January 2017

Testing Theoretical Models Of Binge Eating: An Examination Of Escape Theory And Affect Regulation Model

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TESTING THEORETICAL MODELS OF BINGE EATING: AN EXAMINATION OF ESCAPE THEORY AND AFFECT REGULATION MODEL

by

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Master of Arts, University of North Dakota, 2014

A Dissertation

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

Grand Forks, North Dakota
August
2017

This dissertation, submitted by Terra L. Towne in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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Terra L. Towne
August 1, 2017

TABLE OF CONTENTS

LIST OF FIGURES

Figure Page

LIST OF TABLES

Table Page

ABSTRACT

The present study tested two theoretical models of binge eating (i.e., escape theory and the affect regulation model of binge eating) by combining an experimental design with ecological momentary assessment. After undergoing a negative affect induction, 139 participants, all of whom were current binge eaters, were instructed to eat a pint of ice cream (binge eating condition) or to eat as much as they would during a typical snack (control condition). Participants assigned to the binge eating condition ate either with (binge eating + self-awareness condition) or without (binge eating condition) a visible video camera pointed in their direction. Participants rated their negative affect in the laboratory at four different time points and in their natural environments via Palm Pilot in the four following hours. A mixed measures analysis of variance and generalized linear mixed effects model were used to test escape theory and affect regulation model, respectively. When compared to immediately prior to eating, guilt did not decrease during eating, though having a higher BMI was associated with reductions in guilt during eating. Guilt increased among both the binge eating and binge eating + SA conditions immediately following eating when compared to during eating. Both the control and binge eating conditions experienced postprandial reductions in guilt over the course of the four hours following the laboratory eating episode. However, the binge eating condition experienced these reductions at a faster initial rate with more slowing over time when compared to the control group. Findings provide preliminary support for escape theory in the context of higher BMI and are consistent with affect regulation model, as more rapid decreases in guilt are

thought to negatively reinforce binge eating and distinguish affect regulation following binge eating from the mood enhancing effects of normal eating episodes. Future studies should be conducted with a greater sample size and aim to enhance ecological validity to ensure eating in the laboratory represents binge eating episodes occurring outside of the laboratory.

CHAPTER I

INTRODUCTION

Emotion regulation is defined as an "attempt to influence which emotions we have, when we have them, and how these emotions are experienced or expressed" (Gross, 2007, pp. 220). Deficits in emotion regulation have been implicated in the etiology and maintenance of maladaptive behaviors inherent in psychiatric disorders. Many of these maladaptive behaviors function to decrease negative affect. In turn, they are negatively reinforced, conditioning individuals to continue engaging in them upon experiencing negative emotions (Gross, 1998). Strong support has emerged for the maintaining role of emotion regulation in behaviors such as avoidance (Hofmann, Sawyer, Fang, & Asnaani, 2012), substance use (Sher & Grekin, 2007), and nonsuicidal self-injury (Nock & Prinstein, 2005).

Theoretical models of binge eating, the consumption of an unusually large amount of food accompanied by a subjective loss of control (American Psychiatric Association, 2013), also emphasize the role of emotion regulation. Two widely known models of binge eating include escape theory (Heatherton & Baumeister, 1991) and affect regulation model (Hawkins & Clement, 1984). Both models posit that binge eating is preceded by increases in negative affect. However, they differ on proposed mechanisms by which negative affect is reduced and the timing of this reduction. The affect regulation model suggests binge eating reduces negative affect following the binge through the comfort and distraction of food. Conversely, escape theory asserts that negative affect is alleviated during the binge through the narrowing of

cognitive attention and resulting reductions in aversive self-awareness. Following the binge, escape theory posits that negative affect increases with the return of self-awareness.

Among individuals with bulimia nervosa and binge eating disorder, cognitive behavioral therapy has been deemed efficacious at ameliorating binge eating (Wilson, Grilo, & Vitousek, 2007). Specifically, affective self-efficacy was found to partially mediate the relationship between cognitive behavioral therapy and posttreatment response, such that patients who improved gained confidence in their ability to refrain from binge eating while experiencing unpleasant emotions (Kraemer, Wilson, Fairburn, & Agras, 2002). Consistent with theoretical models of binge eating, the importance of this change in leading to symptom improvement suggests binge eating functions to decrease negative affect.

Findings indicate that characteristics of women who binge eat (i.e., individuals who binge eat at subthreshold levels and individuals diagnosed with bulimia nervosa, binge eating disorder, or the binge-purge subtype of anorexia nervosa) may render them susceptible to behaviors regulating affect. Sanftner and Crowther (1998) found that college women who engage in binge eating experience higher levels and greater fluctuations of guilt than women who do not binge eat. Similarly, Wolff and colleagues (2000) found that college women who binge eat experience greater levels of stress and overall negative mood when compared to healthy controls. In a mixed eating disorder sample, Waller and colleagues (2003) found that women with eating disorders experience higher levels of state anger and anger suppression. Moreover, elevated levels of overall negative affect (e.g., depression, anxiety, obsessionality, guilt, and hostility) have been consistently shown in individuals with anorexia and bulimia nervosa (Allen, Scannell, & Turner, 1998; Engel et al., 2005; Pollice, Kaye, Greeno, & Weltzin, 1997). Self-report and physiological data suggest that, even in response to non-disorder related stimuli, individuals with

anorexia nervosa experience higher intensity emotional reactions (Brunner, Maloney, Daniels, Mays, & Farrell, 1989; Uher et al., 2004) and are slower to return to emotional baseline in response to negative affect (Brunner et al., 1989). Lastly, individuals with binge eating disorder report elevated levels of stress and lower tolerance of negative affect (Kenardy, Arnow, & Agras, 1996). Taken together, findings suggest that women who binge eat experience atypical levels of negative affect and perhaps resort to binge eating as a way of regulating these intense emotions.

Retrospective Research

Retrospective studies provide support for the notion that binge-eating episodes are preceded by increases in negative affect, as posited by both the affect regulation model and escape theory. When asked open-ended questions about typical antecedents of binge eating, between 67 and 100% of participants with bulimia nervosa and binge eating disorder named facets of negative affect (Bruce & Agras, 1992; Arnow, Kenardy, & Agras, 1992; Lynch, Everingham, Dubitzky, Hartman, & Kasser, 2000). Further, when asked to select from a list, emotional factors were the most frequently endorsed triggers of binge eating among individuals with bulimia nervosa, binge eating disorder, anorexia nervosa binge-purge type, and subthreshold binge eating (Davis & Jamieson, 2005; Hsu, 1990; Tachi, Murakami, Murotsu, & Washizuka, 2001; Vanderlinden et al., 2004). Across studies, anxiety was the most commonly cited facet of negative affect preceding binge eating.

Retrospective ratings of mood provide a less clear picture of whether binge eating functions to reduce negative affect. Findings concerning levels of negative affect both during and following binge eating are mixed. Davis and Jamieson (2005) found that 23% of individuals who binge eat reported statistically reliable decreases in negative affect and increases in positive affect during typical binge-eating episodes. A slightly higher percentage (42%) of Arnow and

colleagues' binge eating sample endorsed positive emotions during binge eating, while 21% endorsed no emotion. Similarly, many studies have found that individuals with bulimia nervosa retrospectively reported significant decreases in depression and anxiety during binge eating (Hsu, 1990; Kaye, Gwirtsman, Weiss, & Jimerson, 1986). Anecdotally, many patients with eating disorders describe negative affect as "anesthetized" or "damped down" during binge eating, only to return to heightened levels immediately after (McManus & Waller, 1995). In the only study to examine escape theory with structural equation modeling, Blackburn and colleagues (2006) found that negative affect was significantly associated with cognitive narrowing and that cognitive narrowing was significantly associated with binge eating. These findings appear to be consistent with escape theory; on the contrary, a sizeable number of participants in one retrospective study reported increased negative affect during the act of binge eating (Arnow et al., 1992).

Findings from several retrospective studies suggest that negative affect is reduced following binge eating, as posited by the relief component of the affect regulation model. Across these studies, between 50 and 66% of individuals with bulimia nervosa reported decreased negative affect after binge eating (Abraham & Beumont, 1982; Hawkins & Clement, 1984; Hsu, 1990). Conversely, in similar retrospective studies, increased negative affect following binge eating was reported by 85 to 100% of individuals with bulimia nervosa (Arnow et al., 1992; Mitchell et al., 1985, 1999; Pyle et al., 1981; Tachi et al., 2001). Two studies found that individuals with bulimia nervosa experienced reductions in anxiety and increases in depression after binge eating, perhaps as a result of engaging in behaviors that simultaneously reduce negative affect and elicit concerns about weight and shape.

Retrospective self-report studies provide useful preliminary information about the mood states surrounding binge-eating episodes. Asking individuals who binge eat to directly recall their experiences ensures that information incorporated into treatment will likely be understood and accepted by patients themselves. Moreover, data can easily be collected from a large number of participants, as much of retrospective research examining binge eating is cross-sectional and can be completed online, ensuring minimal participant burden. Unfortunately, retrospective research is subject to several cognitive and affective biases. In addition to forgetting information, research suggests that recollection of past behavior and mood is heavily influenced by more recent or salient events, particularly when individuals are asked to recall events that occurred over long periods of time (Redelmeier & Kahneman, 1996). Moreover, mood can affect which and how past events are described, as individuals are more likely to recall events that are consistent with their current mood state (e.g., recalling a negative event due to experiencing negative affect) and to overemphasize the intensity of the associated emotion (Teasdale & Fogarty, 1979). Lastly, participants are likely to attribute meaning to events or behavior (Smyth & Stone, 2003), which in the case of binge eating, may result in recollection of negative affect regardless of whether or not it was experienced. Such reporting inconsistencies were apparent in a study comparing retrospective and momentary ratings of emotion about the same period of time (i.e., during binge eating). Participants reported increased negative affect when using a momentary monitoring form and decreased negative affect on retrospective questionnaires (Stickney & Miltenberger, 1999).

