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Jenna N. Blewis April 1, 2012

The Restraint Pathway to Binge Eating: Roles of Preoccupation and Appetite Awareness

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Abstract

The Restraint Pathway to Binge Eating: Roles of Preoccupation and Appetite Awareness
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Previous investigations of the dietary restraint pathway have yielded incongruent findings regarding the association between dieting and binge eating, but few studies have explored the mechanisms involved in this complex pathway. Theory and research implicate preoccupying thoughts about food and poor awareness of hunger and fullness signals as potential mediators of the restraint pathway to binge eating. Accordingly, this study examined whether preoccupation with food and appetite awareness mediated the relationship between dieting and binge eating. Ninety college-aged women completed self-report measures assessing dietary restraint, preoccupation with food, appetite awareness, and binge eating. Results from a series of regression analyses indicated that preoccupation with food and appetite awareness mediated the relationship between dietary restraint and binge eating. In addition, exploratory analyses revealed that preoccupation with food mediated the effects of dietary restraint on appetite awareness, though appetite awareness did not mediate the relationship between preoccupation and restraint. These findings suggest that the dieter's growing obsession or preoccupation with thoughts about food may result in limited resources to attend to bodily signals, leading to poorer appetite awareness and less mindful eating. Future research should attempt to investigate these relationships longitudinally to gain a better understanding of the development of this pathway.

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The Restraint Pathway to Binge Eating: Roles of Preoccupation and Appetite Awareness

Binge eating, or overeating accompanied by a sense of loss of control, is an eating disorder symptom that is commonly experienced by female undergraduates. In a recent study (Kelly-Weeder, 2011), 50% of college-aged women reported "eating within a 2-hour period an amount of food that is definitely larger than most people eat in a similar period of time." (p. 34). This finding is similar to those of earlier researchers who reported that 56% (Katzman, Wolchik, & Braver, 1984) and 53% (Lakin & McClelland, 1987) of female undergraduates endorsed binge eating. The idea that binge eating is prevalent among subclinical populations has become widely accepted among practitioners and researchers in the field. Conceptualizations of binge eating, however, have not always encompassed individuals without diagnosable eating disorders. In fact, binge eating was historically assumed to be a symptom unique to bulimia, to the extent that "the terms *bulimia* and *binge eating* [were] often … used interchangeably (Casper, Eckert, Halmi, Goldberg, & Davis, 1980)" in the literature (Lakin & McClelland, 1987, p. 154). It was not until the 1980s, when the symptom was observed in subgroups of both patients with anorexia and patients who binged but did not purge, that the concept of binge eating was recognized as being relevant to much of the diagnostic spectrum of eating disorders (Lakin & McClelland, 1987; Racine, Burt, Iacono, McGue, & Klump, 2010).

According to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM–IV-TR*; American Psychiatric Association [APA], 2000), *binge eating* is defined as the consumption of an objectively large amount of food within a short period of time (i.e., within two hours) that is accompanied by a sense of loss of control over eating behavior (American Psychiatric Association, 2000). However, the concept of binge eating in the context of subclinical disordered eating behaviors typically entails the consumption of a smaller amount of

food than that observed in clinical binge eating and can therefore be referred to as subjective binge eating (Polivy & Herman, 1985). Nonetheless, binge eating has been associated with a number of aversive outcomes, including elevated anxiety and depression; increased body dissatisfaction; poor self-esteem; and weight gain (Craighead, 2006; Smith, Williamson, Bray, and Ryan, 1999). In addition, the loss of control experienced during binge eating episodes can destroy an individual's sense of self-efficacy, and the secrecy surrounding these episodes often leads to social isolation and withdrawal (Craighead, 2006). Most important, subclinical binge eating is a risk factor for the development or exacerbation of obesity (Desai, Miller, Staples, & Bravender, 2008) and a precursor to full-blown eating disorders (e.g., bulimia nervosa, binge eating disorder, and anorexia nervosa binge-purge type). Reducing the risk for binge eating among college women is therefore a primary goal of eating disorder and obesity prevention efforts. Accordingly, identifying factors involved in the onset and maintenance of binge eating has been a research priority.

One prominent risk factor that has emerged from previous research is dietary restraint (Polivy & Herman, 1985; Stice & Shaw, 2002), which refers to "the intent and/or attempt to restrict caloric intake" (Racine et al., 2010, p. 119). This is particularly alarming given the high rate of self-reported dieting among college women, including many who are not overweight. In 1998, Ackard surveyed 560 female undergraduates at an American university and reported that 43% of underweight women (Body Mass Index [BMI] < 19), 68% of normal weight women (BMI = 19 to 24), and 87% of overweight women (BMI > 24) had dieted (as cited in Ackard, Croll, & Kearney-Cooke, 2002). However, although dieting has been implicated in the development of binge eating, it clearly does not always lead to this outcome. According to Van Strien, Engels, Van Leeuwe, & Snoek (2005), this suggests the need "to investigate the

possibility that dieting is linked to [binge eating] only in a subgroup of dieters" (p. 211). The question then arises: what distinguishes the subgroup of dieters who *also* overeat from the dieters who do not?

In order to address this question, it is important to elucidate the specific mechanisms involved in the dietary restraint pathway to binge eating ("the restraint pathway;" Stice & Shaw, 2002). Accordingly, the present study investigates the roles of two potential mechanisms: preoccupation with food and appetite awareness. We examine relationships amongst self-reported levels of preoccupation with food, appetite awareness, dietary restraint, and binge eating among college-aged women in order to determine whether high preoccupation with food and poor appetite awareness partially explain the complex relationship between dietary restraint and binge eating. This is accomplished by examining preoccupation with food and appetite awareness as mediators of the restraint pathway following Baron and Kenny's (1986) criteria for testing mediator effects (which we will discuss in more detail later).

Research on Dieting and Binging

A significant body of cross-sectional and longitudinal research suggests that dietary restraint promotes binge eating (Racine et al., 2010). As noted previously, measures of dietary restraint typically assess the reported *intent* to restrict caloric intake (Racine et al., 2010) and do not evaluate actual dietary intake.

The first line of evidence in support of the dietary restraint model comes from retrospective studies of clinical samples that reveal trends in the temporal onset of dieting and binge eating. In a sample of 108 women with bulimia, retrospective reports revealed that dieting preceded the onset of binge eating in the majority (81%) of participants, and almost all participants (96%) reported dieting prior to the onset of diagnosable bulimia (Bulik, Sullivan,

Carter, & Joyce, 1997). These results are consistent with those of other studies involving clinical samples (e.g., Mussell et al., 1997), indicating that dieting typically comes before binge eating in the development of bulimia.

