the relationships between cognitive-affective responses to lapses and lapse behavior. This was also among the first studies to examine the relationship between weight loss and lapse frequency, as assessed by EMA.

In addition to these strengths, several limitations should be noted. First, due to the largely exploratory nature of the present study, steps were not taken to control for experiment-wise error rate. Thus, results should be interpreted with caution, and

replication is needed. Second, although EMA overcomes many limitations of retrospective self-report measurement, EMA is still a self-report form of assessment and is thus subject to certain limitations and potential threats to validity. For example, in the present study, reports of lapse occurrence were dependent on participants' ability to understand and recognize lapses, and characterization of their responses to lapses was dependent on their understanding of the constructs being assessed, based on the item wording. Third, the survey items that were used to assess self-criticism, self-forgiveness, self-regard, self-efficacy, and lapse attribution were developed for the purpose of this study and psychometric properties of these items are therefore unknown. In addition, due to the need for brevity in EMA surveys, each construct of interest was assessed with only a single, brief item. This may have limited our ability to assess more complex dimensions of each construct (e.g., type of self-criticism, facets of self-compassion or self-regard), and may have allowed for ambiguity in participants' interpretations of the items. There was also limited variability in individuals' responses to several of these items. While it is possible that individuals, in fact, do not vary widely in their self-forgiveness, self-criticism, self-regard, and self-efficacy across lapses, it is also possible that the 4-point scale used to assess each of these constructs had poor sensitivity to detect small fluctuations in individuals' responses. Poor sensitivity of the measures may have limited our ability to detect important relationships between constructs of interest and lapse outcomes (e.g., time until next lapse).

Numerous variables that may be important for understanding individuals' cognitive-affective and behavioral responses to lapses (e.g., coping response, mood, lapse size) also were not assessed. Although the cognitive-affective constructs examined in the

present study appear relevant to understanding lapse behavior—particularly when lapses occur near in time—a richer understanding of the types of responses to lapses that best promote re-adherence to dietary goals, and under what conditions, may be enriched by examining a wider range of variables.

Additionally, the present study examined lapse behavior among a sample of primarily middle-aged women participating in an intensive weight loss treatment in the early weeks of treatment. It is thus unclear how the present findings generalize to other populations (e.g., younger individuals), weight control efforts over time (e.g., later on in weight loss or in weight maintenance), and weight loss efforts in other contexts (e.g., self-guided dieting). For example, it is possible that participants' typical self-efficacy was greater than would be observed at other points in time given that participants had just begun a formal weight loss program, which is when motivation would be expected to be highest and levels of discouragement with weight control efforts low (e.g., due to limited recent experience with failures meeting goals). Average levels of self-criticism, self-forgiveness, and self-regard may have similarly been affected by the fact that participants were reporting on their responses very early on in behavioral weight loss treatment. Finally, although the technical difficulties experienced with the EMA devices are not believed to have significantly the results due to the steps taken to maximize data integrity and the use of self-reported (vs. automatically generated) timestamps for placing lapses in time, some caution should be taken when interpreting the findings of the present study due to the issues experienced.

4.3 Implications and Future Directions

The findings of the present study have several implications for behavioral weight loss treatment. The findings that most individuals experience at least one dietary lapse during the early weeks of treatment and that more frequent lapses are associated with less weight loss suggest that it may be beneficial to explicitly discuss and plan for dietary lapses with individuals in the early weeks of treatment. For example, clinicians may wish to acknowledge that lapses may occur, but also educate patients on the detrimental effects lapses can have on weight loss progress, and encourage patients to take lapses seriously. Earlier provision of skills for preventing lapses may also be beneficial.

With regard to how patients should be encouraged to respond to lapses when they do occur, the current findings provide somewhat mixed evidence on the most adaptive response. However, it appears that working to build patients' overall sense of self-efficacy and improve their self-regard may be helpful on a larger scale, while allowing participants to experience a more "negative" momentary response to lapses (versus immediately intervening to reduce negative affect or prevent individuals from taking a more disapproving perspective on their lapse) may be beneficial for facilitating self-corrective action. As most of the results suggesting that having a more negative attitude toward the self may be beneficial for delaying subsequent lapses were observed only among lapses occurring near in time (e.g., on the same day), additional research is needed to determine for what period of time self-attitudes after lapses most strongly impact future lapse behavior. Additional research is also needed to clarify whether encouraging individuals to be less forgiving and to feel more negatively about themselves temporarily after a lapse can delay subsequent lapses, or whether this need occur organically to confer

benefit. However, with replication, these results suggest that there could be benefit to encouraging participants to take lapses quite seriously and to allow themselves to experience some negative affect for lapsing, in order to reduce risk of or delay subsequent lapses.

There are several directions for future research. First, although the observed relation between lapse frequency and concurrent weight loss suggests lapse reports were meaningful, this relationship was modest in strength. Future research should thus examine how other factors such as lapse size (i.e., number of calories), frequency of known missed lapse reports, compensatory behaviors (e.g., reducing subsequent dietary intake), and the personal threshold individuals used for identifying a given eating/drinking event as a lapse may moderate the relationship between lapse frequency and weight loss. As in previous studies, for example, it may be useful to ask participants about the consistency of their lapse reports after the assessment period (e.g. McKee et al., 2014) to control for unreported lapses. It may also be useful to assess the threshold individuals used for identifying lapses with vignettes.

Future research should also address the aforementioned measurement limitations by developing and employing psychometrically valid, multi-item measures of self-criticism, self-forgiveness, self-efficacy, and self-regard, and by providing response scales with a wider range. For example, rather than merely asking about amount of self-criticism experienced, items could also differentiate the type (e.g., self-punishing vs. self-corrective) of self-criticism experienced. Additional dimensions of self-forgiveness and self-regard could also be assessed to enhance understanding of participants' responses. Similarly, it would be beneficial to assess the degree to which individuals view each

lapse as a mistake or wrongdoing, as the effect of cognitive-affective responses (e.g., self-criticism, self-forgiving) on future lapse behavior may be dependent on whether participants in fact view lapses as a mistake versus a normative occurrence.

Although attributions for lapses were measured in the present study, the moderating role of attributions in predicting lapse outcomes was not examined. As the degree to which an individual accepts responsibility for an event is posited to be important for differentiating between "pseudo" and genuine self-forgiveness (Wenzel et al., 2012), and may also influence the effect of other cognitive-affective responses on future behavior, potential interactions among attribution and the constructs examined in the present study should be investigated. It may also be important to examine whether the present findings differ when controlling for the time difference between when a given lapse occurred (as determined by participant self-report) and when the survey about the lapse was completed (as determined by the survey stamp time), as, for example, reporting being very critical about a lapse that occurred several hours ago may reflect a very different response to the lapse than reporting being very critical just moments after the lapse has occurred.

The present study examined how cognitive-affective responses to lapses predicted future lapse occurrence, but did not assess individuals' more immediate behavioral responses (e.g., coping response). In future work, coping response should be assessed to determine if certain cognitive-affective responses (e.g., more self-corrective self-criticism) are associated with more adaptive coping, as well as to further explain some of the present findings (e.g., why more negative in-the-moment responses delayed lapses on days when multiple lapses occurred). Given these identified improvements, future

research should also examine how the relations between cognitive-affective responses to lapses and future dietary behavior may differ in other contexts (e.g., weight maintenance) and other populations.