Ecological Momentary Assessment

To address these limitations, a growing number of studies have used ecological momentary assessment to test theoretical models of binge eating. Ecological momentary

assessment occurs in participants' natural environments and involves repeated momentary assessments over time (Stone & Shiffman, 1994). In addition to enhanced ecological validity, it allows for temporal ordering of the variables of interest, enabling researchers to test specific hypotheses about changes in negative affect surrounding binge-eating episodes.

Haedt-Matt and Keel (2011) conducted a meta-analysis on 36 ecological momentary assessment studies to test the affect regulation model of binge eating. Consistent with findings from retrospective research, results suggested that negative affect preceding binge eating was higher than both average negative affect and negative affect preceding normal eating episodes in individuals with bulimia nervosa and binge eating disorder. Contrary to the affect regulation model, negative affect was found to have increased following binge-eating episodes, thereby challenging the notion that binge eating is maintained through negative reinforcement occurring immediately after the behavior.

In two large studies, Smyth and colleagues (2007) and Engel and colleagues (2013) also found that negative affect increased prior to binge and loss of control eating episodes in individuals with bulimia and anorexia nervosa, respectively. Significant decreases in negative affect were observed in the hours following binge and loss of control eating episodes (Engel et al., 2013; Smyth et al., 2007), and, in one study, such decreases occurred at significantly faster rates than increases in negative affect preceding binge eating (Smyth et al., 2007). Similarly, in a sample of obese women who binge eat, Berg et al. (2015) found increases in global negative affect and guilt leading up to binge eating and decreases in these affective states following binge eating episodes. These findings are consistent with the affect regulation model, as they suggest that binge and loss of control eating are maintained by decreases in negative affect. However, this assertion has been challenged on the basis of the four hour time period in which post-binge

reductions in negative affect were observed. Haedt-Matt and Keel (2011) noted that negative reinforcement is most powerful when reinforcers are immediate and suggested the delayed reductions in negative affect resulted from the passage of time rather than binge eating. These three studies (Haedt-Matt & Keel, 2011; Engel et al., 2012; Smyth et al, 2007) highlight interpretative differences in the function of binge eating that result from different analytic approaches (Engel et al., 2013).

Ecological momentary assessment studies examining the escape theory of binge eating are less common and have also yielded mixed results. To date, only one such study has found support for the relief component of escape theory. Compared to levels of both pre- and post-binge negative affect, Deaver and colleagues (2003) found that women who binge eat experienced lower levels of negative affect during binge-eating episodes. Interestingly, among binge eaters, the same affective pattern persisted surrounding normal eating episodes. However, during binge-eating episodes, levels of negative affect were significantly higher prior to, during, and following the act of eating compared to affect surrounding regular meals. Individuals who binge ate were more likely to do so upon experiencing higher levels of negative affect, suggesting they anticipated the temporary relief that they reported experiencing.

Two studies found increases in negative affect prior to binge eating in individuals with bulimia nervosa (Hilbert & Tuschen-Caffier, 2007; Powell & Thelen, 1996) and binge eating disorder (Hilbert & Tuschen-Caffier, 2007). In both studies, levels of negative affect remained high throughout the course of the binge. Conversely, Johnson and Larson (1982) and Stickney and Miltenberger (2007) found increases in negative affect during binge eating compared to immediately beforehand in individuals with bulimia nervosa and subthreshold binge eating,

respectively. These findings fail to support escape theory, as it appears that temporary reductions in negative affect did not occur during binge eating.

When testing theoretical models of binge eating, ecological momentary assessment has several advantages over other methodologies. In addition to mitigating several biases inherent in retrospective recall, ecological momentary assessment allows for repeated examination of temporally ordered variables in participants' natural environments. However, its primary limitation is the inability to draw causal inferences between variables. For example, the commonly accepted explanation that increases in pre-binge negative affect cause binge eating cannot be concluded, as the relationship between these events is correlational. This poses a specific concern when predicting events such as binge eating, a behavior that 75% of binge eaters acknowledged "sometimes" pre-planning (Abraham & Beumont, 1982). As noted by Haedt-Matt and Keel (2011), it may be that anticipating the act of binge eating results in increased negative affect. Moreover, it is possible that an unknown variable, as opposed to negative affect, is causing binge eating or, alternatively, that binge eating is caused by the interaction between negative affect and an unknown variable. The same issues are present when inferring the cause of decreased negative affect following binge-eating episodes.

Other concerns with ecological momentary assessment include reactivity and increased participant burden. However, Stein and Corte (2003) found no evidence of behavioral reactivity to ecological momentary assessment among individuals with eating disorders. Further, ecological momentary assessment studies of binge eating have yielded compliance rates of 80% or higher (Haedt-Matt & Keel, 2011).

Experimental Research

While experimental studies are subject to some of the same limitations as ecological momentary assessment (e.g., potential reactivity), the methodology is unique in that findings can establish causal relationships among variables. Moreover, while not employed in all experimental studies of binge eating, random assignment can reduce the possibility that changes in the dependent variable are caused by an unmeasured variable.

Much like findings from studies utilizing retrospective recall and ecological momentary assessment, findings from experimental studies have generally supported negative affect as a trigger of overeating and binge eating. In three studies of binge eating disorder, individuals assigned to a negative affect condition endorsed higher rates of binge episodes and loss of control over eating (Agras & Telch, 1998; Telch & Agras, 1996) and consumed more calories during a subsequent buffet (Agras & Telch, 1998; Chua & Touyz, & Hill, 2004) than individuals in the neutral affect condition. Further, exposure to a negative affect induction triggered overeating in a non-clinical population, though only among restrained eaters (Schotte, Cools, & McNally, 1990). In a study of restrained eaters, healthy controls, and individuals with bulimia nervosa, all participants yielded similar physiological activity and levels of negative affect in response to an interpersonal stress induction. However, despite experiencing similar reactions, individuals with bulimia nervosa endorsed a greater desire to binge eat when compared to other groups of participants (Tuschen-Caffier & Vogele, 1999). Lastly, in response to a negative affect induction, children who experience loss of control eating consumed more energy from fat and were more likely to experience loss of control eating than healthy control children (Goldschmidt, Tanofsky-Kraff, & Wilfley, 2011).

Other studies suggest that binge eating in response to negative affect is unique to individuals with eating psychopathology. Rosenburg and colleagues (2013) found that obese individuals with binge eating disorder reported a higher desire to binge eat following a stress task than obese or healthy weight controls. Similarly, in response to a stress task, obese individuals with binge eating disorder and subthreshold binge eating disorder had faster initial eating rates and diminished deceleration of eating over time (proposed measures of lack of control over eating) when compared to obese individuals without eating disorders (Schulz & Laessle, 2012). Only after accounting for other variables (e.g., high trait anxiety, high negative affectivity) did findings suggest that subgroups of overweight and obese individuals overeat in response to negative affect (Jansen et al., 2008; Schneider, Appelhans, Whited, Oleski, & Pagoto, 2010).

Few experimental studies have examined the relief component of the affect regulation model of binge eating. Telch and Agras (1998) found that individuals with binge eating disorder experienced significant decreases in negative affect immediately following binge eating. Likewise, Hartmann and colleagues (2012) found decreased negative affect after eating episodes in adolescents who experience loss of control eating. However, in both studies, all participants experienced similar levels of postprandial reductions in negative affect regardless of the amount of food they consumed or if they engaged in binge eating. The small number of participants who experienced binge or loss of control eating in these artificial settings may have contributed to the nonsignificant differences between groups. While not an experimental study by definition, a laboratory study found significant reductions in negative affect following a loss of control eating episode among adolescents who experience recurrent loss of control eating (Ranzenhofer et al., 2013). Preliminary findings appear to support the relief component of the affect regulation model, though it remains unclear if reductions in negative affect are caused by binge eating.

Even fewer experimental studies have examined escape theory. Heatherton and colleagues (1993) exposed a sample of dieters to one of three negative feedback conditions before encouraging them to consume as much ice cream as they desired. Participants who watched a video of their "failure" consumed significantly less ice cream than control subjects and dieters in other conditions. Conversely, after receiving negative feedback, participants who were asked to sit quietly or watch an unrelated video consumed equally large amounts of ice cream. While negative affect was not directly measured, all dieters indicated significant decreases in self-esteem, though increased consumption only occurred among those in the two latter conditions. Consistent with escape theory, findings suggest that decreases in self-esteem cause increases in consumption due to temporary reductions in self-awareness; however, when forced to stay in a self-focused state (e.g., when watching video of oneself in the presence of a researcher), aversive self-awareness maintains behavioral inhibition.

Consistent with escape theory and the affect regulation model, findings from experimental studies have further implicated the role of negative affect on pathological eating behavior. However, few studies have examined several components of proposed theoretical models, and many studies have limitations that preclude definitive conclusions from being drawn. To date, a major limitation of binge eating experiments is the use of non-clinical definitions to classify binge-eating episodes (Leehr et al., 2015). While objective overeating and subjective loss of control over eating are required diagnostic criteria of binge-eating episodes (American Psychiatric Association, 2013), many studies used amount of food intake as the sole measure of binge eating. This is potentially problematic when testing theoretical models of binge eating, as objective overeating may function differently than binge eating in terms of affect regulation. Moreover, studies suggest that loss of control over eating is the defining

characteristic of binge-eating episodes, while the objective overeating criterion lacks diagnostic validity (Pratt, Niegro, & Agras, 1997; Shoemaker et al., 2009). Lastly, the dearth of experimental research examining the relief components of the affect regulation model and escape theory prevents comparison of the models and an understanding of when and how negative affect decreases. Given the trajectory of post-binge negative affect found in ecological momentary assessment studies, experimental studies may fail to capture reductions in negative affect by measuring it immediately after binge eating.