Furthermore, the second major line of evidence is the longitudinal finding that self-reported levels of dietary restraint anticipated future increases in bulimic symptoms. Dieting was the strongest predictor of the onset of binge eating in a longitudinal sample of 218 adolescent girls (Stice & Agras, 1998). This finding is consistent with the results of other prospective studies demonstrating that initial reports of dieting predicted subsequent increases in binge eating in high school girls (Stice, 2001; Stice, Presnell, & Spangler, 2002). Comparable findings have been documented in samples of college women. Stice, Nemeroff, and Shaw (1996) surveyed 257 female undergraduates and found that reported levels of dietary restraint mediated the effects of body dissatisfaction on bulimic symptoms, thus providing support for the dietary restraint pathway. Taken together, these findings appear to corroborate the theoretical involvement of dietary restraint in the development of binge eating.

However, the results of other research studies are not consistent with the dietary restraint model. In a longitudinal study of Dutch undergraduates (Spoor et al., 2006), dietary restraint did not predict 12-month increases in binge eating in 127 college-aged women. Furthermore, several experimental studies that assessed long-term caloric deprivation found a negative correlation between dieting and binge eating. For example, assignment to a brief diet intervention resulted in a decrease in bulimic symptoms relative to controls in 82 non-obese women (Presnell & Stice, 2003) and 188 adolescent girls (Stice, Presnell, Groesz, & Shaw, 2005).

Thus, while the results of many survey studies illustrated that self-reported dieting predicted increases in binge eating, several experimental findings indicated that following a

controlled diet did not always confer risk for bulimic symptoms and even resulted in a decrease in these symptoms in some cases. There are many possible explanations for the contradictory research findings. First, dietary restraint may interact with other etiological factors in the development of binge eating. For example, Racine et al. (2010) reported that the effects of genetic and environmental influences on binge eating were significantly moderated by dietary restraint.

Another possibility is that the anomalous findings reflect methodological inconsistencies. Differences in definitions and measures of restraint make it difficult to draw comparison across studies (Howard & Porzelius, 1999; Ogden, 1993; Spurrell, Wilfley, Tanofsky, & Brownell, 1997). Moreover, the construct of dieting that is captured by the self-report dieting scales appears to be markedly different from that reflected by the controlled laboratory studies. Specifically, the finding that self-report measures of dietary restraint predicted weight gain (Stice, 2001) suggests that these measures do not assess actual caloric restriction but rather the perceived intent to restrict calories. Ogden (1993) tested this assumption in a sample of 189 British medical students. He examined participant responses to two measures of restraint and found that "when answering questionnaires, subjects [did] not differentiate between items relating to attempts at dieting and actual restrictive behavior and that restrained eating can be conceptualized in terms of both successful and failed restraint" (p. 69). Moreover, in 2003, Timmerman and Gregg reported significant positive correlations amongst several types of self-reported dieting behaviors (e.g., daily intent to diet, self-reported percentage of time spent dieting, and general dietary restraint).

Taken together, these results indicate that the self-report measures of restraint are in fact accurate reflections of the construct of dieting in the natural environment. Thus, neither binge

eating nor weight loss is a guaranteed outcome of dieting. However, many dieters achieve and/or maintain healthy weight loss while others develop maladaptive symptoms like binge eating. Therefore, the primary purpose of this study is to investigate the factors that might increase the likelihood of developing binge eating as a consequence of dieting.

Theoretical Accounts of the Restraint Model

There are many possible pathways from which dietary restraint may lead to binge eating. One possibility is that binge eating may be a physiological defense or response to the effects of caloric deprivation (Stice, 2002). Research from animal models supports this assertion; assignment of rats to a 12-week restriction-refeeding cycle resulted in binge eating, especially of palatable food, even after a 30-day period of ad-lib eating (Hagan & Moss, 1997). Similar findings have been replicated in experimental studies with human subjects. For example, Coscina and Dixon (1983) observed that participants who were assigned to “diet-like deprivation conditions" subsequently engaged in binge-eating behavior, even after a period of weight restoration (as cited in Polivy & Herman, 1985).

In addition to physiological factors, cognitive mechanisms appear to play an equally if not more important role in promoting binge eating in dieters (Polivy & Herman, 1985). In an attempt to explain the observed association between dieting and binge eating, Polivy and Herman (1985) proposed the restraint theory, which argues that dieting requires an individual to depend more heavily on cognitive cues than on physiological ones to guide eating behavior and regulate consumption. Because dieters are under increasingly less physiological control, they are vulnerable to episodes of disinhibited eating when their cognitive controls are disrupted (Herman & Polivy, 1983; Polivy & Herman, 1985).

This psychological state in which dieters binge eat after breaking one diet rule is often called the "what-the-hell effect," because any diet failure is perceived as losing control and an excuse to temporarily abandon one's diet (Herman & Polivy, 1983; Craighead, 2006). According to Craighead (2006), the what-the-hell-effect can be understood as a classic example of "all-or-nothing thinking," a common yet distorted cognitive style in which one views people, events, and situations as entirely good or entirely bad. Even small diet failures can result in binge eating episodes, because the dieter does not see a point in trying to maintain control after she has already failed (Craighead, 2006). In support of this phenomenon, Polivy (1976) demonstrated that dieters' beliefs about the caloric content of a forced preload (i.e., test meal) had a greater influence on subsequent consumption than did the actual caloric content of the preload (as cited in Polivy & Herman, 1985). Thus, in an "all or nothing" fashion, the dieters ate more after a preload that they believed was high in calories because they *thought* they had already broken their dietary rules (Craighead, 2006).

This phenomenon should theoretically be more pronounced in rigid or strict forms of dieting because they entail an increased reliance on cognitive controls over eating, which increases the likelihood of a perceived dieting failure (Polivy & Herman, 1985). Overeating in response to dieting may therefore ensue when persistent thoughts about food are mistaken for actual hunger, due to poor awareness of internal appetitive signals and high cognitive preoccupation with food and eating. Accordingly, the current investigation hypothesized that the relationship between dietary restraint and overeating/binge eating would run through the intervening variables preoccupation with food/eating and appetite awareness. An overview of the available theoretical and experimental support for each of these potential mediators is discussed in detail below.

Preoccupation with Food as an Hypothesized Mediator

The first proposed mediator is preoccupation with food/eating (see Figure 1). The theory is that dieting may lead to feelings of deprivation (*perceived deprivation*; Timmerman & Gregg, 2003), which may result in increased preoccupation with thoughts about food, particularly forbidden and highly palatable foods. Dieters may attempt to suppress these unwanted thoughts about food, and this has been shown to lead to overeating (Polivy & Herman, 1985; Smith et al., 1999).