Finally, it is unclear from the present study whether similar relationships between cognitive-affective response to lapses and lapse behavior would be observed if participants were encouraged to respond to lapses in a particular way, compared to when certain types of responses occurred organically. For example, it is possible that having a more "negative" in-the-moment response delays further lapses when one naturally responds to a lapse in this manner, but that having an outside individual (e.g., weight loss counselor) tell one to respond in this way would not confer benefit, and may even quicken lapse progression (e.g., due to feeling dejected). Future research should thus attempt to experimentally manipulate cognitive-affective responses to clarify whether inducing a certain cognitive-affective response is possible, and, if so, whether similar findings are obtained.

4.4 Conclusion

The findings of the present study indicate that majority of adults participating in behavioral weight loss treatment experience dietary lapses in the early weeks of treatment, and that greater frequency of lapses is associated with lesser weight loss. Individuals generally feel minimally self-critical and moderately self-forgiving after lapsing. Although individuals also tend to report moderate amounts of self-efficacy and a relatively positive view of themselves after lapses, their self-efficacy is lower and their self-regard more negative after lapses compared to times when they have not recently lapsed. Overall greater self-efficacy and a more positive opinion of the self after lapses

were associated with fewer lapses and longer time between lapses. This suggests that individuals who tend to feel more confident in their weight control and feel more positively about themselves are more adherent to their dietary goals.

When the relationships between cognitive-affective response to lapses and time until next lapse were examined among lapses that occurred near in time, which is when one would expect the potential influence of responses to be greatest, greater overall self-efficacy and a more positive opinion of the self remained predictive of better outcomes, although a more negative (i.e., less forgiving, more critical, more negative opinion of the self) in-the-moment response to a lapse also appeared to be adaptive. This finding runs counter to the traditional approach to responding to lapses and relapse prevention taught in behavioral weight loss programs, but raises the possibility that a more critical response to lapses may be beneficial, perhaps by facilitating self-corrective behavior. Additional research is needed to clarify for what reason a more "negative" momentary response may delay further lapses while an overall more "positive" response is adaptive.

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APPENDIX A: Tables and Figures

Table 1. *Sample characteristics for the full sample and for the subsample included in EMA analyses*

	Full sample (n = 100)	Sample used in EMA analyses (n = 91)[1]
Age (years)	M = 52.07, SD = 9.02	M = 52.09, SD = 8.88
BMI (kg/m^2)[2]	M = 37.51, SD = 5.88	M = 37.21, SD = 5.79
Number of Women (% Women)	79 (79.00%)	72 (79.1%)
Race (%)		
Caucasian/White	70 (70.00%)	64 (70.33%)
African American/Black	24 (24.00%)	22 (24.18%)
Asian	1 (1.00%)	1 (1.10%)
More than one race	5 (5.00%)	4 (4.40%)
Ethnicity (%)		
Not Hispanic/Latino	96 (96.00%)	87 (95.60%)
Hispanic/Latino	4 (4.00%)	4 (4.40%)

[1] Includes participants with ≥50% compliance.
[2] Baseline height and weight data was missing for one participant. Weight at first week of treatment and height at mid-treatment assessment were used to calculate starting BMI for this individual.

Table 2. *Summary of study findings*

Research Question(s)	Results
How do participants respond to lapses in terms of their self-criticism, self-forgiveness, self-regard, and self-efficacy? To what extent to participants attribute lapses to themselves vs. other people or circumstances? *(Primary Aim 1)*	Among participants who had at least one lapse (n = 81), the average participant reported feeling slightly self-critical, slightly-to-mostly forgiving, slightly-to-very confident, and having a somewhat positive opinion of themselves. Lapses were attributed largely to participants' own selves.
To what extent do participants' responses vary across lapses? *(Primary Aim 1)*	Although some variability was observed in participants' responses, many participants had a small range in responses across lapses.
Is self-efficacy lower and self-regard more negative after lapses compared to times when a lapse did not recently occur? *(Secondary Aim 2)*	Self-efficacy was lower and self-regard more negative at surveys where a lapse was reported. The size of the effects of lapse occurrence on self-efficacy and self-regard was small.
How many participants have at least one dietary lapse? On average, how often do people lapse? *(Primary Aim 2)*	89.01% (81/91) participants reported at least one lapse. Mean lapse frequency was 6.88 (7.27 when prorated to 14-day average)
Does the likelihood of lapsing at any given EMA survey differ between assessment weeks (first vs. second)? *(Secondary Aim 1)*	The risk of lapsing in week 1 versus week 2 of EMA was not significantly different.
Is lapse frequency related to concurrent weight loss?	Controlling for number of partially completed surveys, there was small to moderate sized relationship between lapse frequency and percent weight loss.
Do participants' typical (i.e., average across lapses) levels of self-criticism, self-forgiveness, self-efficacy, or self-regard predict total number of lapses experienced? *(Primary Aim 4)*	• Self-criticism predicted according to a curvilinear relationship • Self-efficacy predicted according to a negative linear relationship

Table 2 (continued)

Research Question(s)	Results
Do participants' typical (i.e., average across lapses) or momentary (i.e., response at that moment) levels of self-criticism, self-forgiveness, self-efficacy, or self-regard predict time until next lapse across all lapses? (*Primary Aim 3)* Among lapses that occur on the same day as another lapse, or on the same day or the day following another lapse? *(Post-hoc)*	Across all lapses: • Typical self-regard predicted according to a positive linear relationship • Typical self-efficacy predicted according to a positive linear relationship Among lapses on the same day (*also observed for lapses on the same day or the day following): • Momentary self-criticism predicted according to positive linear relationship • Momentary self-forgiveness predicted according to a negative linear relationship* • Momentary self-regard predicted according to a negative linear relationship*, while typical self-regard predicted according to a positive linear relationship* • Typical self-efficacy predicted according to a positive linear relationship
Do participants' typical or momentary levels of self-criticism, self-forgiveness, self-efficacy, or self-regard predict whether, once one lapse has occurred, the next lapse will occur on the same or a different day? *(Post-hoc)*	• Momentary self-criticism predicted according to a negative linear relationship • Typical self-regard predicted according to a curvilinear relationship
Does psychological flexibility moderate the relationships between typical self-criticism, self-forgiveness, self-efficacy, or self-regard and time until next lapse, across all lapses? *(Exploratory Aim)*	No significant interactions were observed.
Does psychological flexibility moderate the relationships between typical self-criticism, self-forgiveness, self-efficacy, or self-regard and number of lapses reported? *(Exploratory Aim)*	• Psychological flexibility interacts with the linear self-criticism term • Psychological flexibility interacts with the linear self-efficacy term

Table 3. *Frequency of reported responses after lapses across all participants and reported lapses*