Present Study

The present study tested two commonly accepted theoretical models of binge eating (i.e., escape theory and affect regulation model) in a way that attempted to overcome several limitations of previous research. Specifically, the study examined components of models that are infrequently studied in a laboratory setting (i.e., relief component of the affect regulation model, escape from self-awareness during binge episodes), adhered to clinical definitions of binge eating, and combined strengths of previous studies by utilizing both an experimental design and ecological momentary assessment. Consistent with escape theory (Heatherton & Baumeister, 1991), it was hypothesized that only participants given the opportunity to escape aversive self-awareness during the laboratory eating episode would experience reductions in negative affect while eating. Consistent with affect regulation model (Hawkins & Clements, 1984), it was hypothesized that negative affect would decrease at some point following binge eating. Because this theory specifically applies to binge eating, it was hypothesized that only participants in the binge eating condition would experience postprandial reductions in negative affect.

CHAPTER II

METHODS

Participants

Eligibility criteria included being at least eighteen years of age, engaging in binge eating at least one time within the past three months, and endorsing marked distress about engaging in binge eating. Underweight individuals, or those whose self-reported height and weight constituted a body mass index (BMI) of less than 18.5 kg/m^2, were excluded from the study to avoid confounding effects of starvation. Individuals who endorsed lactose intolerance or milk allergies were also excluded.

In exchange for their participation, participants were compensated $20.00 or, if enrolled in psychology courses at the University of North Dakota, received extra credit points or credit toward course requirements. Students selected their method of compensation. Sixty-six percent of the sample was compensated with money.

Measures

Participant Screener

To determine their eligibility, individuals interested in participating completed phone screens in which they were asked questions about their binge eating and associated distress level, food allergies, and height and weight. Questions regarding binge eating were modeled after the Eating Disorder Diagnostic Scale (EDDS; Stice, Telch, & Rizvi, 2000). Specifically, potential participants self-reported their current height and weight and were asked the following questions:

1) In the past three months, have there been times when you felt you have eaten what other people would consider an unusually large amount of food given the circumstances?, 2) During the times when you ate an unusually large amount of food, did you experience a loss of control, or feel you couldn't stop eating or control what or how much you were eating?, 3) Could you provide an example of what you ate when you ate an unusually large amount of food and experienced a loss of control?, 4) On a scale from one to seven, with one being not at all and seven being extremely, how upset are you about this behavior? and 4) Are you lactose intolerant or allergic to milk products? Individuals who endorsed questions one and two and were deemed by the research assistant to have consumed an objectively large amount of food, rated their distress level about binge eating as a four of higher, and did not meet exclusionary criteria were invited to participate in the study.

Demographics

A demographics measure assessed participants' age, gender, race, year in school (if applicable), major, and socioeconomic status.

Eating Disorder Examination Questionnaire (EDE-Q)

The EDE-Q (Fairburn, Cooper, & O'Connor, 2008) is a 28-item self-report measure of eating psychopathology. It contains four scales (i.e., dietary restraint, eating concern, weight concern, and shape concerns), and a global score can be calculated. The frequency of binge eating, self-induced vomiting, laxative misuse, and compulsive exercise over the prior four weeks is also assessed. The EDE-Q global score and each of its subscales have demonstrated acceptable internal consistency reliability (Peterson et al., 2007) and good convergent and criterion validity during previous studies; subscales yielded high correlations with daily food

records and measures of similar constructs and successfully differentiated between control women and women with eating disorders (Berg, Peterson, Frazier, & Crow, 2011).

The EDE-Q was used to characterize the severity of the sample and in subsequent analyses to examine the effect of eating disorder psychopathology and frequency of past month eating disorder behaviors on changes in negative affect. In the present study, the EDEQ global score and restraint and shape concern subscales demonstrated acceptable internal consistency reliability (α = .800 to .852), while the eating and weight concern subscales demonstrated fair internal consistency reliability (α = .734 and .725, respectively).

Difficulties in Emotion Regulation Scale (DERS)

The DERS (Gratz & Roemer, 2004) is a 36-item measure designed to assess various aspects of emotion dysregulation. It contains a global score as well as six subscales: nonacceptance of emotional responses, difficulties engaging in goal-directed behaviors, impulse control difficulties, lack of emotional awareness, lack of emotional regulation strategies, and lack of emotional clarity. Each response is rated on a 1 to 5 Likert scale where one represents "almost never" and five represents "almost always." The DERS has demonstrated acceptable test-retest reliability and good internal consistency (Gratz & Roemer, 2004). It is a valid predictor of both eating disorder severity and disordered eating behaviors (Cooper, O'Shea, Atkinson, & Wade, 2014).

The DERS was used in subsequent analyses to examine the effect of emotion dysregulation, a known characteristic of individuals who binge eat and of potential importance to affect regulation, on relevant outcome variables. The DERS total score demonstrated good internal consistency reliability in the present study (α = .934). Internal consistency reliability for DERS subscales ranged from adequate to good (α = .781 to .913).

Mindful Eating Questionnaire (MEQ)

The MEQ (Framson, Kristal, Schenk, Littman, Zeliadt, & Benitz, 2009) is a 28-item questionnaire measuring five components of mindful eating: disinhibition, awareness, external cues, emotional response, and distraction. Items are rated on 4-point Likert scales such that one represents "never/rarely" and four represents "usually/always." The MEQ has demonstrated acceptable internal consistency reliability, though sample sizes in validation studies have been small. It has been shown to have construct validity, as it is positively associated with yoga practice and inversely associated with BMI (Framson et al., 2009).

The MEQ was used to characterize the sample with regards to disengaging from self-awareness while eating. However, the MEQ summary score demonstrated poor internal consistency reliability in the present study ($\alpha = .57$), and alpha values for MEQ subscales ranged from poor to fair ($\alpha = .232$ to $.732$).

Three-Factor Eating Questionnaire (TFEQ)

The TFEQ (Stunkard & Messick, 1985) is a 51-item measure assessing three dimensions of eating behavior: cognitive restraint, disinhibition, and hunger. Items consist of true-false statements and questions on which participants rate their responses on 4-point and 6-point Likert scales. Each dimension of the TFEQ has demonstrated adequate internal consistency reliability (Karlsson, Persson, & Sullivan, 2000). Further, its factor structure suggests acceptable construct validity (Kavazidou et al., 2014), though not in every population for which it has been validated (Mazzeo, Aggen, Anderson, Tozzi, & Bulik, 2003).

The TFEQ was used in analyses subsequent to the present study to examine the effects of restraint and disinhibition on changes in negative affect prior to, during, and following eating. The disinhibition subscale yielded poor internal consistency reliability ($\alpha = .561$), while internal

consistency reliability was adequate for the hunger and cognitive restraint subscales (α = .755 for hunger; α = .840 for restraint) in the present study.

Clinical Impairment Assessment (CIA)

The CIA (Bohn & Fairburn, 2008) is a 16-item measure assessing level of psychosocial impairment as a result of eating disorder psychopathology. The measure assesses impairment in a range of domains typically affected by eating disorders (e.g., mood, cognitive functioning, work performance) to form a single index score representing impairment severity. The CIA has demonstrated good internal-consistency and test-retest reliability (Bohn, Doll, Cooper, O'Connor, Palmer, & Fairburn, 2008). Additionally, it has proved to be construct and criterion valid, as it distinguished between and predicted with high levels of accuracy eating disordered women with varying levels of eating psychopathology (Vannucci et al., 2012). The CIA was used to characterize the severity of the sample and demonstrated good internal consistency reliability in the present study (α = .927).

Positive and Negative Affect Schedule- Expanded Version (PANAS X)

The PANAS X (Watson & Clark, 1994) is a 60-item measure assessing two higher order dimensions of affect (i.e., negative and positive affect) and 11 specific emotional facets. Participants rated the extent to which they are experiencing each feeling or emotion "right now" on a scale from one to five, such that one represents "very slight or not at all" and five represents "extremely." Three items from the guilt scale (i.e., guilty, blameworthy, ashamed) were combined to represent the dependent variable. These items were selected for their theoretical relevance to binge eating and the particular negative affect induction used in the present study. Additionally, a short measure is necessary for assessing affect during binge eating, as asking participants to consider their mood likely enhances their self-awareness. The original guilt scale

has demonstrated good internal consistency reliability (α = .88). It has good construct validity, as evidenced by high correlations with general negative affect and low cross-loadings (< .25) on items measuring positive affect. Each subscale was sensitive to intraindividual mood fluctuation and validated with eight different temporal instructions (e.g., right now, today, during the past few days; Watson & Clark, 1994), suggesting it is appropriate to administer in a within subjects design. However, it cannot be assumed that all psychometric properties of the original guilt scale apply, as three items were deleted for the purposes of the present study. The modified guilt scale demonstrated good internal consistency reliability at each time point in the present study; coefficient alphas ranged from .838 at time one to .922 at time eight.

Food and Appetite Evaluation Form

This measure consists of nine questions assessing participants' satiation, perceived self-control over eating, and desire to engage in eating disorder behaviors after eating in the laboratory. Each item was assessed using horizontal visual analogue scales (VAS); for each item, participants moved a slider to indicate their endorsement of the item from "not at all" to "extremely." The endpoint labeled "not at all" corresponded to 0, and the endpoint labeled "extremely" corresponded to 100. Sliders placed at intermediate points on the scale were quantified accordingly. This measure was used to assess the extent to which artificially induced binge eating resulted in a subjective loss of control.

Procedure

Recruitment and Screening

Participants were recruited from the community and the University of North Dakota through the use of Facebook advertising, posters, and the Department of Psychology's research participation system. Six hundred and thirty-two individuals expressed an interest in participating

in the study by providing their contact information via the Facebook advertisement, writing the laboratory email account, or calling the UND Eating Behaviors Lab. Five hundred forty-six individuals completed a phone screen, 235 of whom were deemed eligible to participate in the study. Three hundred eleven participants were deemed ineligible for reasons including solely endorsing subjective binge eating (i.e., experiencing a loss of control over eating in the absence of consuming an objectively large amount of food; $n = 138$), solely endorsing objective overeating (i.e., consuming an objectively large amount of food in the absence of loss of control over eating; $n = 134$), denying significant distress about engaging in binge eating ($n = 22$), endorsing a milk allergy and/or lactose intolerance ($n = 10$), and reporting a height and weight constituting a BMI of less than 18.5 kg/m^2 ($n = 7$).