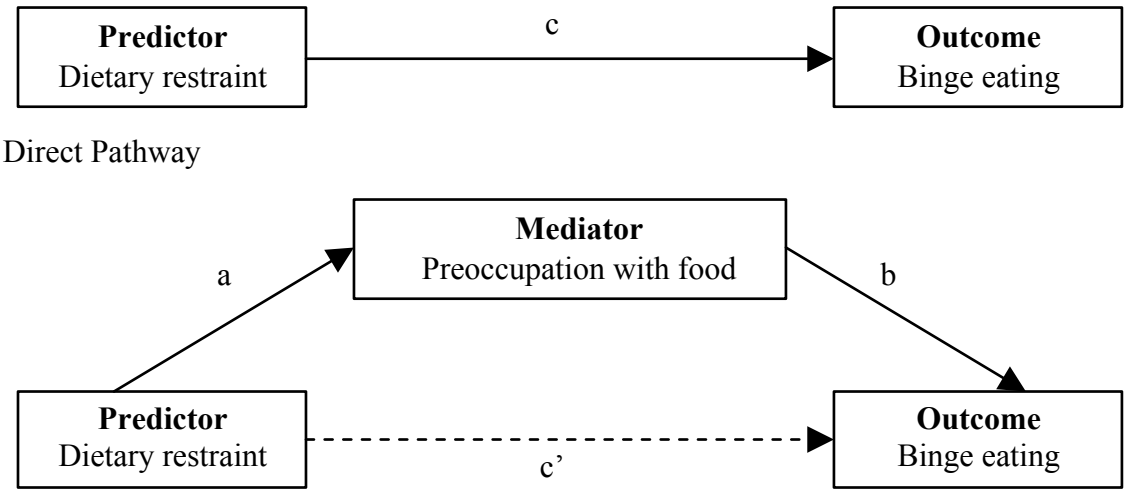

Figure 1. Graphical model of preoccupation with food as a hypothesized mediator of the restraint pathway to binge eating. Path a = independent variable affects the mediator; path b = mediator affects the outcome variable; path c = independent variable affects the outcome variable; path c' = effect of the independent variable on the outcome when controlling for the mediator. Adapted from "Eating Disorder Prevention in Sororities: Testing Mediators of Intervention Effects (Master's thesis)," by L. M. Smith, 2009. Retrieved from http://www.etd.library.emory.edu.

In support of this, previous research has reported significant positive correlations between preoccupation with food and both dietary restraint (Timmerman & Gregg, 2003) and binge eating (Lakin & McClelland, 1987). Lakin and McClelland (1987) surveyed a random population of high school students and reported that unwanted thoughts about food

(preoccupation) and the meaning of food were the best predictors of binge eating. Moreover, Lakin and McClelland (1987) indicated that their results converge with those from previous studies that reported an association between preoccupation with food and binge eating in samples of college women. Ondercin (1979), for example, found that an increased preoccupation with food significantly predicted the severity of binge eating among female undergraduates (as cited in Lakin & McClelland, 1987).

In addition, Tapper and Pothos (2010) also investigated the prevalence and correlates of preoccupation with food in college students. Female students, current dieters, and individuals with a history of dieting reported more frequent and more negative thoughts about food (Tapper & Pothos, 2010). Moreover, frequency and negativity of thoughts about food were significantly positively correlated with all psychopathology-related measures, including two measures of restraint and a measure of binge eating. Tapper and Pothos also found a linear relationship between dieting status and both frequency and negativity of food-related thoughts (2010). Thus, preoccupation with food was lowest in undergraduates who had never dieted and highest in those who were currently dieting. This body of research implicates the possible mediating role of preoccupation with food and eating in the pathway from dieting to binging.

Appetite Awareness as an Hypothesized Mediator

Poor appetite awareness is the second proposed mechanism (see Figure 2). *Appetite awareness* is—in conjunction with emotional awareness—one of the two components of *interoceptive awareness* (i.e., awareness of internal sensations), and it refers to awareness of internal sensations of hunger and fullness. *Poor* appetite awareness therefore reflects difficulties in the recognition of internal appetitive signals (Brown, Smith, & Craighead, 2010). Dieting theoretically leads to binge eating through poor appetite awareness because dieting is mediated

by cognitive factors, rather than physiological ones, and the likelihood of binge eating is thought to increase when eating behavior is not governed by internal hunger and fullness cues (Craighead & Allen, 1995). Thus, by attending primarily to cognitive cues to guide eating behavior, the dieter may be ignoring or tuning out internal appetitive signals. If positively reinforced over time, this could lead to an impaired ability to recognize hunger and fullness cues.

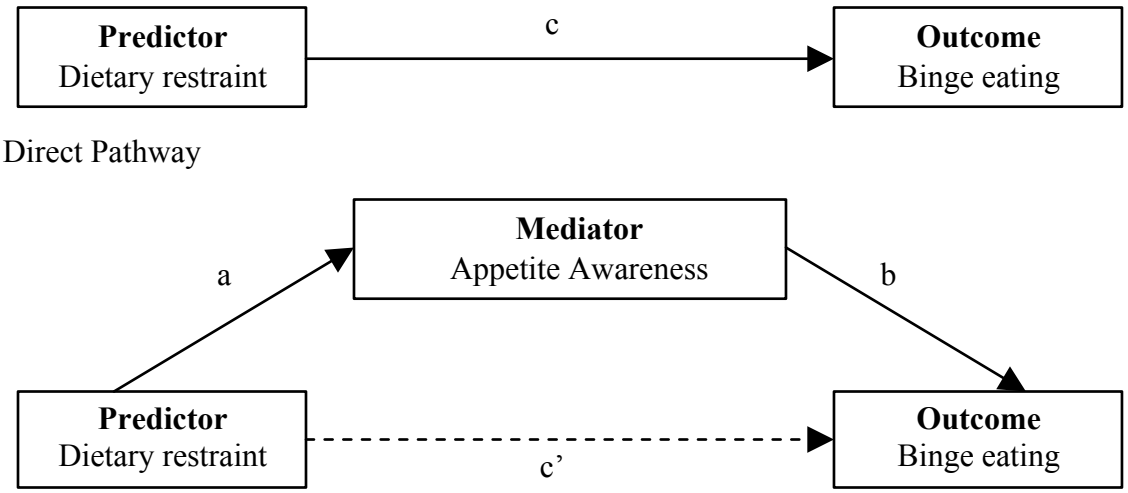

Figure 2. Graphical model of appetite awareness as a hypothesized mediator of the restraint pathway to binge eating. Path a = independent variable affects the mediator; path b = mediator affects the outcome variable; path c = independent variable affects the outcome variable; path c' = effect of the independent variable on the outcome when controlling for the mediator. Adapted from "Eating Disorder Prevention in Sororities: Testing Mediators of Intervention Effects (Master's thesis)," by L. M. Smith, 2009. Retrieved from http://www.etd.library.emory.edu.