	Percent of Responses (*n*)
Self-criticism	
1 *(Not at all critical)*	19.5% (122)
2 *(Slightly critical)*	61.2% (383)
3 *(Very critical)*	14.5% (91)
4 *(Highly critical)*	3.2% (20)
Self-forgiveness	
1 *(Not at all forgiving)*	4.5% (28)
2 *(Slightly forgiving)*	35.5% (222)
3 *(Mostly forgiving)*	32.7% (205)
4 *(Completely forgiving)*	25.6% (160)
Self-efficacy	
1 *(Not at all confident)*	3.0% (19)
2 *(Slightly confident)*	40.7% (255)
3 *(Very confident)*	42.8% (268)
4 *(Extremely confident)*	11.3% (71)
Self-regard	
1 *(I have a very negative opinion of myself)*	2.7% (17)
2 *(I have a somewhat negative opinion of myself)*	24.1% (151)
3 *(I have a somewhat positive opinion of myself)*	42.8% (268)
4 *(I have a very positive opinion of myself)*	28.4% (178)
Attribution	
1 *(Totally due to myself)*	66.9% (419)
2 *(Mostly due to myself)*	11.0% (69)
3 *(Slightly due to myself)*	2.9% (18)
4 *(Slightly due to other people/circumstances)*	12.5% (78)
5 *(Mostly due to other people/circumstances)*	4.0% (25)
6 *(Totally due to other people/circumstances)*	.8% (5)

Note: The following number of responses were missing for each variable due to incomplete surveys: self-criticism = 10, self-forgiveness = 11, self-regard = 12, self-efficacy = 13, attribution = 12.

Table 4. *Between-person variability in self-forgiveness, self-criticism, and internality-externality of lapse attribution at surveys at which a lapse was reported for participants who reported two or more lapses*

	Mean		Standard Deviation		MSSD		Range	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Self-criticism	2.00	1.00 – 3.18	.44	0 – 1.07	.48	0 – 2.10	1.10	0 – 3.00
Self-forgiveness	2.85	1.50 – 4.00	.47	0 – 1.41	.57	0 – 4.00	1.12	0 – 3.00
Internality-externality	1.73	1.00 – 3.83	.90	0 – 2.52	2.58	0 – 13.98	2.20	0 – 5.00

Table 5. *Frequency of response range for self-criticism, self-forgiveness, and internality-externality of attribution at surveys where a lapse was reported for participants who reported two or more lapses*

Range	Self-criticism	Self-forgiveness	Attribution
0	16 (22.5%)	15 (21.1%)	20 (28.2%)
1	37 (52.1%)	32 (45.1%)	10 (14.1%)
2	13 (18.3%)	19 (26.8%)	4 (5.6%)
3	5 (7.0%)	5 (7.0%)	15 (21.1%)
4	--	--	17 (23.9%)
5	--	--	5 (7.0%)

Note: Maximum range was 3 for self-criticism and self-forgiveness, and 5 for attribution.

Table 6. *Between-person variability for self-efficacy and self-regard across all surveys*

	Mean		Standard Deviation		MSSD		Range	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Self-efficacy	2.98	1.48 – 4.00	.14	0 – .50	.14	0 – .81	.30	0 – 1.07
Self-regard	3.33	1.60 – 4.00	.15	0 – .64	.16	0 – .96	.32	0 – 1.36

Note: Values were first calculated on the daily level, and then indices of variability across days were computed.

Table 7. *Frequency of response range for self-efficacy and self-regard across all surveys for all participants who completed EMA*

Range	Self-efficacy	Self-regard
0	13 (14.3%)	18 (19.8%)
1	42 (46.2%)	37 (40.7%)
2	27 (29.7%)	28 (30.8%)
3	9 (9.9%)	8 (8.8%)

Note: Maximum range was 3 for both variables.

Table 8. *Frequency for raw number of reported lapses and for fourteen-day lapse totals*

Number of Lapses	Frequency, Raw Number of Lapses	Frequency, 14-day Lapse Total[1]
0	10	10
1	8	6
2	6	6
3	8	7
4	6	6
5	3	4
6	5	5
7	12	9
8	2	5
9	4	2
10	7	8
11	6	8
12	1	1
13	4	3
14	1	2
15	0	0
16	0	1
17	3	1
18	0	3
19	2	1
20	0	0
21	1	0
22	0	0
23	0	1
24	1	1
25	0	0
26	0	0
27	0	0
28	0	0
29	1	1

[1] Values were rounded to the nearest integer prior to calculating frequencies.

Table 9. *Relationships between self-criticism, self-forgiveness, self-efficacy, and self-regard after a lapse and time until next lapse (in hours)*

	B	SE	95% CI	Wald χ^2	*p*
Self-criticism					
Between-subject effect					
Untransformed	-.14	.12	[-.38, .10]	1.29	.26
Squared	-.07	.14	[-.34, .19]	.29	.59
Within-subject effect					
Untransformed	.11	.10	[-.08, .30]	1.37	.24
Squared	.16	.09	[-.01, .33]	3.56	.06
Self-forgiveness					
Between-subject effect					
Untransformed	.03	.11	[-.18, .25]	.08	.78
Squared	.04	.11	[-.18, .26]	.12	.73
Within-subject effects					
Untransformed	-.08	.08	[-.23, .07]	1.01	.32
Squared	.08	.11	[-.13, .29]	.56	.45
Self-efficacy					
Between-subject effect					
Untransformed	.24	.09	[.07, .41]	8.01	.01
Squared	-.002	.08	[-.17, .16]	.001	.98
Within-subject effect					
Untransformed	.08	.11	[-.14, .31]	.52	.47
Squared	.15	.16	[-.17, .47]	.82	.36
Self-regard					
Between-subject effect					
Untransformed	.20	.10	[.01, .39]	4.36	.04
Squared	-.15	.11	[-.36, .06]	1.92	.17
Within-subject effect					
Untransformed	-.08	.10	[-.29, .12]	.66	.42
Squared	.09	.09	[-.09, .27]	1.03	.31

Note: Between-subjects untransformed variables were grand mean centered and within-subjects untransformed variables were centered within person. Squared terms were calculated using centered variables.

Table 10. *Relationships between typical (i.e., between-subject) self-criticism, self-forgiveness, self-efficacy, and self-regard reported across lapse surveys and total number of lapses*

	B	SE	95% CI	Wald χ^2	*p*
Self-criticism					
Untransformed	-.004	.17	[-.34, .33]	.001	.98
Squared	-.41	.17	[-.74, -.08]	6.03	.01
Self-forgiveness					
Untransformed	.002	.12	[-.24, .25]	<.001	.99
Squared	-.16	.15	[-.46, .14]	1.04	.31
Self-efficacy					
Untransformed	-.40	.11	[-.62, -.19]	13.68	<.001
Squared	-.02	.13	[-.28, .24]	.02	.89
Self-regard					
Untransformed	-.23	.13	[-.48, .02]	3.15	.08
Squared	-.10	.14	[-.38, .17]	.55	.46

Note: All untransformed variables were centered within person, and squared terms were calculated using centered variables.