Of the 235 eligible individuals, thirty-one participants declined to participate in the study. There were no differences in BMI ($t(232) = .312$, $p = .756$) based on self-reported height and weight or distress about binge eating ($t(232) = -1.033$, $p = .308$) between individuals who declined to participate and individuals who indicated their intent to participate and were emailed a link to Phase I of the study (i.e., online questionnaires). Two hundred four individuals were emailed online questionnaires, and 189 completed or partially completed them. One hundred thirty-nine of the 189 Phase I participants (73.5%) went on to participate in Phase II. When compared to participants who completed both phases of the study, participants who only completed/partially completed Phase I were older ($t(173) = 3.039$, $p = .003$) and less likely to be enrolled in college at the time of their participation ($X^2(1, N = 181) = 17.274$, $p < .001$). They reported greater eating disorder psychopathology ($t(173) = 3.039$, $p = .003$) and resulting psychosocial impairment ($t(173) = 3.039$, $p = .003$).

Phase I

Following completion of the phone screen, eligible individuals were informed of the study procedures and, if interested in participating, scheduled an afternoon laboratory visit at 1, 2, or 3 PM. To control for baseline hunger levels, they were instructed to fast (i.e., consume nothing but water) for five hours prior to their visit. Participants were sent a confirmation email including the date and time of their laboratory visit and a link to Phase I of the study. Phase I of the study consisted of completing the demographics questionnaire, EDE-Q, DERS, MEQ, TFEQ, and CIA via Qualtrics Survey Software.

Phase II

Upon arrival in the laboratory, a research assistant verified that participants had fasted (i.e., by asking "When was the last time that you ate?), and participants were administered the modified guilt scale as a baseline measure of negative affect. Each participant was instructed to consume a preload of plain Quaker oatmeal (1 serving, 100 kilocalories). Preloads are typically used as an attempt to hold extraneous variables affecting satiation constant (Blundell et al., 2009). Next, participants underwent a negative affect induction. Participants were instructed to recount a recent experience in which they felt very guilty, ashamed, or self-blaming by writing about it in detail for a period of 10 minutes. They were then asked to read what they wrote aloud to the research assistant. This particular negative affect induction was selected due to the effectiveness of autobiographical recall in eliciting negative affect (Lench, Flores, & Bench, 2011; Westermann, Spies, Stahl, & Hesse, 1996) and the relevance of guilt to binge eating (Berg et al., 2013; De Young et al., 2013). Immediately following the induction, participants completed the modified guilt scale.

Participants were then assigned to either a control condition or one of two binge eating conditions using unequal allocation ratio randomization (Rosenberger & Lachin, 2002). Specifically, participants were assigned to the binge eating conditions at a ratio of 2:1. The binge eating conditions had 92 participants, who were further randomly assigned to either the induced self-awareness binge eating (n = 45) or typical binge eating (n = 47) condition. These conditions are hereafter referred to as the BE + SA condition and BE condition, respectively. Forty-seven participants were assigned to the control condition.

Objective control was manipulated to influence the subjective experience of perceived control over eating. Participants in both binge eating conditions were instructed to consume a pint of Ben and Jerry's ice cream in its entirety within 25 minutes. In doing so, participants consumed an unusually large amount of food given the circumstances in a situation where loss of control is artificially implied. Each participant chose one of three ice cream flavors to consume: Cherry Garcia (4 servings, 1040 kilocalories), Chocolate Fudge Brownie (4 servings, 1040 kilocalories), or Chocolate Chip Cookie Dough (4 servings, 1120 kilocalories).

Participants assigned to the BE + SA condition were seated in front of a video camera and falsely informed that they were randomly selected to be recorded. They were told the recording would later be viewed to ensure the study protocol is being followed and consistently applied across participants. This is a valid (Davis & Brock, 1975; Geller & Shaver, 1976) and frequently used (e.g., Duval & Silvia, 2001; Silvia & Duval, 2002; Silvia & Phillips, 2004) self-awareness induction. In contrast, participants assigned to the BE condition consumed their ice cream alone in the laboratory. Participants in the control condition were instructed to eat as much of the ice cream as they would "during a typical snack", which implies that they retain objective control over how much they consume.

Ten minutes into the eating episode, participants were instructed to complete the modified guilt scale while consuming the ice cream. This time interval was selected based on a finding from an EMA study in which participants reported decreases in negative affect during eating between the eight and 15-minute mark (Deaver et al., 2003).

Immediately following the eating episode, participants completed the modified guilt scale and the Food and Appetite Evaluation form, and the research assistant recorded the length of the eating episode. Participants were then given a Palm Pilot on which they were prompted by the device to complete the modified guilt scale four times over the next four hours in their natural environments. Before leaving the laboratory, they were informed of how to complete measures on the Palm Pilot and when to return the Palm Pilot to the laboratory. Participants were debriefed on the purpose of the study and the procedures used, offered referral information, and compensated for their participation upon returning the Palm Pilot.

Statistical Analysis

Descriptive statistics were conducted to describe the demographics and clinical characteristics of the sample. One-way analysis of variance (ANOVA) and chi square tests were used to examine differences between conditions on continuous and categorical study-relevant variables, respectively. *p*-values less than .05 were considered statistically significant.

To determine if the negative affect induction had the expected effects, a two-tailed paired sample t-test was used to detect differences between participants' baseline and post-induction affect scores. One-way ANOVAs and two-tailed independent samples t-tests were used to test the effectiveness of the remaining experimental manipulations (i.e., perceived loss of control over eating and group eating instructions). *p*-values less than .05 were considered statistically significant.

A 2 x 3 mixed measures ANOVA was used to test the escape theory of binge eating. Group (BE and BE + SA conditions) and time (before, during, and after the binge eating episode) were the independent variables, and guilt was the dependent variable. The control condition was not included in this analysis, as escape theory posits that reductions in aversive self-awareness are exclusive to binge-eating episodes. Time one affect ratings (i.e., those made prior to the negative affect induction) were included as a covariate. Both univariate and multivariate approaches were used to interpret the results of the repeated measures ANOVA. When using the multivariate approach, a deviation contrast was used to compare the affect rating made during binge eating to the average of affect ratings made prior to and following binge eating. When using the univariate approach, differences between modified guilt scale ratings across time points were examined with paired t-tests adjusted for multiple comparisons using a Bonferonni correction.

Generalized linear mixed effects models were used to test the affect regulation model of binge eating. In this analysis, the independent variables were group (control and BE conditions) and time (5 total time points), and the dependent variable was guilt. Specifically, the five time points consisted of guilt ratings made immediately after the eating episode in the laboratory and once per hour in the following four hours in the natural environment. The induced BE + SA condition was not included in this analysis, as exposure to the self-awareness induction may have affected subsequent negative affect. Linear and quadratic functions of time and their interactions with condition were included in the model as random factors; condition was included as a fixed factor. Based on the distribution of negative affect across the five time points, the model was fit with an inverse Gaussian distribution with a log link function. The covariance structure of the

random effects was specified to be scaled identity based on model fit indices and model convergence. Model parameters were estimated with maximum likelihood.

CHAPTER III

RESULTS

Sample Characteristics

Participants (N = 139) who completed both phases of the study (i.e., online questionnaires and laboratory visit) were primarily female (n = 108; 77.698%) and Caucasian (n = 117; 84.173%). Other races included Black (n = 4; 2.878%), Hispanic (n = 5; 3.597%), Asian (n = 3; 2.158%), Native American (n = 5; 3.597%), and biracial (n = 3; 2.158%); two participants did not specify their race. Participant ages ranged from 18 to 74 years, with a mean age of 27.029 (SD = 12.632).

The majority of the sample was not enrolled in college at the time of the study (n = 44; 31.655%). The second largest group was comprised of college freshman (n = 36; 25.899%) followed by juniors (n = 18, 12.95%), sophomores (n = 17, 12.23%), seniors (n = 13, 9.352%), and graduate students (n = 11; 7.914%). The modal household income was under $10,000; a complete list of household incomes is depicted in Table 1.

Participants had a mean BMI of 28.942 (SD = 7.656) kg/m^2. According to the Centers for Disease Control and Prevention (2010), 41% of the sample were of a healthy weight (n = 57), 23% were overweight (n = 32), and 36% were obese (n = 50). Study conditions differed on BMI ($F(2, 136) = 3.351$, $p = .038$), such that those assigned to the BE condition had a significantly lower BMI (M = 26.766, SD = 5.622) than those in the BE + SA condition (M = 30.758,

Table 1. Frequency of Household Incomes.

Household Income	*n*	Percentage[a]
Under $10,000	37	26.619
$10,001 to $20,000	15	10.791
$20,001 to $30,000	14	10.072
$30,001 to $40,000	12	8.633
$40,001 to $50,000	8	5.755
$50,001 to $60,000	7	5.036
$60,001 to $70,000	10	7.194
$70,001 to $80,000	11	7.914
$80,001 to $90,000	1	.719
$90,001 to $100,000	5	3.597
Over $100,000	19	13.669

[a]Due to rounding, the sum of values does not equal 100%.

SD = 8.571; $p = .036$, $d = .36$). Participants in the control condition ($M = 29.379$, $SD = 8.12$) did not differ on BMI from participants in the BE + SA ($p = 1$) or BE conditions ($p = .285$).

Men in the present study reported levels of psychopathology that were not statistically different from a male mixed eating disorder sample ($N = 373$; Smith et al., in press) on the Global ($t(400) = 1.407$, $p = .16$, $d = .576$), Restraint ($t(400) = 1.665$, $p = .09$, $d = .347$), Shape Concern ($t(400) = 1.448$, $p = .148$, $d = .213$), and Weight Concern ($t(400) = 1.665$, $p = .09$, $d = .176$) subscales of the EDE-Q; they reported less psychopathology than males with eating disorders on the EDE-Q Eating Concern subscale ($t(400) = 3.0375$, $p = .003$, $d = .374$).