The literature on appetite awareness, dietary restraint, and binge eating is scarce. The majority of the research on interoceptive awareness and eating pathology has not differentiated between the effects of appetite awareness and emotional awareness. To date, only one study (Brown et al., 2010) has examined the distinct influence of appetite awareness on bulimic pathology. Brown and colleagues (2010) separately evaluated the roles of appetite awareness and emotional awareness in an eating disorder prevention program and found that only appetite awareness mediated observed improvements in binge eating and dietary restraint. Consistent

with this, an impaired response to appetite cues has been observed in women who binge (Craighead & Allen, 1985), and binge-eating college students were less aware of satiety cues than their non-binging peers in one study (Heilbrun & Worobow, 1991). Although more research is needed, the results of these studies implicate poor appetite awareness as a potential mediating mechanism.

Statement of Problem and Hypotheses

We hope to contribute to the existing literature on the etiology of binge eating by clarifying some of the mechanisms involved in the restraint pathway to binge eating. The results of this study may shed light on the discrepancies in the literature. An additional objective of this investigation is to add to the limited available data on appetite awareness and eating pathology, because we believe this is an important yet largely ignored subject. Although poor interoceptive awareness has consistently been linked with disordered eating attitudes and behavior (Jacobi et al., 2004; Myers & Crowther, 2008), only one study to our knowledge (Brown et al., 2010) has investigated the distinct influence of appetite awareness on the development and maintenance of eating pathology. Last but most important, we hope that the results of this study will have clinical implications for the prevention and treatment of eating disorders, subclinical eating problems, and obesity.

Aim 1a. In an effort to elucidate the mechanisms involved in the dietary restraint pathway to binge eating (Stice, 1994, 2001), our first aim was to investigate preoccupation with food as a mediator of the relationship between dieting and binge eating. Given theory and research suggesting that preoccupation with food is a consequence of dieting and a risk factor for binge eating, we hypothesized that the effects of dietary restraint on binge eating would run through preoccupation with food.

Aim 1b. Further, our second aim was to investigate appetite awareness as a mediator of the dietary restraint pathway. Based on restraint theory (Polivy & Herman, 1985) and the finding of Brown and colleagues (2010) that appetite awareness mediated improvements in binge eating, we predicted that appetite awareness would mediate the relationship between dietary restraint and binge eating.

Exploratory Aims. To further explore the processes involved in the theoretical restraint pathway, a secondary, exploratory aim was to examine the directionality of the relationship between preoccupation with food and appetite awareness. Furthermore, when using Baron and Kenny's (1986) procedure to test for the effects of multiple mediators, it is important to verify that the mediators are conceptually distinct constructs. Restraint theory links both of these processes to dieting on the one hand and to binge eating on the other (Polivy & Herman, 1985). However, to our knowledge, no study has addressed the question of how these two processes interact and relate to each other. Does learning to depend on cognitive controls over eating result in limited resources to attend to internal appetitive signals? Is increased preoccupation with thoughts about food a consequence of deliberately ignoring internal hunger cues? Or, do these two processes co-occur and influence each other?

To address the question of directionality, a third aim of this study was to explore preoccupation with food as a mediator of the relationship between dietary restraint and binge eating. Conversely, a fourth aim was to investigate appetite awareness as a mediator of the effects of dietary restraint on preoccupation with food. Due to insufficient theory and research on the relationship between preoccupation with food and appetite awareness, no a priori hypotheses regarding directionality were made.

Method

The current study used baseline data collected from a larger parent investigation of self-monitoring techniques as secondary disordered eating prevention efforts at Emory University (IRB #00045500). Only the procedures and methods relevant to this project are discussed below (Brown et al., 2010).

Participants

Participants included female students ($N = 86$) and employees ($N = 4$) at Emory University who self-identified as concerned about eating, weight, or weight gain. We limited our sample to female participants, because eating disorders are more prevalent among women compared to men (American Psychiatric Association, 2000). Most participants (91.1%) were undergraduate students (7.8% freshmen, 8.9% sophomores, 17.8% juniors, 15.6% seniors), first-year graduate students (17.8%), or second-year graduate students (23.3%) at Emory University. The age of participants ranged from 18 to 29, with a mean age of 22.09 and a modal age of 20 ($SD = 2.77$). The sample was 61.1% White, 12.2% African American, 20% Asian, 3.3% other, and 3.3% multiple races. Additionally, 10 participants (11.1%) identified themselves as Hispanic, Latino, or Spanish in origin. Overall, the ethnic composition of our sample reflected that of the Emory University student body (53% White, 10% African American, 18% Asian American, 3% Hispanic, and 16% other).

Participants had a mean BMI (calculated from reported height and weight) of 23.22 ($SD = 3.98$), which is within the normal weight range for adults (Centers for Disease Control and Prevention, 2011). Though still within the normal range, the average desired BMI of the sample (calculated from reported height and ideal weight) was slightly lower ($M = 21.24$; $SD = 2.55$). No participants had ever been diagnosed with an eating disorder. Thirty-four participants (39.5%) indicated that they had dieted at least once in their life.

Participants were recruited from Emory University through announcements and flyers inviting women between the ages of 18 and 30 with heightened eating and weight concerns to participate in a healthy eating study. Individuals who were interested in participating were pre-screened for eligibility via telephone by one of the researchers. Females between 18 and 30 years old who were enrolled as students at Emory University or employed by Emory University were invited to participate if they were not pregnant or planning to become pregnant. Ninety interested and eligible individuals were entered into the study.

Procedure

The Emory University Institutional Review Board approved all study procedures. All participants provided written informed consent at the time of the experiment. Information about the study procedures, risks, benefits, confidentiality, compensation, and contact persons was discussed in the consent form. Participants then completed packets that included demographic and background questions as well as measures assessing binge eating (BES); awareness of internal feelings and appetite levels (IAQ-E); and preoccupation with food, eating, weight, and shape (PEWS); among other variables not relevant to this study. Upon completion of the survey packet, participants were compensated monetarily ($20). All data were collected at the Emory Center for Eating and Weight Concerns on Emory University's main campus.

Measures

Binge Eating. The Binge Eating Scale (BES; Gormally, Black, Dastin, & Rardin, 1982) is a 16-item measure designed to assess severity of binge eating. Each item consists of three or four statements that depict behavioral, emotional, and cognitive components of binge eating and that are rank-ordered to reflect a rating of severity. Total scores on the BES range from 0 to 46, with higher scores reflecting greater severity of binge eating. Scores $\geq$ 27 typically indicate

severe binge eating, while scores ≤ 17 suggest mild to absent binge eating. The BES is internally (α = .85; Gormally et al., 1982) and temporally (test-retest coefficient = .87; Timmerman, 1999) reliable.