Table 11. *Moderating effect of psychological flexibility on the relationships between typical (i.e., between-subjects) self-criticism, self-forgiveness, self-efficacy, and self-regard experienced after lapses and time until next lapse (in hours)*

	B	SE	95% CI	Wald χ^2	*p*
Self-criticism					
Untransformed	-.20	.17	[-.53, .13]	1.45	.23
AAQ-II	-.01	.01	[-.02, .01]	.26	.61
Untransformed x AAQ-II	-.04	.03	[-.09, .02]	1.53	.22
Squared	.32	.25	[-.18, .82]	1.53	.22
Squared x AAQ-II	.02	.03	[-.04, .07]	.38	.54
Self-forgiveness					
Untransformed	.06	.12	[-.19, .30]	.20	.66
AAQ-II	.01	.01	[-.02, .03]	.17	.68
Untransformed x AAQ-II	.02	.02	[-.01, .05]	2.06	.15
Squared	.15	.13	[-.10, .40]	1.36	.24
Squared x AAQ-II	-.01	.01	[-.04, .02]	.24	.62
Self-efficacy					
Untransformed	.31	.14	[.04, .58]	5.17	.02
AAQ-II	.01	.01	[-.01, .03]	.26	.61
Untransformed x AAQ-II	.02	.02	[-.01, .05]	2.48	.12
Squared	.22	.15	[-.07, .52]	2.17	.14
Squared x AAQ-II	.01	.01	[-.02, .03]	.16	.69
Self-regard					
Untransformed	.38	.16	[.06, .70]	5.33	.02
AAQ-II	.004	.01	[-.02, .03]	.09	.77
Untransformed x AAQ-II	.02	.02	[-.02, .06]	.63	.43
Squared	-.08	.22	[-.50, .35]	.13	.72
Squared x AAQ-II	.01	.01	[-.02, .04]	.88	.35

Note: Each untransformed variable and AAQ-II were grand mean centered prior to squaring and creating interaction terms.

Table 12. *Moderating effect of psychological flexibility on the relationships between typical self-criticism, self-forgiveness, self-efficacy, and self-regard reported across lapse surveys and number of reported lapses*

	B	SE	95% CI	Wald χ^2	*p*
Self-criticism					
Untransformed	-.05	.13	[-.31, .22]	.12	.73
AAQ-II	.02	.01	[-.004, .04]	2.60	.11
Untransformed x AAQ-II	.05	.02	[.01, .08]	6.14	.01
Squared	-.50	.11	[-.72, -.28]	20.17	<.001
Squared x AAQ-II	-.03	.03	[-.08, .03]	.97	.33
Self-forgiveness					
Untransformed	.002	.12	[-.22, .23]	<.001	.98
AAQ-II	.01	.01	[-.02, .03]	.22	.64
Untransformed x AAQ-II	-.02	.01	[-.05, .01]	2.34	.13
Squared	-.21	.12	[-.45, .03]	2.95	.09
Squared x AAQ-II	.01	.01	[-.02, .03]	.10	.75
Self-efficacy					
Untransformed	-.34	.13	[-.60, -.08]	6.41	.01
AAQ-II	-.002	.01	[-.03, .02]	.02	.89
Untransformed x AAQ-II	-.03	.01	[-.05, -.003]	4.94	.03
Squared	-.20	.17	[-.53, .13]	1.39	.24
Squared x AAQ-II	.01	.01	[-.02, .03]	.14	.71
Self-regard					
Untransformed	-.18	.16	[-.48, .13]	1.26	.26
AAQ-II	-.004	.01	[-.03, .02]	.06	.80
Untransformed x AAQ-II	-.02	.02	[-.05, .02]	.77	.38
Squared	-.20	.14	[-.46, .07]	2.13	.14
Squared x AAQ-II	.01	.01	[-.02, .04]	.62	.43

Note: Each untransformed variable and AAQ-II were grand mean centered prior to squaring and creating interaction terms.

Table 13. *Self-criticism, self-forgiveness, self-efficacy, and self-regard as predictors of whether or not the next reported lapse occurred on the same day*

	B	SE	95% CI	Wald χ^2	*p*
Self-criticism					
Between-subject effect					
Untransformed	.13	.23	[-.32, .58]	.31	.58
Squared	.03	.31	[-.57, .63]	.01	.93
Within-subject effect					
Untransformed	-.49	.14	[-.77, -.22]	12.64	<.001
Squared	.01	.18	[-.34, .37]	.01	.94
Self-forgiveness					
Between-subject effect					
Untransformed	-.13	.21	[-.53, .28]	.38	.54
Squared	.01	.20	[-.38, .41]	.003	.95
Within-subject effect					
Untransformed	.29	.18	[-.06, .64]	2.69	.10
Squared	.01	.17	[-.32, .33]	.002	.97
Self-efficacy					
Between-subject effect					
Untransformed	-.31	.19	[-.67, .06]	2.76	.10
Squared	.07	.18	[-.27, .42]	.18	.67
Within-subject effect					
Untransformed	.19	.22	[-.24, .61]	.74	.39
Squared	-.19	.40	[-.97, .60]	.21	.64
Self-regard					
Between-subject effect					
Untransformed	-.16	.19	[-.53, .21]	.74	.39
Squared	.40	.16	[.09, .71]	6.39	.01
Within-subject effect					
Untransformed	.28	.17	[-.06, .62]	2.62	.11
Squared	.35	.23	[-.10, .79]	2.38	.12

Note: Between-subjects untransformed variables were grand mean centered and within-subjects untransformed variables were centered within person. Squared terms were calculated using centered variables. Occurrence of the subsequent lapse on the same day was coded 1, while occurrence of the subsequent lapse on a different day was coded 0.

Table 14. *Relationships between self-criticism, self-forgiveness, self-efficacy, and self-regard after a lapse and time until next lapse (in hours) for days on which more than one lapse was reported*

	B	SE	95% CI	Wald χ^2	*p*
Self-criticism					
Between-subject effect					
Untransformed	.01	.18	[-.34, .35]	.002	.96
Squared	.09	.23	[-.35, .54]	.17	.68
Within-subject effect					
Untransformed	.25	.12	[.02, .48]	4.44	.04
Squared	<.001	.13	[-.25, .25]	<.001	.99
Self-forgiveness					
Between-subject effect					
Untransformed	.05	.10	[-.15, .25]	.23	.63
Squared	-.05	.10	[-.26, .15]	.27	.60
Within-subject effect					
Untransformed	-.30	.13	[-.56, -.04]	5.28	.02
Squared	.04	.15	[-.26, .34]	.06	.80
Self-efficacy					
Between-subject effect					
Untransformed	.22	.11	[-.004, .43]	3.99	.05
Squared	-.12	.09	[-.29, .05]	1.92	.17
Within-subject effect					
Untransformed	-.31	.20	[-.70, .09]	2.30	.13
Squared	-.24	.46	[-1.13, .66]	.26	.61
Self-regard					
Between-subject effect					
Untransformed	.19	.10	[.001, .38]	3.89	.05
Squared	-.06	.11	[-.28, .16]	.28	.60
Within-subject effect					
Untransformed	-.44	.08	[-.59, -.28]	30.35	<.001
Squared	-.05	.13	[-.31, .20]	.17	.68

Note: Between-subjects untransformed variables were grand mean centered and within-subjects untransformed variables were centered within person. Squared terms were calculated using centered variables.