Conversely, females in the present study reported significantly less psychopathology than a large female eating disorder sample (N = 1425; Smith et al., in press) on the five domains of the EQE-Q: Global ($t(1531) = 1.407$, $p = < .001$, $d = .576$), Restraint ($t(1531) = 5.994$, $p < .001$, $d = .665$), Eating Concern ($t(1531) = 6.591$, $p = <.001$, $d = .593$), Shape Concern ($t(1531) = 4.293$, $p < .001$, $d = .461$), and Weight Concern ($t(1531) = 2.783$, $p = .006$, $d = .306$). However, both men (M = 18.452, SD = 10.363) and women (M = 21.26, SD = 9.896) in the present study reported mean levels of psychosocial impairment as a result of eating disorder psychopathology that exceeded the clinical cut-off of 16 (Reas, Stedal, Lindvall, & Ro, 2016). Clinical characteristics of the sample are detailed in Table 2. There were no significant differences between study conditions on any of the measures described (ps > .05).

Study Variable Comparisons

The majority of participants attended a 1 PM laboratory visit (n = 55), followed by 2 PM (n = 43) and 3 PM visits (n = 41). The proportion of participants in each time slot did not differ across study conditions ($\chi^2(4, N = 139) = 2.895$, $p = .592$).

Self-reported duration of fasting prior to the laboratory visit ranged from five to 24 hours. Participants reported fasting for an average of 10.575 (SD= 5.661) hours; the median fast time was seven hours. There were no differences in fast times across the three conditions (F (2, 136) = 1.454, p = .237).

Chocolate Chip Cookie Dough was the most frequently selected ice cream flavor (n = 76) in the study, followed by Chocolate Fudge Brownie (n = 43) and Cherry Garcia (n = 20). The proportion of participants selecting each ice cream flavor did not differ across study conditions ($\chi^2(4, N = 139) = 2.642$, $p = .619$).

Table 2. Clinical Characteristics of the Sample.

Frequency of Eating Disorder Behaviors in the Past 28 Days	*N*	Range	Median	Mean	Standard Deviation
Binge Eating	139	0-30	5	7.036	5.895
Self-Induced Vomiting	138	0-20	0	.424	2.028
Laxative Misuse	139	0-20	0	.623	2.732
Driven Exercise	139	0-28	3	5.290	6.518
Eating Disorder Psychopathology (Range of Possible Responses)					
EDEQ Global (0-6)	139	.42-5.37	3.042	3.040	1.085
EDEQ Restraint (0-6)	139	0-6	2	2.246	1.439
EDEQ Weight Concern (0-6)	139	.2-6	3.6	3.531	1.267
EDEQ Shape Concern (0-6)	139	.63-6	4.25	3.992	1.251
EDEQ Eating Concern (0-6)	139	0-5.2	2.2	2.387	1.267
TFEQ Restraint (0-21)	132	1-21	10	10.162	4.893
TFEQ Disinhibition (0-16)	132	4-16	12	11.838	2.372
TFEQ Hunger (0-14)	132	2-14	10	9.622	3.069
CIA (0-48)	132	2-45	20	20.595	10.040
MEQ (1-4)[a]	136	1.793-3.046	2.421	2.431	.266
MEQ Awareness (1-4)[a]	136	1.14-3.57	2.286	2.3739	.489
MEQ Disinhibition (1-4)[a]	138	1-3.5	2	2.039	.546
MEQ Emotional (1-4)[a]	136	1-4	2.25	2.284	.700
MEQ External (1-4)[a]	136	1.5-4	2.83	2.761	.518

Table 2 cont.

Frequency of Eating Disorder Behaviors in the Past 28 Days	*N*	Range	Median	Mean	Standard Deviation
DERS Total (36-180)[a]	139	50-158	96	96.264	23.144
DERS Nonacceptance of Emotional Responses (6-30)[a]	139	6-30	16	16.991	6.518
DERS Goal-Directed Behavior (5-25)[a]	139	5-25	17	15.707	4.707
DERS Impulse Control (6-30)[a]	139	6-29	14	14.692	5.783
DERS Emotional Awareness (6-30)[a]	139	6-30	17	16.633	4.437
DERS Emotion Regulation Strategies (7-40)[a]	139	9-39	20	20.578	7.630
DERS Emotional Clarity (5-25)[a]	139	5-23	11	11.655	3.648

[a] Lower scores on the DERS represent greater emotion dysregulation, and lower scores on the MEQ are in the direction of mindful eating. The MEQ Distraction subscale was not included in the table due to its unacceptably low internal consistency reliability in the present study (a = .232).

Experimental Manipulations

There were significant differences between participants' baseline and post-induction affect scores ($t(138) = -13.615$, $p < .001$; $d = 1.194$), such that participants reported experiencing greater negative affect after undergoing the negative affect induction. The three study conditions did not differ on pre- (F (2, 138) = .542, p = .583) or post-induction (F (2, 138) = .379, p = .685) affect ratings or changes in pre-to-post affect ratings (F (2, 138) = .16, p = .852), suggesting the induction was equally effective across groups.

Despite condition-specific instructions, 13 participants in the binge eating conditions (seven in the BE condition and six in the BE + SA condition) did not finish the ice cream in its entirety, while 13 participants in the control condition consumed the entire pint (this was not

necessarily contrary to the control instructions). Nevertheless, participants assigned to the control condition consumed significantly less ice cream on average than participants in the binge eating conditions ($t(90) = 6.808$, $p < .001$, $d = 1.299$), suggesting the induction was effective at differentiating groups on the amount of food consumed. There were no significant differences in amount of ice cream consumed between the two binge eating conditions ($t(90) = 1.291$, $p = .541$, $d = .129$).

Contrary to the intended purpose of the study conditions, individuals assigned to the control condition reported feeling significantly more out of control while eating in the laboratory than individuals assigned to the binge eating conditions ($F(1, 137) = 16.7$, $p < .001$, $d = .741$). There were no significant differences in loss of control over eating between the two binge eating conditions ($F(1, 90) = .263$, $p < .609$). Participants assigned to binge eating conditions who did not consume the ice cream in its entirety did not differ in perceived loss of control ($M = 44.58$, $SD = 28.799$) from participants in the binge eating conditions ($M = 29.56$, $SD = 29.419$) who consumed the full pint of ice cream ($t(89) = -1.653$, $p = .102$, $d = .516$).

Data Screening

Two participants were excluded from all analyses. One was excluded for incorrectly completing the negative affect induction, while the other was excluded for engaging in self-induced vomiting following consumption of the preload, as this behavior has been shown to regulate affect among individuals with eating disorders (Smyth et al., 2007; Engel et al., 2013). Six univariate outliers and one multivariate outlier were discovered using z-scores and Mahalanobis distances, respectively, and removed from the escape theory analysis.

Escape Theory

Skewness and kurtosis of negative affect at time two, three, and four were examined by dividing their coefficients by their standard errors; *z*-scores for each variable were between two and negative two, suggesting the assumption of normality was met. Levene's Test of Equality revealed equal variances of negative affect ratings made prior to ($F(1, 83) = .201$, $p = .655$), during ($F(1, 83) = .043$, $p = .836$), and following binge eating ($F(1, 83) = 1.734$, $p = .191$). Covariance matrices of the dependent variables were equal across conditions (Box's M = 4.229; $F(6, 46338.209) = .494$, $p = .668$), suggesting the assumption of homogeneity of covariances was met. Mauchley's test indicated a violation of sphericity ($\chi^2(2) = 50.319$, $p < .001$), and degrees of freedom were corrected using Greenhouse-Geisser estimates ($\varepsilon = .684$). The analysis was conducted with 85 participants, 39 in the BE + SA condition and 46 in the BE condition. This analysis excludes participants with missing data.

After adjusting for time one affect ratings, multivariate (Wilks' Lambda = .859, $F(2, 81) = 6.662$, $p = .002$, $\eta_p^2 = .141$) and univariate ($F(1.367, 112.120) = 3.756$, $p = .042$; $\eta_p^2 = .044$) tests revealed a main effect of time. Contrary to escape theory, negative affect was not significantly different during eating than the average of negative affect ratings made prior to and immediately following eating ($F(1, 81) = 1.724$, $p = .193$, $\eta_p^2 = .021$). Participants reported greater negative affect immediately after eating when compared to the mean of negative affect ratings made prior to and during eating ($F(1, 81) = 9.016$, $p = .004$, $\eta_p^2 = .099$). Pairwise comparisons revealed that this was accounted for by greater negative affect following eating when compared to during eating ($t(84) = 5.456$, $p < .001$, $\eta_p^2 = .034$), as there were no significant differences between negative affect ratings made prior to and immediately after eating ($t(84) = .710$, $p = .479$).

Further, there was no main effect of group ($F(1, 81) = .705$, $p = .404$), indicating average affect ratings across time points did not differ between conditions. There were no multivariate (Wilks' Lambda = .997, F(2, 81) = .106, $p = .900$) or univariate ($F(1.367, 112.20) = .171$, $p = .757$) interaction effects between time and condition, suggesting the effect of time on negative affect did not differ by the presence or absence of the self-awareness condition. These results are depicted in Figure 1. The same results were detected upon removing the 13 participants who were assigned to the binge eating conditions but did not consume the ice cream in its entirety.