Dietary Restraint. The Dietary Intent Scale (DIS; Stice, Shaw, & Nemeroff, 1998) contains nine items that assess dietary restraint on a 5-point Likert scale from 1 (*Never*) to 5 (*Always*). Sample items of this scale include statements such as "I take small helpings in an effort to control my weight" and "I count calories to try to prevent weight gain." Results from a pilot study (Stice et al., 1998) indicated that the DIS has internal consistency (α = .94); test-retest reliability (*r* = .92); and convergent and discriminant validity.

Appetite Awareness. A Composite Appetite Score (CAS) was used to assess awareness of internal appetite cues. The CAS comprised eight items—six items from the Appetite Awareness Scale (AAS; Brown & Craighead, 2012) and two eating items from the Interoceptive Awareness Subscale of the Eating Disorders Inventory (EDI-IA Eat; Garner, 1991; see also Meyers & Crowther, 2008)—that loaded onto the same appetite awareness factor in a recent investigation (Brown & Craighead, 2012; manuscript in preparation). Factor loadings for these eight items ranged from .69 to .84. Each item is rated on a 6-point Likert scale from 1 (*Never*) to 6 (*Always*). Sample AAS items of the CAS include statements such as: "I don't notice I'm full until I'm stuffed" and "I feel out of touch with my hunger feelings." Total scores on the CAS range from 8 to 48, with higher scores indicating poorer awareness of appetite cues and less mindful eating.

Preoccupation with Food. Lastly, the Preoccupation with Eating, Weight, and Shape Scale (PEWS; Craighead & Niemeier, 1999; Niemeier, Craighead, Pung, & Elder, 2002) was used to evaluate preoccupation with food and eating. This PEWS was adapted from the Modifying

Distressing Thoughts Questionnaire (Clark, Feldman, & Channon, 1989) and contains eight items that assess cognitive preoccupation with food/eating and weight/shape as well as one item that measures perceived weight status. The PEWS comprises two subscales, Food/Eating and Weight/Shape, but the current investigation only used scores on the former subscale. Items from the Food/Eating subscale ask participants to indicate on a scale from 0 (*Not at all*) to 6 (*Extremely*) how distressing their food thoughts were, how difficult they were to stop, and how much they interfered with concentration over the past three weeks. Respondents are also asked to estimate the percentage of the day (0% to 100%) that they spend thinking about food, but this study did not include scores on this item. Higher scores on the PEWS reflect greater cognitive preoccupation with food and eating, while lower scores on this measure indicate lesser preoccupation with food and eating. Results from preliminary analyses (Niemeier et al., 2002) indicated that the PEWS has convergent and discriminant validity as well as internal consistency ($\alpha = .84$).

Statistical Analyses

The primary aim of the current study was to investigate whether preoccupation with food and appetite awareness independently mediated the influence of dietary restraint on binge eating. A secondary objective was to further elucidate the processes involved in the theoretical restraint pathway by examining directionality between the two hypothesized mediators (preoccupation with food and appetite awareness). We wanted to examine whether dietary restraint influenced one mediator *through* the other mediator or whether the two mediators were bidirectional and thus mutually influenced each other.

The Baron and Kenny (1986) procedure for testing mediator effects was used to examine the primary and exploratory meditational models outlined above. In this procedure, three

regression analyses are conducted in order to determine whether four conditions necessary for mediation are satisfied. First, to test whether the independent variable affects the mediator (Path a), the mediator is regressed onto the independent variable. Second, to test whether the independent variable affects the dependent variable (Path c), the dependent variable is regressed onto the independent variable. Third, to test whether the mediator affects the dependent variable (Path b), the dependent variable is regressed onto the mediator in Block 1 and onto the independent variable in Block 2. Fourth, to assess whether the effect of the independent variable on the dependent variable is attenuated or non-existent when controlling for the mediator (Path c'), the result of the linear regression analysis in criterion 2 is compared with that of the multiple regression analysis in criterion 3 (Smith, 2009). Full mediation is established if the effect of the independent variable on the dependent variable (Path c) is eliminated when controlling for the mediator (Path c'). Partial mediation is concluded if the relationship between the independent variable and the dependent variable in the second analysis (Path c) is attenuated when controlling for the mediator in the third analysis (Path c').

All regression analyses were tested for significance at an alpha level of $p < .05$. Scores on the DIS, PEWS Food/Eating Scale, CAS, and BES were used to measure dietary restraint, preoccupation with food, appetite awareness, and binge eating, respectively.

Results

Correlations Between the Variables

Prior to conducting the mediational analyses, psychometric properties for scores on the DIS, PEWS food/eating scale, CAS, and BES were obtained. Results of the bivariate correlations confirmed that all variables were significantly related; alpha coefficients were either $p < .05$ or p

< .01. Table 1 presents a summary of the intercorrelations and psychometric properties of scores on the DIS, PEWS food/eating scale, CAS, and BES.

Mediational Analyses

Aim 1a. In line with the criteria for testing mediator effects proposed by Baron and Kenny (1986), a series of regression analyses were conducted to examine whether preoccupation with food, as measured by the PEWS food/eating scale, mediated the effects of dietary restraint on binge eating. Table 2 depicts the outcome of this sequence of regression analyses.

Criterion 1. The first criterion is that the mediator (preoccupation with food) must be significantly related to the independent variable (dietary restraint). To test this criterion, preoccupation with food was regressed onto dietary restraint in a simple linear regression analysis. When we estimated this regression equation, we found that preoccupation with food was significantly positively related to dietary restraint ($\beta = .342$, $p = .001$). Because this relationship was significant, we proceeded to test the second criterion.

Criterion 2. To test the second criterion for mediation, that the independent variable (dietary restraint) significantly affects the dependent variable (binge eating), we conducted another linear regression analysis. Dietary restraint, as measured by total scores on the DIS, was significantly related to binge eating, as measured by total scores on the BES ($\beta = .241$, $p = .023$).

Criterion 3. The mediator (preoccupation with food) must affect the dependent variable (binge eating) in the third criterion for mediation. To test this criterion, the dependent variable was regressed onto the mediator in Block 1 and onto the independent variable in Block 2. When we ran this regression analysis, we found that preoccupation with food accounted for 55.1% of the variance in binge eating ($\beta = .744$, $p = .000$). Because preoccupation with food significantly predicted binge eating, we proceeded to test the final criterion.