Table 15. *Relationships between self-criticism, self-forgiveness, self-efficacy, and self-regard after a lapse and time until next lapse (in hours) among lapses that occurred on the same day as another lapse or on the following day*

	B	SE	95% CI	Wald χ^2	*p*
Self-criticism					
Between-subject effect					
Untransformed	-.05	.13	[-.30, .20]	.17	.68
Squared	-.17	.17	[-.49, .17]	.96	.33
Within-subject effect					
Untransformed	.11	.10	[-.08, .30]	1.38	.24
Squared	.10	.08	[-.06, .26]	1.59	.21
Self-forgiveness					
Between-subject effect					
Untransformed	.09	.09	[-.09, .26]	.90	.34
Squared	-.07	.09	[-.25, .11]	.58	.45
Within-subject effect					
Untransformed	-.26	.09	[-.44, -.08]	7.89	.005
Squared	-.03	.10	[-.22, .17]	.06	.80
Self-efficacy					
Between-subject effect					
Untransformed	.19	.09	[-.004, .37]	3.70	.06
Squared	-.001	.10	[-.19, .19]	<.001	.99
Within-subject effect					
Untransformed	-.09	.13	[-.34, .16]	.53	.47
Squared	-.19	.20	[-.21, .59]	.87	.35
Self-regard					
Between-subject effect					
Untransformed	.17	.09	[-.01, .36]	3.55	.06
Squared	-.11	.10	[-.30, .09]	1.17	.28
Within-subject effect					
Untransformed	-.23	.10	[-.42, -.03]	5.33	.02
Squared	.004	.10	[-.19, .20]	.002	.97

Note: All untransformed variables were centered within person, and squared terms were calculated using centered variables.

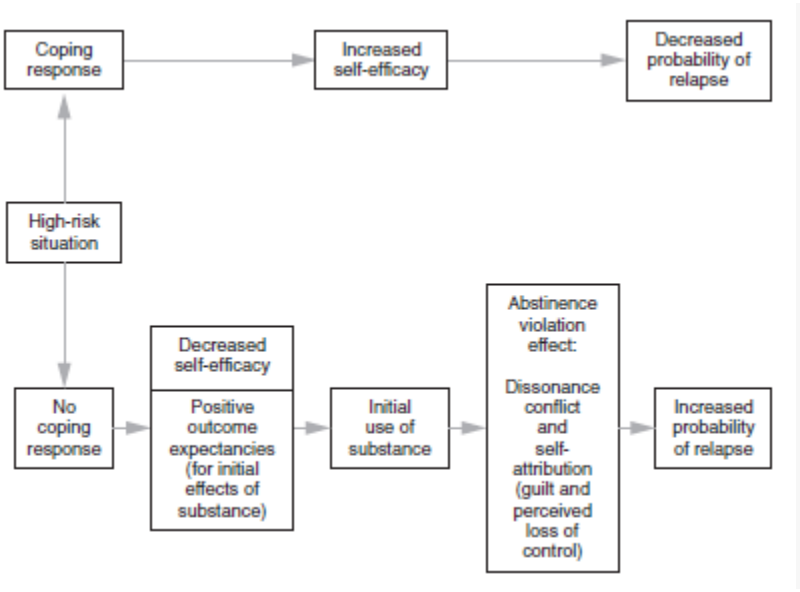

Figure 1. *Marlatt and Gordon's (1985) cognitive-behavioral relapse model*

Note: Reprinted from "Relapse and Relapse Prevention," by T. H. Brandon, J. I. Vidrine, and E. B. Litvin, 2007, *Annual Review of Clinical Psychology, 3*, p. 267.

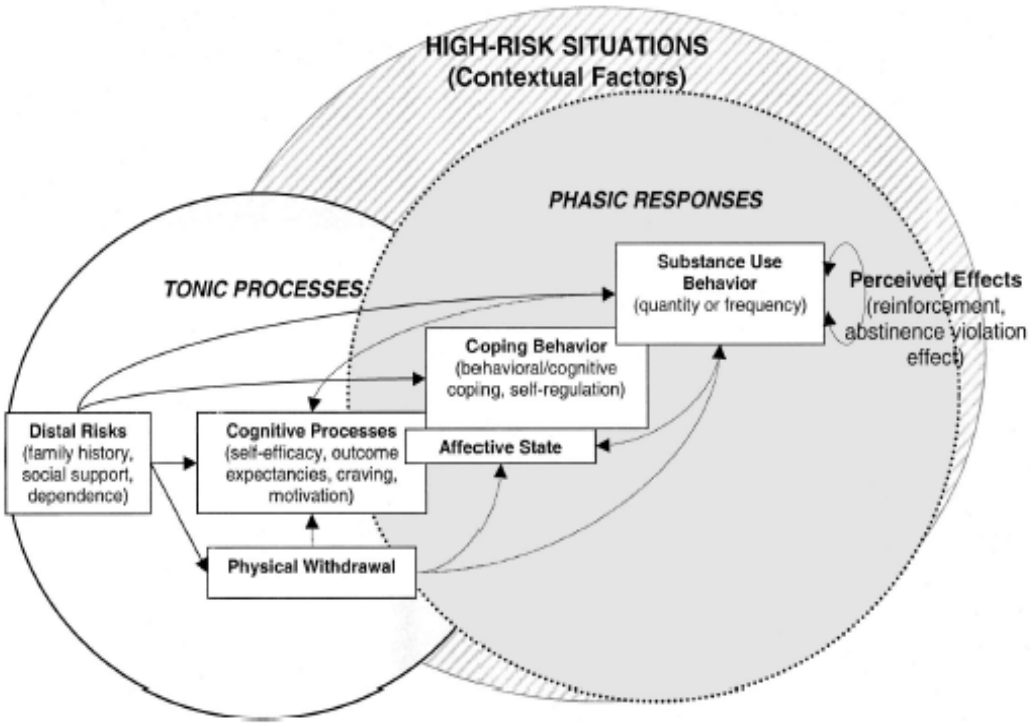

Figure 2. *Witkiewitz and Marlatt's (2004) reconceptualized, dynamic relapse model*

Note: Reprinted from "Relapse Prevention for Alcohol and Drug Problems: That was Zen, This is Tao," by K. Witkiewitz and G. A. Marlatt, 2004, *American Psychologist*, *59*(4), p. 230.