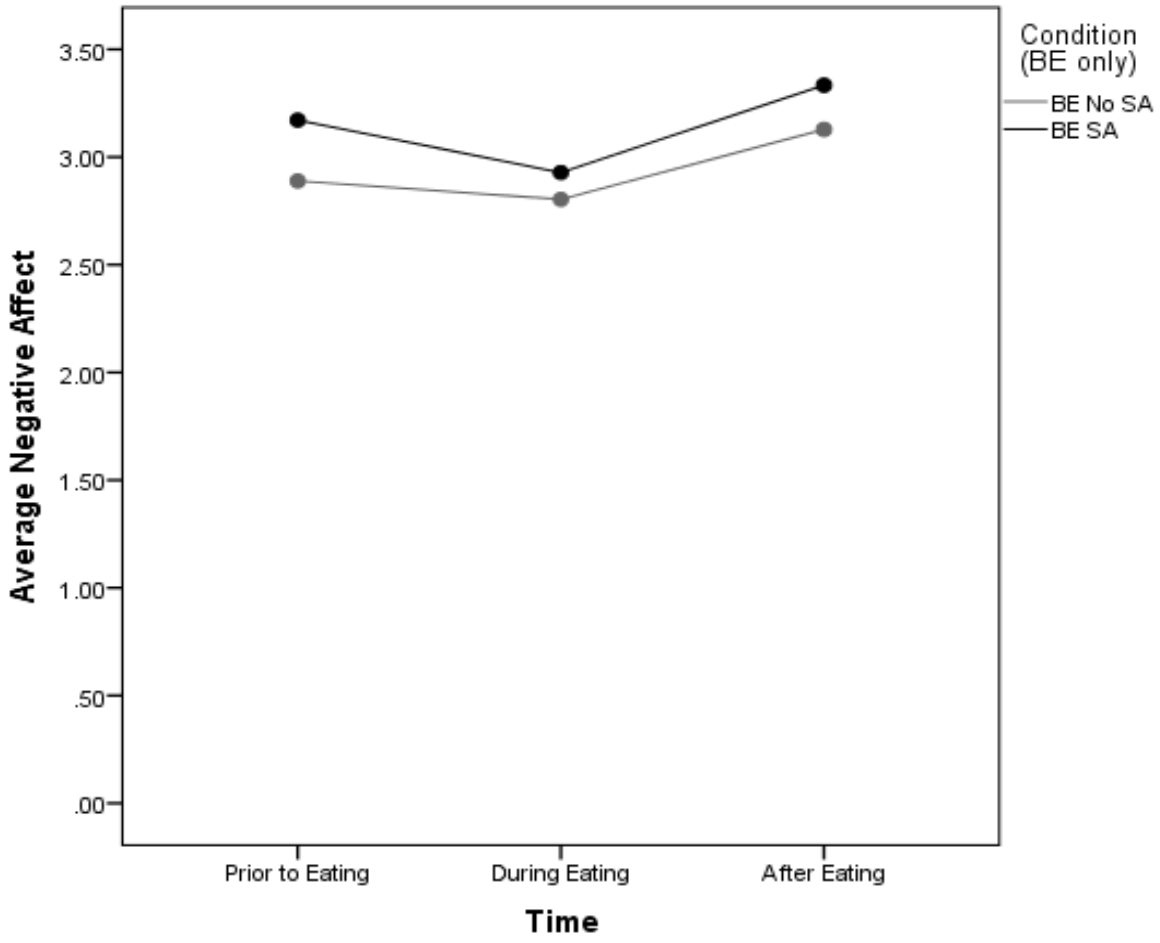

Figure 1. Negative affect ratings made prior to, during, and immediately following eating.

The same analysis was repeated with the addition of sex, BMI, loss of control, and cognitive restraint (as measured by the TFEQ). These variables were selected to examine their moderating effects on the relationship between time and guilt. Examination of between-group effects yielded no significant differences between groups on these variables (*p*s > .05), and the main effect of condition remained non-significant ($F(1, 79) = 2.135$, $p = .138$, $\eta_p^2 = .026$) following their addition to the model. The time by sex ($F(2, 78) = 1.554$, $p = .218$, $\eta_p^2 = .038$), time by loss of control ($F(2, 77) = 1.374$, $p = .259$, $\eta_p^2 = .034$), and time by cognitive restraint interaction ($F(2, 78) = 1.750$, $p = .181$, $\eta_p^2 = .043$) terms were not statistically significant. Multivariate tests revealed a significant time by BMI interaction effect ($F(1, 112.20) = 5.338$, $p = .007$, $\eta_p^2 = .122$), such that the relationship between time and guilt during the eating episode depended on BMI ($\beta = -.040$, $p = .010$, $\eta_p^2 = .081$). Specifically, for every one point increase in BMI, there was a .040 unit decrease in guilt during the eating episode. BMI did not moderate the relationship between time and guilt immediately prior to ($\beta = .004$, $p = .800$, $\eta_p^2 = .001$) or immediately following eating ($\beta = -.015$, $p = .383$, $\eta_p^2 = .010$).

Additional interactions were tested as an attempt to explain the relationship between BMI and guilt during eating. The interaction terms between time and disinhibition ($F(2, 77) = .470$, $p = .627$, $\eta_p^2 = .012$), past month binge-eating episodes ($F(2, 77) = .259$, $p = .773$, $\eta_p^2 = .007$), minutes spent eating in the laboratory ($F(2, 77) = 1.296$, $p = .279$, $\eta_p^2 = .033$), limited access to emotion regulation strategies ($F(2, 77) = 1.056$, $p = .138$, $\eta_p^2 = .027$), and nonacceptance of emotion ($F(2, 77) = 1.132$, $p = .273$, $\eta_p^2 = .033$) were not significant, suggesting the aforementioned variables neither moderate the relationship between time and guilt nor explain the relationship between BMI and guilt during eating.

Affect Regulation Model

Seven participants (all in the BE condition) did not complete the ecological momentary assessment phase of the study due to non-compliance with instructions to consume a pint of ice cream in its entirety. Of the remaining participants, 37 (43.529%) completed zero of five affecting ratings and were therefore excluded from the analysis. Missing data are assumed to be missing at random, as they were unrelated to age ($t(130) = .710$, $p = .479$), sex ($\chi^2(1, N = 132) = 3.492$, $p = .062$), student status ($\chi^2(1, N = 132) = .097$, $p = .756$), BMI ($t(130) = .175$, $p = .861$), eating disorder psychopathology ($t(130) = .450$, $p = .650$), psychosocial impairment ($t(128) = -.044$, $p = .965$), emotion dysregulation ($t(130) = -.796$, $p = .427$), guilt after eating ($t(130) = .093$, $p = .926$), and urge to engage in self-induced vomiting ($t(130) = 1.432$, $p = .155$). The analysis was conducted with 188 affect ratings from 48 total participants, 24 in each condition. On average, participants completed 3.916 of the 5 postprandial affect ratings (SD = .592). All participants completed the first affect rating, which was collected in the laboratory immediately following eating; the four subsequent ratings were collected in participants' natural environments via Palm Pilot. This analysis allows for the presence of missing data.

There was no main effect of condition (*Est.* = -.105, $t = -1.244$, $p = .217$), suggesting the BE and control group reported similar levels of guilt across the five time points. When time was centered at the average number of minutes since the eating episode, no condition by time interaction effect (*Est.* = -.056, $t = -.636$, $p = .526$) was found. However, there was a significant main effect of time (*Est.* = -.204, $t = -3.002$, $p = .003$) and condition by time squared interaction effect (*Est.* = .207, $t = 2.112$, $p = .037$). The main effect of time indicates that negative affect significantly decreased as the time since the laboratory eating episode increased. The condition by time squared interaction effect indicates that while the slopes of postprandial guilt were not

different between conditions, the slope representing the binge eating condition is more curvilinear. That is, there was significant acceleration in the initial rate of decrease in negative affect and more slowing in this decrease over time among individuals in the BE condition when compared to the control condition. These results are depicted in Figure 2.

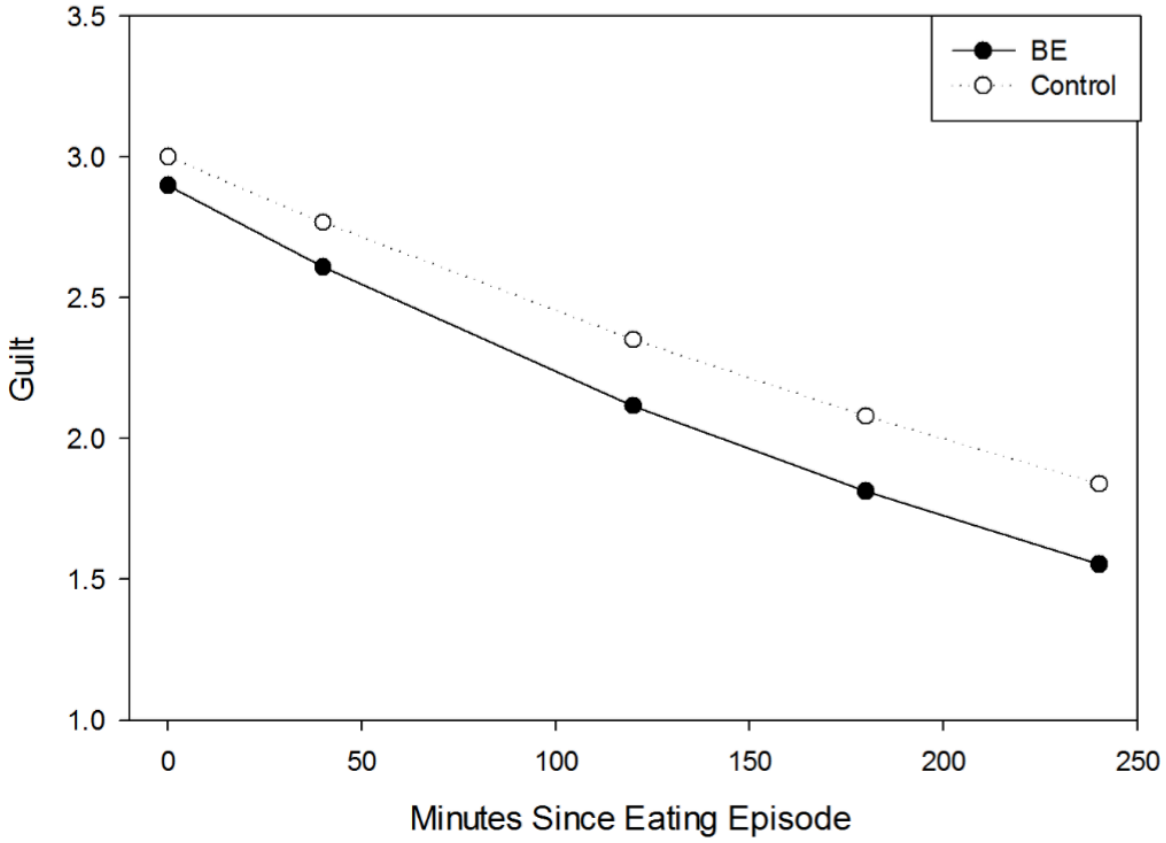

Figure 2. Postprandial guilt ratings.