Criterion 4. Finally, the previously significant effect of the independent variable (dietary restraint) on the dependent variable (binge eating) in criterion 2 must be attenuated or eliminated when controlling for the mediator (preoccupation with food) in criterion 4. To assess this criterion, we compared the effect of dietary restraint on binge eating in the second regression analysis, when preoccupation with food was not controlled for, to the effect of dietary restraint on binge eating in the third regression analysis, when controlling for preoccupation with food. When controlling for the mediator, the relationship between the independent variable and the dependent variable was no longer statistically significant (from $\beta = .241$, $p = .023$ to $\beta = -.004$, $p = .957$), suggesting that preoccupation with food, as measured by the PEWS food/eating scale, completely mediated the relationship between dietary restraint and binge eating (see Figure 3).

Aim 1b. The same series of regression analyses were used to examine appetite awareness, as measured by the CAS, as a mediator of the relationship between dietary restraint and binge eating. Table 3 depicts the outcome of these mediational analyses.

Criterion 1. To test the first criterion for mediation, we regressed the mediator (appetite awareness) onto the independent variable (dietary restraint). Appetite awareness was significantly positively related to dietary restraint ($\beta = .218$, $p = .039$), indicating an association between poorer appetite awareness, as measured by higher CAS scores, and higher dietary restraint, as measured by higher DIS scores. Because this relationship was statistically significant, we proceeded to test the next criterion.

Criterion 2. The independent and dependent variables in aims 1a and 1b are the same, so the results of the linear regression analysis in aim 1a can be applied here. As described above, we tested the effects of the independent variable on the dependent variable by regressing the dependent variable (binge eating) onto the independent variable (dietary restraint). The results

indicated that dietary restraint significantly predicted binge eating, so we proceeded to test criterion 3 ($\beta = .241$, $p = .023$).

Criterion 3. In the third criterion, the mediator (appetite awareness) must significantly predict the dependent variable (binge eating). To test this criterion, we ran a multiple linear regression analysis in which the dependent variable was regressed onto the mediator in Block 1 and onto the independent variable in Block 2. When we regressed binge eating onto appetite awareness, we found that appetite awareness accounted for 41.8% of the variance in binge eating ($\beta = .623$, $p = .000$). Because appetite awareness was significantly related to binge eating, we continued on to assess the final criterion.

Criterion 4. To determine if the independent variable (dietary restraint) was still a statistically significant predictor of the dependent variable (binge eating) when controlling for the mediator (appetite awareness), we compared the effects of dietary restraint on binge eating in criterion 2 with those in criterion 4. When controlling for the mediator, the relationship between dietary restraint and binge eating was no longer statistically significant (from $\beta = .241$, $p = .023$ to $\beta = .119$, $p = .156$), suggesting that appetite awareness completely mediated the relationship between dietary restraint and binge eating (see Figure 4).

Aim 2a. We used the same procedure for testing mediator effects to explore preoccupation with food as a mediator of the relationship between dietary restraint and appetite awareness (see Table 4). The results of this series of regression analyses showed that the independent variable (dietary restraint) was significantly related to the mediator (preoccupation with food; $\beta = .342$, $p = .001$) and to the dependent variable (appetite awareness; $\beta = .218$, $p = .039$), satisfying criterions 1 and 2, respectively. In support of criterion 3, there was a significant association between the mediator (preoccupation with food) and the dependent

variable (appetite awareness; $\beta = .526$, $p = .000$). When controlling for the mediator (preoccupation with food) in criterion 4, the effect of the independent variable (dietary restraint) on the dependent variable (appetite awareness) in criterion 2 was no longer significant (from $\beta = .218$, $p = .039$ to $\beta = .038$, $p = .691$). Thus, preoccupation with food, as measured by the PEWS food/eating scale, completely mediated the effects of dietary restraint on appetite awareness (see Figure 5).

Aim 2b. Lastly, three regression analyses were carried out to investigate appetite awareness, as measured by the CAS, as a mediator of the relationship between dietary restraint and preoccupation with food. Table 5 depicts the outcome of these mediational analyses. Consistent with the first two criteria for mediation, the independent variable (dietary restraint) was associated with the mediator (appetite awareness; $\beta = .218$, $p = .039$) and the dependent variable (preoccupation with food ($\beta = .342$, $p = .001$). The mediator (appetite awareness) was also a significant predictor of the dependent variable (preoccupation with food; $\beta = .488$, $p = .000$). However, the effects of the independent variable (dietary restraint) on the dependent variable (preoccupation with food) were still statistically significant when controlling for the mediator (appetite awareness) in criterion 4 (from $\beta = .342$, $p = .001$ to $\beta = .235$, $p = .010$), suggesting that appetite awareness was not a mediator of the effects of dietary restraint on preoccupation with food (see Figure 6).

Discussion

In the current study, preoccupation with thoughts about food and appetite awareness were separately evaluated (on the basis of Baron and Kenny, 1986) as potential mediators of the relationship between dieting and binge eating in college women.

Interpretation of Findings

Aim 1a. Consistent with the first hypothesis, preoccupation with food, as measured by the PEWS food/eating scale, fully mediated the relationship between dietary restraint and binge eating. This finding contributes to a growing body of research (Jones & Rogers, 2003; Tapper & Pothos, 2010) in support of Herman and Polivy's (1985) original assertion that cognitive preoccupation with food is a negative consequence of dieting. Furthermore, this result corroborates that of Ondercin (1979), who found that increased preoccupation with food was a significant predictor of severity of binge eating among female undergraduates.

Aim 1b. Appetite awareness, as measured by the CAS, mediated the relationship between dietary restraint and binge eating, thus confirming our second hypothesis. This finding supports the theoretical importance of this component of interoceptive awareness as central to discussions of eating behaviors in its own right (Myers & Crowther, 2007). The finding that appetite awareness influenced binge eating aligns with Brown et al.'s (2010) finding that appetite awareness mediated improvements in eating pathology. Thus, appetite awareness appears to be an important yet largely ignored factor in the development and maintenance of binge eating.

Exploratory Aims. Preoccupation with food completely mediated the influence of dietary restraint on appetite awareness. In contrast, appetite awareness did not mediate the relationship between dietary restraint and preoccupation with food. Although conclusions regarding causality cannot be drawn, these results suggest that dietary restraint may increase preoccupation with thoughts about food, which in turn appears to decrease awareness of internal appetite signals, eventually increasing the risk for binge eating.

One interpretation of these results is that certain dieting behaviors, such as avoiding favorite foods or eating less than desired, create feelings of deprivation (i.e., perceived deprivation; Timmerman & Gregg, 2003), which increase or exacerbate preoccupation with food.