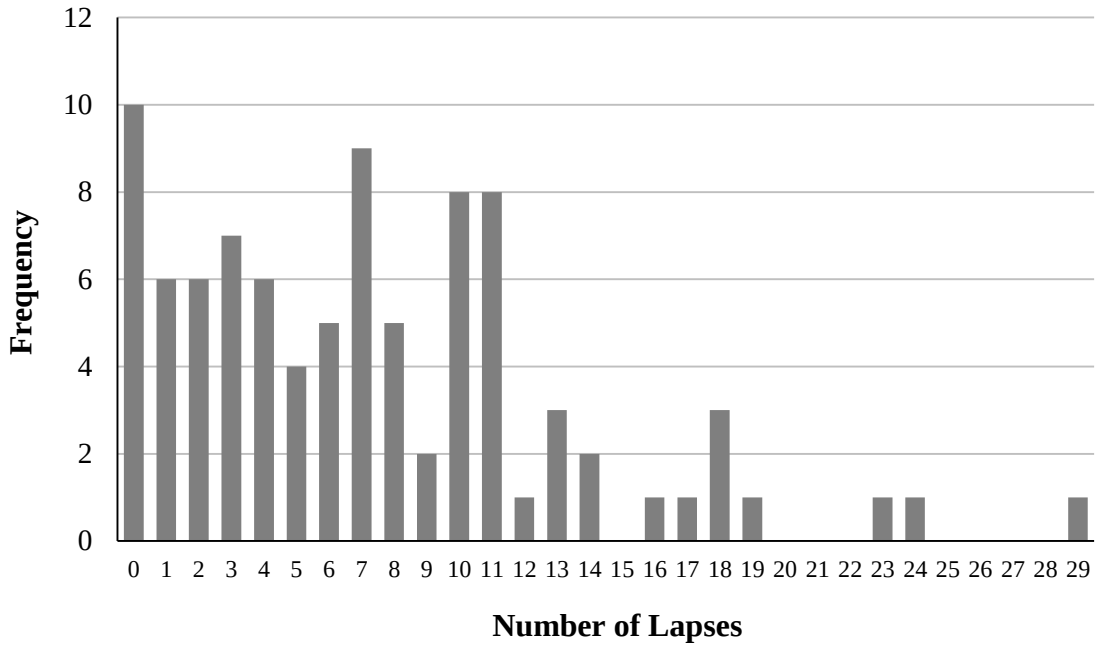

Figure 3. *Fourteen-day lapse totals, rounded to the nearest integer*

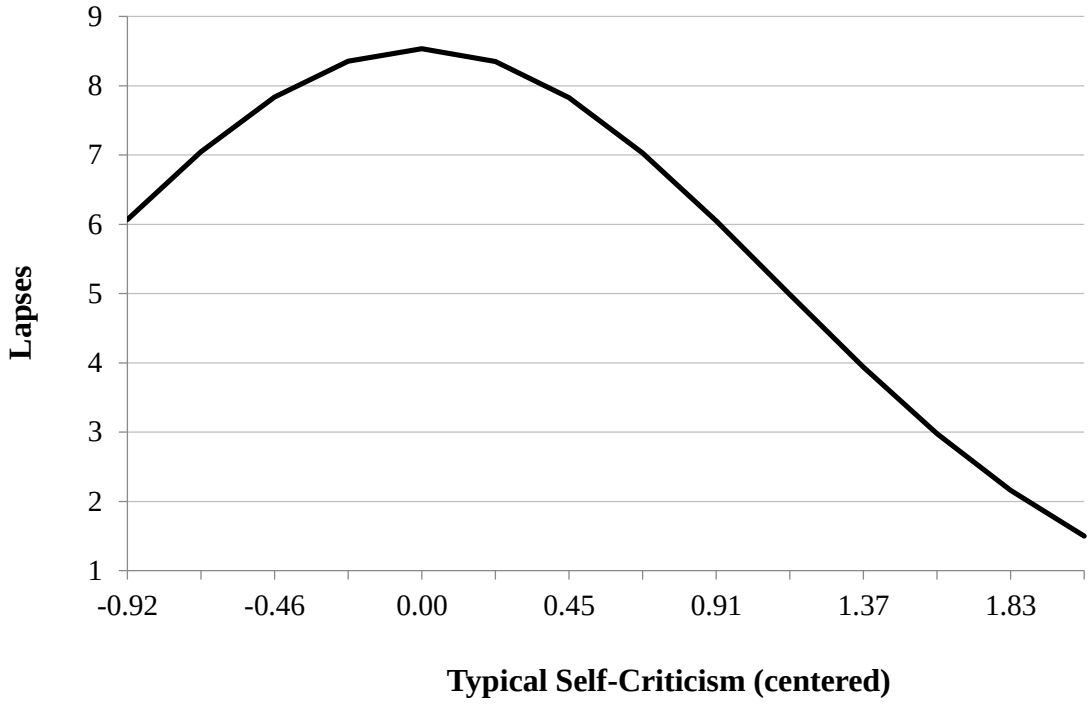

Figure 4. *Relationship between typical self-criticism at surveys where a lapse was reported and overall number of lapses*

Note: Typical self-criticism was centered at the between-subjects mean (2.03). Change is displayed in +/- 1 standard deviation units.

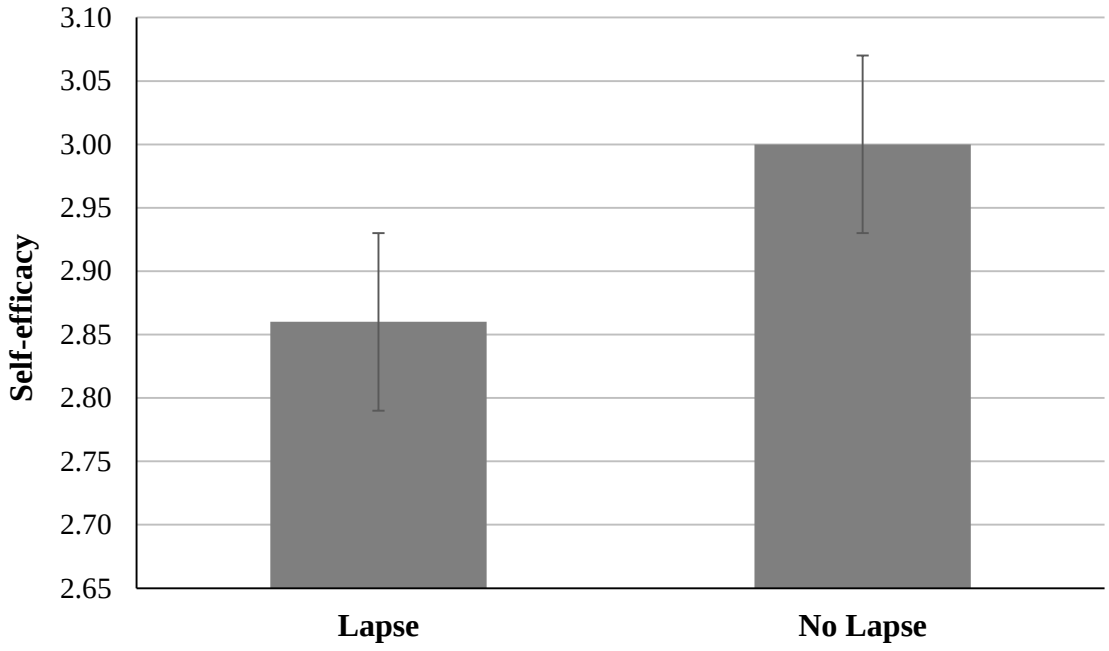

Figure 5. *Self-efficacy at surveys where a lapse was versus was not reported*

Note: Scale range was 1 (*not at all confident*) to 4 (*extremely confident*).