The same analysis was repeated with the addition of sex, BMI, and loss of control. Each variable's interaction with condition, time, and time squared was included in the model as a random factor. The main effect of sex was included as a fixed factor. No additional effects were detected with the inclusion of these variables, though the model may have had insufficient power to detect interaction effects. The time by BMI interaction term (*Est.* = -.004, $t = 1.462$, $p = .146$) trended toward significance, suggesting trajectories of postprandial guilt may depend on BMI.

Importantly, the main effect of time (*Est.* = -.201, *t* = 3.00, *p* = .004) and condition by time squared interaction effect (*Est.* = .204, *t* = 2.110, *p* = .041) remained significant in the same direction with the inclusion of additional variables. As such, the non-significant condition by loss of control (*Est.* = -.011, *t* = -.110, *p* = .912), time by loss of control (*Est.* = .002, *t* = .903, *p* = .368), and time squared by loss of control (*Est.* = .001, t = .452, p = .652) interaction effects suggest self-reported loss of control does not account for group similarities in postprandial reductions in guilt or the curvilinear trajectory of guilt found among the BE group.

CHAPTER IV

DISCUSSION

Escape Theory

Tests of escape theory revealed post-binge increases in guilt among participants who binge eat. Guilt was shown to be significantly higher immediately following eating than during the eating episode. These findings support the relief component of escape theory, as increases in post-binge guilt may have resulted from the return of aversive self-awareness. On the contrary, after controlling for baseline affect, there were no differences between guilt immediately prior to and during the eating episode, suggesting participants did not experience reductions in self-awareness while eating as a function of cognitive narrowing and decreased inhibition. Further, participants who were induced to be self-aware and those who were left alone with their ice cream displayed the same pattern of guilt across time points, possibly suggesting that maintenance factors of binge eating are independent of processes that occur during binge-eating episodes. These discrepant findings may suggest that escape theory best explains eating behavior among a subset of individuals. The present study identified BMI as one such moderator of the relationship between time and guilt, suggesting those with higher BMIs are more prone to "escape" during eating. While it remains unclear why BMI affects guilt during eating, it is possible that consuming ice cream in a culture that values and rewards thinness elicits greater aversive self-awareness in individuals with higher BMIs, resulting in a strong desire for immediate relief.

Alternatively, the experiment may have failed to adequately induce self-awareness among most participants, accounting for the non-significant difference between antecedent and during eating guilt. Upon being debriefed, two participants assigned to the induced self-awareness binge eating condition noted suspecting that the camera used in the induction was not actually recording them, though it is unknown how many participants questioned or did not believe the induction. It is also possible that knowledge of being recorded is insufficient to increase self-awareness in the age of social media, in which 90% of 18- to 29-year-olds use networks where media is shared without explicit consent (e.g., "snapchatting" a video of a friend, Perrin, 2015). Future experimental studies examining escape theory may benefit from inducing self-awareness by placing a confederate in the room.

Alternatively, the unfamiliar laboratory setting may have induced heightened levels of awareness even among participants who did not undergo the self-awareness induction. It is possible that the laboratory setting or frequency in which the research assistant entered the room prevented reductions in self-awareness that occur while binge eating under real-life circumstances. Lastly, despite the intentional brevity of the modified guilt scale, it is likely that assessing an internal mood state facilitates self-awareness. It is generally thought that participants need to be self-aware in order to assess their mood state. This renders testing escape theory difficult, as the theory's central premise is that decreases in aversive self-awareness cause reduced negative affect during bingeing, negatively reinforcing the behavior. While a previous study measured heart rate and heart rate variability preceding loss-of-control eating episodes (Ranzenhofer et al., 2016), such measures would be inappropriate indicators of emotion or arousal during eating due to the concurrent physiological effects of eating. As such, it may not be possible to reliably test escape theory at the present state of technology.

Other elements of the study may have led to the failure to capture reductions in guilt during binge eating, if they actually occurred. For instance, the modified guilt scale was administered 10 minutes into the binge-eating episode, which was selected on the basis of a previous finding (Deaver et al., 2003) in which reductions in negative affect while bingeing occurred between eight and 15 minutes. However, administering the measure at the ten-minute mark excluded affect ratings during bingeing among several participants (5.6%) who had already finished their ice cream. Given the relation between eating rate and distraction (de Graaf & Kok, 2010), such participants may have been less self-aware while eating than participants who took longer to consume the ice cream. Future studies could randomize the time that measures of "while eating" affect are administered, as escape theory does not identify the point during binge ending at which guilt decreases.

Findings of the present study appear to be consistent with those of Hilbert and Tuschen-Caffier (2007), whose EMA study revealed continuous negative affect prior to and throughout the course of binge eating among women with bulimia nervosa and binge-eating disorder. Differences between pre- and post-binge negative affect ratings found by Haedt-Matt and Keel (2011) were not replicated in the present study. This may be the result of method variance or the varied timing of pre-binge affect measurements included in their meta-analysis.

Affect Regulation Model

Tests of the affect regulation model of binge eating found reductions in guilt over the course of four hours following a laboratory eating episode. Decreases in guilt occurred in both the control and BE conditions, suggesting the relief component of affect regulation model may not be specific to one type of eating episode among individuals who binge eat. However, guilt was found to have initially decreased more rapidly following eating among those in the BE

condition than the control condition. This suggests that the emotion regulatory function of eating among individuals who ate an objectively large amount of food in the absence of objective control was better accounted for by the manipulated eating episode than the mood-enhancing effects of normal eating episodes possibly found among control participants. The rate of these initial decreases in guilt among the BE condition increase the likelihood that the behavior will be repeated, reflecting the negatively reinforcing function of binge eating. Accelerated reductions in guilt may have resulted from the comfort and distraction of food, as posited by affect regulation model to occur in the context of binge eating.

Taken together, these findings lend support for the relief component of affect regulation model and appear to be partially consistent with previous experimental and ecological momentary assessment studies. Consistent with the BE condition in the present study, Berg and colleagues (2015) found decreases in guilt over the course of four hours following both objective overeating and binge-eating episodes among obese adults. Telch and Agras (1998) also found postprandial reductions in negative affect among individuals who binge eat regardless of caloric consumption or eating episode type. However, their findings are in contrast with those of the present study in that reductions in negative affect occurred immediately following eating; guilt increased after eating in the present study.

The present study's finding that guilt initially decreased more rapidly following eating in the BE condition was most consistent with an ecological momentary assessment study of women with bulimia nervosa (Smyth et al., 2007). Specifically, the study found accelerated rates of reductions in negative affect and anger/hostility in the four hours following binge eating. In contrast with the present study, Berg and colleagues (2015) and Engel and colleagues (2013) found linear, but not accelerated rates of, decreases in guilt and negative affect following binge

eating/objective overeating episodes and loss of control eating episodes among women who are obese and have anorexia nervosa, respectively. The present study's finding could not be compared with findings from experimental studies testing affect regulation model, as the two studies examining the model's relief component used pre- and post-affect ratings to test affective changes (Telch & Agras, 1998; Ranzenhofer et al., 2013).

The present study extends experimental research on affect regulation model in several meaningful ways. To this author's knowledge, it was the first experimental study to manipulate the amount of food consumed in the BE condition and examine the relief component of the model in the hours following eating. These additions decrease error associated with variability of eating episodes and ensure participants in the BE condition consumed an objectively large amount of food. This is particularly important in understanding how eating behavior affects affect regulation, as studies have suggested that individuals with and without eating disorders often inaccurately report the quantity of their eating episodes (Mitchell et al., 1998). Additionally, the study design extends laboratory findings on pre- and post-eating affect ratings to include post-eating trajectories of guilt in the natural environment.

The inclusion of the control condition represents a strength of the present study and was necessary to differentiate postprandial reductions in negative affect occurring as a function of normal eating episodes from those occurring as a function of disordered eating behavior. However, the extent to which participants assigned to the control condition engaged in normal eating episodes is unclear, as they reported higher average loss of control than participants in the binge eating conditions, and a quarter of the group consumed the full pint of ice cream. Despite these qualities resembling binge or loss of control eating episodes, findings suggest that reductions in guilt over time did not depend on self-reported loss of control. As such, it may be

that groups perceived loss of control differently as a result of assigning meaning to their eating behavior based on the induction they underwent. Indeed, while loss of control over eating is an established construct uniquely associated with increased distress and impairment, it remains unclear whether loss of control drives disordered eating behavior or if eating disorder psychopathology results in interpreting eating behavior as indicating a loss of control (Goldschmidt, 2017). Because the control condition did not undergo the objective control manipulation, they theoretically had control over the amount of ice cream they consumed. Consequently, the decision to consume the amount of ice cream they did may have been more distressing than being instructed to consume the ice cream in its entirety, resulting in the interpretation that they must have lost control.

Perhaps the greatest limitation of the present study's examination of affect regulation model was the small sample size and large proportion of participants with no recorded ecological momentary assessment data (43.529%). This reduces the reliability and generalizability of results and decreases power to examine how additional variables affect the relationships observed. Further, because ecological momentary assessment data only represent a proportion of total participants, comparisons of guilt ratings made during the laboratory visit (which were completed by the entire sample) to those made in the following hours should be made cautiously, limiting the extent to which trajectories of guilt can be examined.

Additionally, this study did not assess for eating disorder behaviors that may have occurred during the four-hour period following the laboratory eating episode. This is problematic, as such behaviors (e.g., additional binge eating, self-induced vomiting) have been found to be associated with reductions in negative affect (Berg et al., 2015; Engel et al., 2013,

Smyth et al., 2013) and may better account for reported reductions in guilt than the laboratory eating episode.