Consistent with this interpretation, dietary restraint was significantly related to both preoccupation with food and perceived deprivation in a recent study (Timmerman & Gregg, 2003). However, additional research is needed to test the theoretical assumption that psychological deprivation is what most proximally leads to cognitive preoccupation with food. We also recommend that future research investigate whether certain dieting rules (e.g., strict rules about food amount or type) are more problematic than other, more flexible rules or if dieting rules in general lead to psychological deprivation. The identification of dieting behaviors or techniques that increase the risk for perceived deprivation would have important implications for the prevention of eating disorders, as this could further elucidate constructs to target in eating disorder prevention efforts.

Furthermore, these findings have important implications for the prevention of binge eating. As the closest pathogenic link to binge eating, poor appetite awareness may be the most direct target of intervention for subclinical eating problems. Accordingly, Appetite Awareness Training (AAT; Craighead, 2006; Craighead & Allen, 1995) may be a particularly helpful form of treatment for both clinical and subclinical eating problems because it teaches clients how to (a) get in touch (or back in touch) with their internal feelings of hunger and fullness and (b) utilize these internal appetitive cues to regulate consumption and thus overcome maladaptive eating patterns or symptoms, such as binge eating (Craighead, 2006).

Limitations

Several important limitations of this study should be noted. First, the cross-sectional nature of our study limits the statistical power, inferential confidence, and generalizability of our findings. Furthermore, this study's meditational design limited our ability to test for the presence of other potential mediators of the restraint pathway beyond the two theorized mechanisms. It is

therefore possible that other nonspecific variables, such as perceived deprivation (Timmerman & Gregg, 2003), food-related thought suppression (Soetens & Braet, 2006), or a predisposition toward weight gain (Markowitz, Butryn, & Lowe, 2008), may account for as much of or more of the relationship between dieting and binge eating. Future research should examine these relationships over time in order to elucidate the temporal sequence of variables in this pathway.

Third, the exclusive reliance on self-report data may have biased the magnitude of relations amongst the variables (Stice, 2001) and limited the generalizability of the findings. Future research should consider incorporating multiple types of assessment, such as peer, sibling, teacher, and parental reports of dieting (Stice, 2001) as well as observational research to reduce bias and increase statistical power. In addition, we recommend that future research use multiple indicators of the same construct (e.g., two or more measures of dietary restraint) to increase reliability (Baron & Kenny, 1986).

Fourth, because our sample included only females between 18 and 30 years old, our findings cannot be easily generalized to men or to women outside of this age range. We recommend that future research investigate the processes explored here in a longitudinal sample of adolescents, because disordered eating behaviors typically emerge during this period (Stice & Shaw, 2002). Further, because we recruited a subclinical sample from a private university, our findings cannot be generalized to clinical populations or to individuals of lower levels of education. Future research should consider recruiting participants from the community or from clinical settings to increase generalizability.

Lastly, our appetite awareness measure may have limited our results. Although the CAS contained items that loaded onto the same appetite awareness factor (Craighead & Hill, 2012, manuscript in preparation), these results should be interpreted cautiously because the CAS is not

a standard assessment tool. Research on the validity and reliability of using this combination of AAS and EDI-IA EAT items as a measure of appetite awareness is necessary.

Conclusion

In conclusion, our findings contribute to a growing understanding of the mechanisms involved in the complicated pathway from dietary restraint to binge eating. We found significant mediation of the relationship between dietary restraint and binge eating by reported levels of preoccupation with food and appetite awareness in a sample of university women. These findings are consistent with the results of several prospective studies (Stice, 2001; Stice & Agras, 1998; Stice et al., 2002), thus providing additional support to the dietary restraint model (Polivy & Herman, 1985). Furthermore, a second major contribution of this research is the post-hoc finding that preoccupation with food mediated the relationship between dietary restraint and appetite awareness, but appetite awareness did not mediate the relationship between dietary restraint and preoccupation with food. Although prospective research is needed to examine the direction of effects between variables, these results suggest some direction to the theoretical restraint pathway that warrants further exploration. Future research should consider the presence of other potential mediating mechanisms in this pathway, such as perceived deprivation and food-related thought suppression.

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Table 1

Summary of Intercorrelations, Means, and Standard Deviations for Scores on the DIS, PEWS Food/Eating Scale, CAS, and BES

Measure	1	2	3	4	*M (SD)*	*N*
1. DIS	—	.342**	.218*	.241*	22.72 (4.83)	90
2. PEWS Food/Eating Scale		—	.539**	.743**	1.54 (1.17)	90
3. CAS			—	.646**	2.56 (0.71)	90
4. BES				—	12.16 (5.67)	89

Note. The Dietary Intent Scale (DIS) is from Stice, Shaw, & Nemeroff (1998); the Food/Eating subscale of the Preoccupation with Eating, Weight, and Shape Scale (PEWS) is from Craighead and Niemeier (1999); the Composite Appetite Score (CAS) was adapted from Smith et al. (2005); and the Binge Eating Scale (BES) is from Gormally et al. (1982).
*$p < .05$. **$p < .01$.

Table 2

Tests of Preoccupation with Food as Hypothesized Mediator of the Effects of Dietary Restraint on Binge Eating

	Effects				
	r	R^2	R^2 change	*p* value	*β*
Analysis 1:					
PEWS food/eating on DIS	.342	.117		.001	.342
Analysis 2:					
BES on DIS	.241	.058		.023	.241
Analysis 3:					
Step 1: BES on PEWS food/eating	.743	.551		.000	.744
Step 2: BES on DIS | PEWS food/eating	.743	.551	.000	.957	-.004

Note. The Food/Eating subscale of the Preoccupation with Eating, Weight, and Shape Scale (PEWS) is from Craighead and Niemeier (1999); the Dietary Intent Scale (DIS) is from Stice, Shaw, & Nemeroff (1998); and the Binge Eating Scale (BES) is from Gormally et al. (1982). | indicates controlling for a given variable.

Table 3

Tests of Appetite Awareness as Hypothesized Mediator of the Effects of Dietary Restraint on Binge Eating

	Effects				
	r	R^2	R^2 change	*p* value	*β*
Analysis 1:					
CAS on DIS	.218	.048		.039	.218
Analysis 2:					
BES on DIS	.241	.058		.023	.241
Analysis 3:					
Step 1: BES on CAS	.646	.418		.000	.623
Step 2: BES on DIS | CAS	.657	.431	.014	.156	.119

Note. The Composite Appetite Score (CAS) was adapted from Smith et al. (2005); the Dietary Intent Scale (DIS) is from Stice, Shaw, & Nemeroff (1998); and the Binge Eating Scale (BES) is from Gormally et al. (1982). | indicates controlling for a given variable.