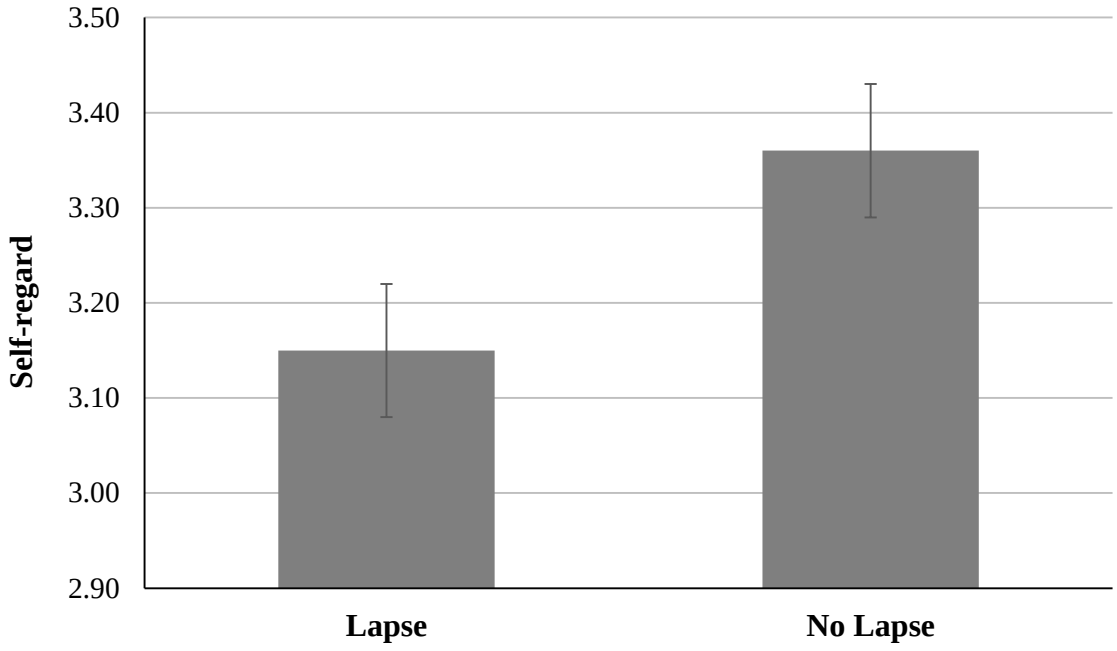

Figure 6. *Self-regard at surveys where a lapse was versus was not reported*

Note: Scale range was 1 (*I have a very negative opinion of myself*) to 4 (*I have a very positive opinion of myself*).

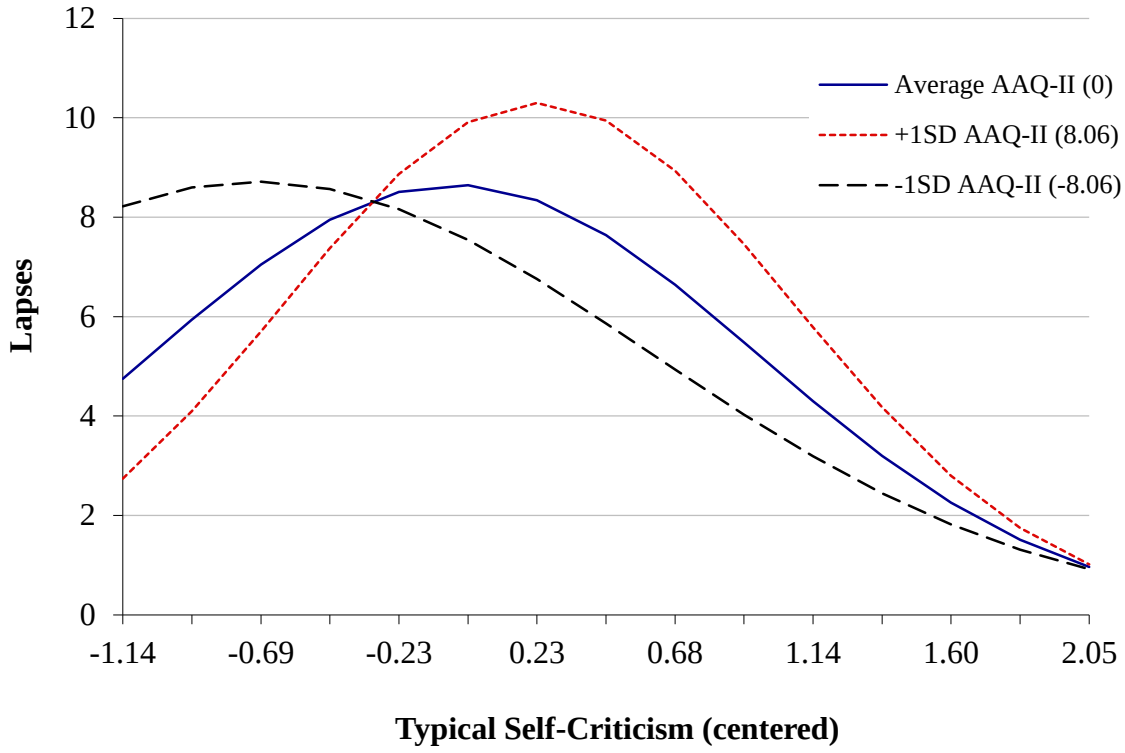

Figure 7. *Interaction between typical self-criticism after lapses and psychological flexibility in predicting total number of lapses*

Note: Typical self-criticism was centered at the between-subjects mean (2.03). Change is displayed in +/- .5 standard deviation units.

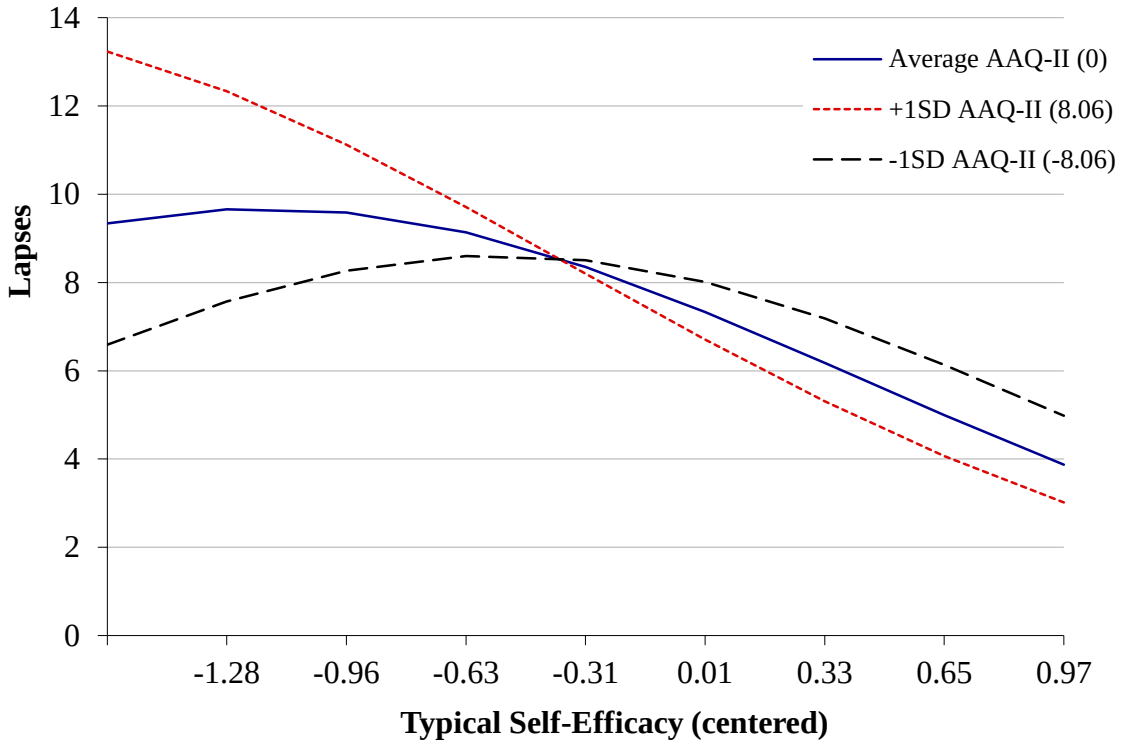

Figure 8. *Interaction between typical self-efficacy after lapses and psychological flexibility in predicting total number of lapses*

Note: Typical self-efficacy was centered at the between subjects mean (2.83). Change is displayed in +/- .5 standard deviation units.