Overall Strengths and Limitations

The present study's use of an experimental design overcame limitations of previous research on affect regulation models of binge eating and expanded upon the literature by testing components of such models that are infrequently studied in laboratory settings. Unlike previous experiments studying binge and loss of control eating, both objective overeating and loss of control were measured as an attempt to adhere to clinical definitions of binge eating. Moreover, objective overeating was defined by the quantity of food consumed as opposed to energy consumption, which can over or underestimate binges depending on the macronutrients of the food. Laboratory eating episodes have the additional advantage of reducing self-report biases inherent in ecological momentary assessment (e.g., reporting objective overeating as a binge eating episode), and, combined with randomization, the likelihood that postprandial affective changes are the result of an unknown variable.

The use of ecological momentary assessment following the laboratory visit constituted an additional strength. Ecological momentary assessment enhanced the ecological validity of the study and reduced response biases associated with retrospective recall. Importantly, it provided a feasible method for assessing the four-hour time frame following a controlled laboratory eating experiment (Berg et al., 2015, Engel et al., 2013, Smyth et al., 2007), which would be burdensome and unrealistic if assessed in the laboratory. This study was the first to use ecological momentary assessment to measure affective changes following a laboratory eating experiment and found support for the affect regulation model of binge eating using this combined methodology.

The present study utilized a combined college and community sample of individuals who binge eat. The use of a non-clinical sample extended findings on maintenance models of binge eating in the eating disorders to a broad range of individuals who engage in binge eating. However, the sample was very small, and its heterogeneity of eating disorder symptomatology and behaviors may have increased error, further reducing power to detect significant effects. Moreover, the small sample may have underrepresented or misrepresented specific demographics. While this was one of the first studies of affect regulation models of binge eating to include men, only 31 men participated. This is likely not a representative sample of all men who binge eat, particularly given that participants' eating disorder psychopathology scores on the EDE-Q were not statistically different from a male eating disorder population. Thus, this might have been a particularly pathological community sample of males who binge eat. Lastly, the fifty participants who completed Phase I but not Phase II of the study were older and less likely to be currently enrolled in college with greater eating disorder psychopathology and resulting psychosocial impairment when compared to the current sample. While such individuals may have been more representative of a clinical sample, they provide further evidence that certain demographics were underrepresented in the present study.

Another limitation of the present study is the difficulty classifying eating episodes among participants across conditions. One factor contributing to this difficulty is the large number of participants who were assigned to the control condition and consumed the ice cream in its entirety or assigned to the binge eating conditions but did not finish the pint. Even so, the binge eating manipulation was effective in influencing the amount of ice cream consumed, and tests of escape theory were significant in the same direction regardless of the inclusion or exclusion of participants who did not finish their ice cream. Future studies could manipulate the amount of ice

cream consumed by the control condition to better differentiate normal eating episodes from binge-eating episodes.

Relatedly, it is unclear if the manipulation of control induced loss of control among participants in the binge eating conditions. Perceived loss of control over eating was assessed dimensionally (i.e., on a scale from 0-100) in this study, as opposed to dichotomously as detailed in the DSM-5 (American Psychiatric Association, 2013). While this approach yields more detailed information, there is no established cut-off for determining what constitutes a clinically significant loss of control, complicating classification of eating episodes among participants who rated loss of control while eating as greater than zero. Despite undergoing different experimental inductions, it is possible that each condition is comprised of participants with vastly different laboratory eating experiences. For example, some participants in the control condition may have engaged in binge eating, while some participants in the binge eating condition may not have experienced a sense of loss of control. Given this possibility, caution should be warranted when generalizing findings to specific types of eating episodes (e.g., those who binge ate in the laboratory). Similar variation may exist within classifications of binge, objective overeating, and loss of control eating episodes in previous ecological momentary assessment studies, as cut-offs on scales measuring loss of control (e.g., score of 3 or higher on a scale from 1-5 on at least one of four loss of control items; Berg et al., 2015) and participant classification of eating episodes (e.g., self-reporting a "binge"; Engel et al., 2013) have typically been utilized to determine loss of control.

Importantly, the study lacked adequate power to test many of the proposed relationships and post hoc interpretations of results, thereby limiting more nuanced interpretations of findings. Two major issues contributing to low power were non-compliance with ecological monetary

assessment and recruitment difficulties. It is unclear why compliance with ecological momentary assessment was so low, as participant data were shown to be missing at random. In addition to occasional technological difficulties that precluded the signaling of participant questions or the encoding or retrieval of participant data, one such explanation is that carrying and using an outdated, unfamiliar, and relatively heavy device, in addition to other devices that are frequently transported throughout the day (e.g., cell phone, laptop), likely increased participant burden and facilitated non-compliance. Low drop-out and high compliance rates reported in recent ecological momentary assessment studies of eating behavior were achieved with the use of more recent technology such as Palmtop computers. Recruitment difficulties were characterized by an inability to reach interested participants (i.e., those that called, emailed, or provided their contact information online via a Facebook advertisement) via telephone or email and frequent "no shows" to laboratory visits despite confirmation emails and phone calls.

Clinical Implications

Despite its limitations, findings of the present study have preliminary theoretical and treatment-related implications. Overall, guilt did not did decrease during eating episodes when compared to immediately preceding them, but decreases were associated with higher BMI, suggesting escape theory may be most applicable to individuals of a higher BMI. Increases in guilt were found in the immediate moments after consuming a large quantity of food in the absence of objective control but were followed by initial accelerated reductions in guilt followed by increased slowing over the next four hours. Such findings provide support for the relief component of the affect regulation model in a mixed college and community sample of adults who binge eat, suggesting accelerated reductions in guilt may have resulted from the comfort and distraction of food and serve to maintain the eating behavior via negative reinforcement.

Postprandial reductions, but not accelerated decreases, in guilt were also found among participants who retained objective control over eating, which may be a mood-enhancing function of normal eating episodes.

Treatments targeting the role of negative emotions in precipitating and maintaining eating disorder behaviors may be beneficial for non-clinical individuals who engage in binge eating. Given the self-evaluative cognitive processes involved in the development of guilt (Tracy & Robins, 2004), Cognitive Behavioral Therapy- Enhanced (CBT-E; Fairburn, 2008) may be helpful for influencing negative emotions through cognitive restructuring of thoughts regarding failing to prevent negative outcomes through exertion of behavioral control. While tailored to individuals with full or subthreshold bulimia nervosa, Integrative Cognitive Affective Therapy (ICAT-BN; Wonderlich et al., 2014) may be particularly beneficial for learning emotion regulation skills and applying them in response to high levels of guilt.

Future Research Directions

Future research could greatly improve upon the present study. The study should be replicated with much larger samples, allowing adequate power to test mediators and moderators of the relationship between binge and normal eating episodes and affect regulation. Additionally, a diagnostic interview such as the Eating Disorder Examination (Fairburn & Beglin, 2008) or full self-report Eating Disorder Diagnostic Scale (Stice et al., 2000) should be administered at baseline to accurately characterize the severity of the sample and examine the effect of eating disorder diagnosis on the relationship between eating episode and resulting affect regulation.

Recent studies have examined constructs that could potentially enhance the understanding of affect regulation models of binge eating (Berner et al., in press, Mason et al., 2017). For example, one study found temporal relationships between affective instability and

bingeing and purging behaviors, such that affective instability was greater following eating disorder behaviors than it was prior to them (Berner et al., 2017). These findings suggest that while short-lived reductions in negative affect occur after eating disorder behaviors, they may come at the expense of exacerbating affect instability and driving subsequent eating disordered behaviors. Future studies should examine both average negative affect instability and negative affect over time to better understand these constructs and their unique relationship to binge eating.

Future studies should focus on increasing the ecological validity of laboratory eating studies to ensure that behaviors and constructs of interest (e.g., binge eating, loss of control) are either adequately experimentally induced or are able to occur naturally. While the negative affect induction employed in the current study was highly effective, reading an emotional passage to a stranger may have drawn attention to the artificial setting and uniqueness of the situation immediately prior to eating. For this reason, it may be beneficial to use a real-time interpersonal stressor as an affect manipulation. One option would be to utilize deception and allow confederates who appear to be uninvolved with the study to facilitate a stressful interaction with the participant prior to the eating episode. Interpersonal stressors are powerful triggers of binge eating in the natural environment (Goldschmidt et al., 2014; Ivanova et al., 2015) and should not decrease the effectiveness of the affect induction. Affect inductions replicating the present study should aim to elicit guilt.

In addition to ecological validity, perceived participant privacy should be prioritized in future laboratory eating studies to ensure the eating environment does not induce negative affect or distract participants from eating. For example, to reduce the number of times the experimenter enters the laboratory, participants could be instructed to retrieve and prepare their own food (e.g.,

from an in-lab refrigerator) and signaled electronically (much like ecological momentary assessment) to complete affect ratings on a phone or iPad in the laboratory. Experimenters could arrange to observe participants from a concealed camera to ensure compliance and facilitate the signaling of measures at the appropriate times. When attempting to facilitate binge eating, participants should be provided clear study instructions and informed beforehand that the research assistant will not enter the laboratory until signaled via electronic communication. Lastly, researchers should attempt to involve participants in the creation of future study designs by asking them how representative the laboratory setting was of environments they typically binge eat in and what specific changes could be implemented to improve it.

Conclusion

The present study aimed to examine the relief components of two commonly accepted theoretical models of binge eating (e.g., escape theory and affect regulation model of binge eating) that are infrequently experimentally tested. Two methodological (i.e., experimental design and ecological momentary assessment) and data analytic approaches (i.e., pre-post ratings of affect and mixed effects modeling) were utilized to combine strengths of previous studies and better understand discrepant findings regarding these models of binge eating. Results were consistent with the affect regulation model of binge eating and provided preliminary support for escape theory among those with higher BMIs. While guilt increased immediately following eating when compared to during eating, participants experienced postprandial reductions in negative affect in the four hours following eating. Such reductions initially occurred more rapidly among those who consumed an objectively large amount of food in the absence of objective control, providing support for the relief component of the affect regulation model and the role of negative reinforcement in maintaining this eating behavior. Replication of these

findings with larger sample sizes is necessary. Future studies should aim to enhance ecological validity of the laboratory study and improve study design to ensure eating episodes reliably represent binge and normal eating episodes occurring outside of the laboratory.

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