Table 4

Tests of Preoccupation with Food as Hypothesized Mediator of the Effects of Dietary Restraint on Appetite Awareness

	Effects				
	r	R^2	R^2 change	*p* value	*β*
Analysis 1:					
PEWS food/eating on DIS	.342	.117		.001	.342
Analysis 2:					
CAS on DIS	.218	.048		.039	.218
Analysis 3:					
Step 1: CAS on PEWS food/eating	.539	.291		.000	.526
Step 2: CAS on DIS | PEWS food/eating	.541	.292	.001	.691	.038

Note. The Food/Eating subscale of the Preoccupation with Eating, Weight, and Shape Scale (PEWS) is from Craighead and Niemeier (1999); the Dietary Intent Scale (DIS) is from Stice, Shaw, & Nemeroff (1998); and the Composite Appetite Score (CAS) was adapted from Smith et al. (2005). | indicates controlling for a given variable.

Table 5

Tests of Appetite Awareness as Hypothesized Mediator of the Effects of Dietary Restraint on Preoccupation with Food

	Effects				
	r	R^2	R^2 change	*p* value	*β*
Analysis 1:					
CAS on DIS	.218	.048		.039	.218
Analysis 2:					
PEWS food/eating on DIS	.342	.117		.001	.342
Analysis 3:					
Step 1: PEWS food/eating on CAS	.539	.291		.000	.488
Step 2: PEWS food/eating on DIS | CAS	.586	.344	.053	.010	.235

Note. The Composite Appetite Score (CAS) was adapted from Smith et al. (2005); the Dietary Intent Scale (DIS) is from Stice, Shaw, & Nemeroff (1998); and the Food/Eating subscale of the Preoccupation with Eating, Weight, and Shape Scale (PEWS) is from Craighead and Niemeier (1999). | indicates controlling for a given variable.

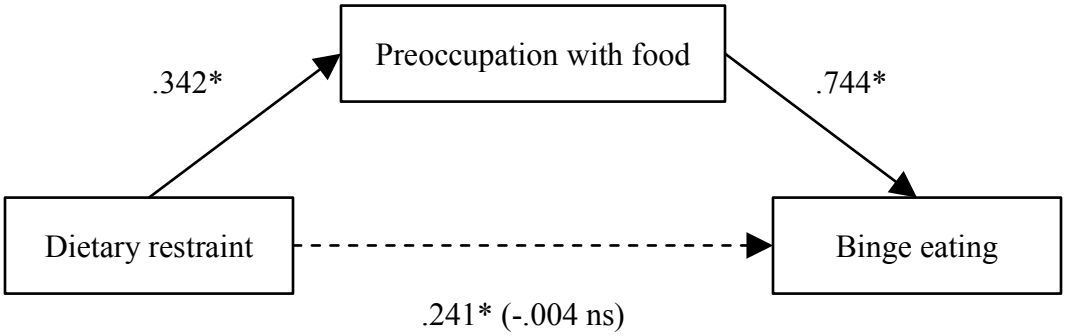

Figure 3. Graphical representation of the regression coefficients in model 1 (on the basis of Baron & Kenny, 1986).
*$p < .05$.

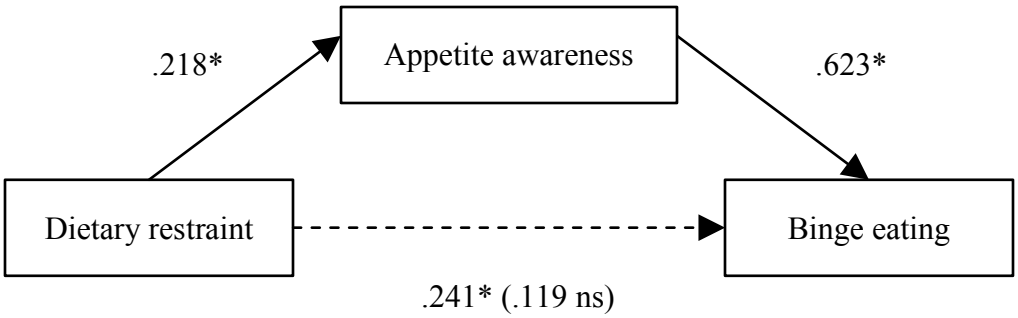

Figure 4. Graphical representation of the regression coefficients in model 2 (on the basis of Baron & Kenny, 1986).
*$p < .05$.

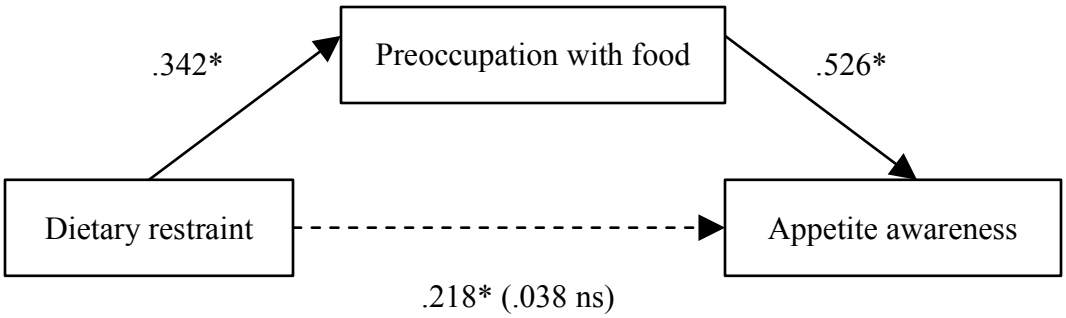

Figure 5. Graphical representation of the regression coefficients in model 3 (on the basis of Baron & Kenny, 1986).
*$p < .05$.

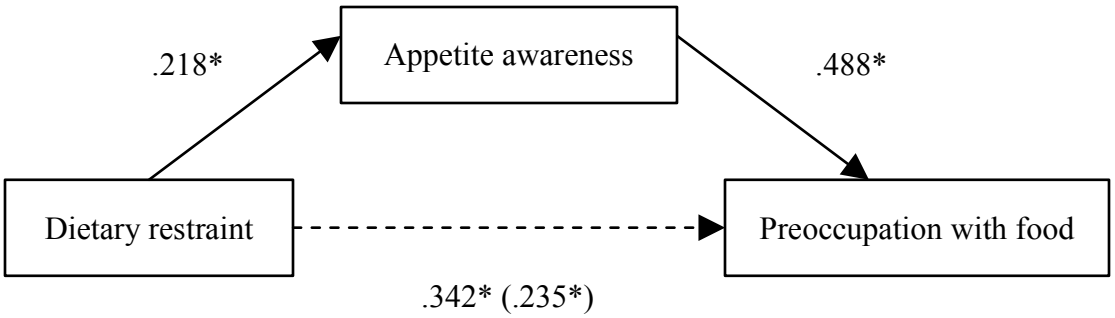

Figure 6. Graphical representation of the regression coefficients in model 4 (on the basis of Baron & Kenny, 1986).
*$p < .05$.