Figure 9. *Momentary self-criticism predicted whether the next lapse would occur on the same day*

Note: Momentary self-criticism was centered at the within subjects mean. Change is displayed in +/- 1 standard deviation units. Graph displays values for a mean (i.e., 2.03) level of self-criticism across lapses (i.e., mean between subjects self-criticism).

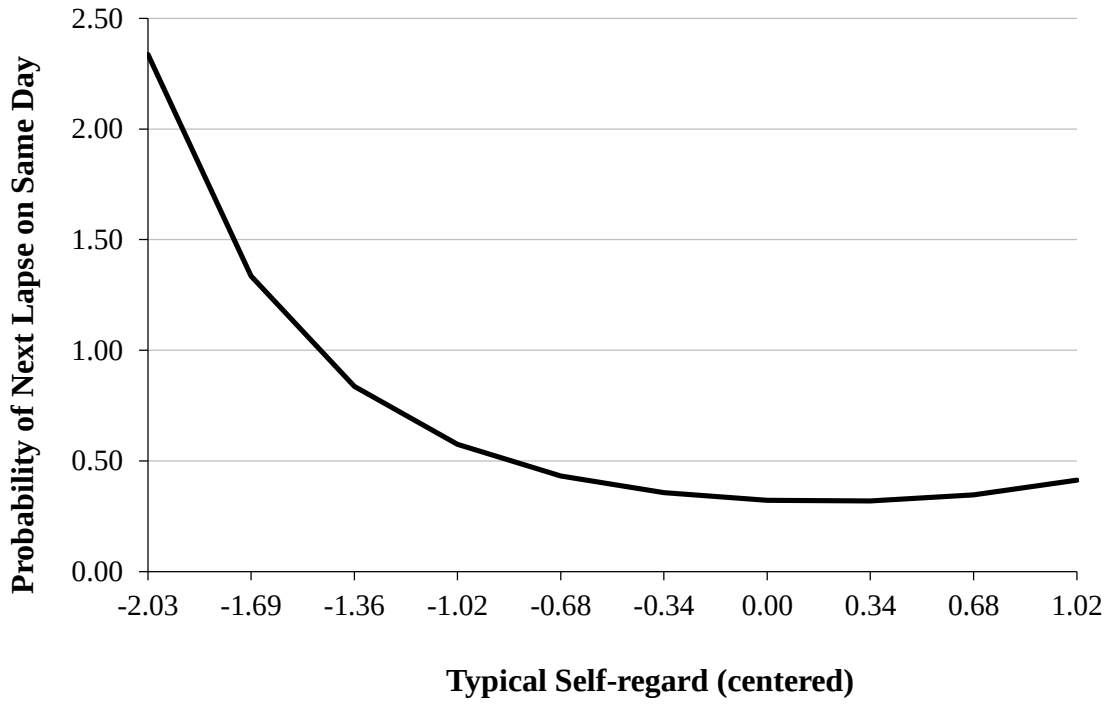

Figure 10. *Typical self-regard predicted whether the next lapse would occur on the same day according to a curvilinear relationship*

Note: Typical self-regard was centered at the sample mean (2.99). Change is displayed in +/- .5 standard deviation units. Graph displays values for mean level of momentary self-regard.

APPENDIX B: Measures

Priority of Dietary Goals Questionnaire

How much of a priority is meeting your calorie goal and/or other eating goal(s) this next week? (*circle one*)

1 – Very low. Meeting my calorie/eating goal(s) is not what I'm focused on at this time.

2 – Somewhat low. I'll try to meet my calorie/eating goal(s), but it's not a priority.

3 – Somewhat high. Eating according to my calorie/eating goal(s) is one of my top priorities.

4 – Very high. Meeting my calorie/eating goal(s) is my number one, top priority.

Ecological Momentary Assessment Lapse-Specific Questions

1. Since the last time you completed this survey, did you have a dietary lapse? A dietary lapse is eating or drinking likely to cause weight gain, and/or put weight loss/maintenance at risk.

The last time you completed the survey might have been yesterday. (If this is the first time completing, select No.)

□ Yes.
□ No.

[Note: If participant selects "Yes," survey proceeds to the following questions. If participant selects "No," the following questions are not asked.]

2. When did the lapse occur? *Select date and time.*

3. How critical do you feel towards yourself for having a lapse? *Select one.*

□ Not at all critical.
□ Slightly critical.
□ Very critical.
□ Highly critical.

4. Thinking about your lapse, which best describes how forgiving you feel toward yourself? *Select one.*

□ Not at all forgiving.
□ Slightly forgiving.
□ Mostly forgiving.
□ Completely forgiving.

5. The cause/reason for my lapse was… *Select one.*

□ Totally due to myself.
□ Mostly due to myself.
□ Slightly due to myself.
□ Slightly due to other people/circumstances.
□ Mostly due to other people/circumstances.
□ Totally due to other people/circumstances.

Ecological Momentary Assessment Questions at All Survey Points

1. Right now, how confident do you feel in your ability to succeed in your weight control goals? *Select one.*

□ Not at all confident.
□ Slightly confident.
□ Very confident.
□ Extremely confident.

2. Right now, how would you describe your overall opinion about yourself? *Select one.*

□ I have a very negative opinion of myself.
□ I have a somewhat negative opinion of myself.
□ I have a somewhat positive opinion of myself.
□ I have a very positive opinion of myself.

Acceptance and Action Questionnaire-II (Bond et al., 2011)

Below you will find a list of statements. Please rate how true each statement is for you by circling a number next to it. Use the scale below to make your choice.

1	2	3	4	5	6	7
never true	very seldom true	seldom true	sometimes true	frequently true	almost always true	always true

1. My painful experiences and memories make it difficult for me to live a life that I would value.	1 2 3 4 5 6 7
2. I'm afraid of my feelings.	1 2 3 4 5 6 7
3. I worry about not being able to control my worries and feelings.	1 2 3 4 5 6 7
4. My painful memories prevent me from having a fulfilling life.	1 2 3 4 5 6 7
5. Emotions cause problems in my life.	1 2 3 4 5 6 7
6. It seems like most people are handling their lives better than I am.	1 2 3 4 5 6 7
7. Worries get in the way of my success.	1 2 3 4 5 6 7