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A Test of a State-Based, Self-Control Theory of Binge Eating in Adults with Obesity

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Abstract

It has been theorized that state levels of self-control depletion (as caused by negative affect and restraint) may lead to binge eating (BE) when individuals also endorse momentary expectancies that eating will make them feel better (EE). Given commonalities in precipitants of BE across populations, the current study tested this theory in a sample of adults with obesity using ecological momentary assessment (EMA). Fifty obese adults completed the EMA protocol during which they provided pre-eating episode ratings of negative affect, restraint, and EE, and post-eating episode ratings of BE. Generalized estimating equations (GEE) identified a 3-way interaction between within-person pre-eating episode variables: higher self-control depletion (e.g., higher restraint and higher negative affect) was predictive of BE episodes *only* when individuals also endorsed higher EE. To our knowledge, this is the first empirical test of this theory, highlighting the impact of momentary self-control depletion and EE on BE in obese adults.

Keywords

binge eating; obesity; self-control; eating expectancies; negative affect

Binge eating, which involves consuming an unambiguously large amount of food while feeling a sense of loss of control (American Psychiatric Association [APA] 2013), is associated with negative physical and psychosocial sequelae (APA, 2013), including obesity. Because psychopathology and comorbidities may be compounded in individuals with co-occurring binge eating and obesity (e.g., de Zwaan et al., 1994), it is important to develop and test theoretical models designed to elucidate antecedents of binge eating behavior in

individuals who are obese to aid in the development and refinement of future interventions for both eating- and weight-related problems. One example is a state-based model for binge eating developed by Pearson and colleagues (2015), which posits that depletion of self-control resources via, for example, dietary restraint and/or negative affect, can increase risk for binge eating. Although this state-based, emotion-focused theory was originally applied to conceptualizing the risk and maintenance of bulimia nervosa (BN), it may be applicable to individuals with obesity as well given shared antecedents (e.g., dietary restraint, negative affect, and eating expectancies) to binge eating across both populations. Thus, the purpose of the current research was to provide the first empirical examination of this state-based, self-control theory of binge eating in a sample of adults with obesity.

Binge Eating and Obesity

Binge eating is one of the most commonly reported disordered eating behaviors among individuals with obesity, even in the absence of full-syndrome binge eating disorder (BED; APA, 2013; Greeno, Wing, & Shiffman, 2000). Binge eating more common among adults with obesity than in the general population, and individuals who binge eat are more likely to become obese than individuals without disordered eating (Hudson, Hiripi, Pope, & Kessler, 2007). This is particularly concerning because the co-occurrence of binge eating and obesity is linked to a variety of problems (e.g., de Zwaan et al., 1994). Even when individuals with concomitant binge eating and obesity receive promising treatments for binge eating behavior (cognitive behavioral therapy, CBT; Fairburn, 2008), 25–64% of individuals remain symptomatic (e.g., Grilo, Masheb, Wilson, Gueorguieva, & White, 2011). In order to improve existing treatments and develop more effective interventions, it is necessary to understand the complex interplay of precipitating factors that promote binge eating among individuals with obesity.

Negative Affect and Binge Eating in Obesity

Studies of binge eating across populations, including obese individuals, have consistently identified negative affect as an important precipitant. Although the impact of negative affect on self-control has not been specifically examined in obese populations, EMA studies with obese and disordered eating samples found that global negative affect rapidly increased in the hours immediately preceding binge eating (Berg et al., 2015; Haedt-Matt & Keel, 2011). Furthermore, two recent reviews identified negative mood as an antecedent of binge eating among obese individuals with BED (Leehr et al., 2015; Nicholls, Devonport, & Blake, 2016). In laboratory studies as well, obese individuals who binge eat tend to consume more food and report greater desires to binge following a negative mood induction than healthy controls or non-binge eating obese adults (Nicholls et al., 2016). Taken together, these findings thus suggest that momentary negative affect appears to be an important precipitant of binge eating in obese individuals, perhaps through the mechanism of self-control depletion.

Dietary Restraint and Binge Eating in Obesity

Dietary restraint is thought to lead to binge eating via a number of potential pathways (Hagan, Chandler, Wauford, Rybak, & Oswald, 2003; Polivy & Herman, 1985). For example, dietary restraint in obese individuals may lead to feelings of psychological and physiological deprivation, and thus prompt binge eating in the presence of an avoided food. Findings regarding dietary restraint in obese individuals with BED tend to be somewhat mixed. On a trait-like level, dietary restraint has been linked to binge eating in obesity via self-report (Womble et al., 2001) and laboratory-based experimental studies (Chua, Toyz, & Hill, 2004). Findings are not as clear on a momentary-level; in fact, few studies have investigated the momentary effects of restraint on binge eating in obese samples. A daily diary study found that when obese women dieted, they experienced more food cravings than non-dieters and found it more difficult to resist those cravings of restricted foods than non-dieters (Massey & Hill, 2012). In a laboratory study, findings of individuals with BED and BN suggest that they compensated for food deprivation but did not overcompensate (Telch & Agras, 1996). Taken together, it appears that dietary restraint may be linked to binge eating in obese populations, but that more research is needed to clarify this relationship, particularly in momentary study designs.

Eating Expectancies and Binge Eating in Obesity

Expectancies represent summaries of individuals' learning histories and are learned anticipations of likely consequences of behavioral choices (Tolman, 1932). One particularly salient type of eating expectancy involves the learned belief that eating will alleviate negative affect. Therefore, according to expectancy theory, the more strongly one believes eating will alleviate his or her negative mood, the more likely he or she will be to pursue food with vigor when distressed. This theory has received support in research on binge eating in several populations (e.g., Fischer, Peterson, McCarthy, 2013; Pearson, Combs, Zapolski, & Smith, 2012), although research in the obesity literature has been limited. However, given the overlap between binge eating and obesity, this may be a particularly relevant construct for understanding binge eating in obesity. Indeed, support for the role eating expectancies in obesity may be drawn from the similar construct of anticipatory food reward. For example, evidence suggests that, compared to lean individuals, individuals with obesity tend to experience increased reward during anticipation and receipt of food (for review, see Stice, Spoor, Ng, & Zald, 2009). Furthermore, preliminary research in other binge eating populations suggests that momentary negative mood may enhance the anticipatory reward value of food (Bohon & Stice, 2012; Pearson, Chester, Powell, Wonderlich, & Smith, 2016) and that anticipating a binge eating episode may in fact serve to reduce negative affect (Pearson et al., 2016). Though this has not yet been studied using a momentary-based design, it does appear that food is likely a particularly salient reward for individuals with greater eating expectancies, perhaps especially when in distress.

State-Based Theory

Integrating the risk factors of negative affect, restraint, and eating expectancies, Pearson and colleagues (2015) proposed a state-based theory of binge eating that is based on self-control

theory (Baumeister, Heatherton, & Tice, 1994; Muraven & Baumeister, 2000). The theory applied to binge eating in individuals with obesity is as follows: an obese individual who is attempting to restrain food intake is exercising self-control as he/she is working against the basic biological drive for food. Additionally, when the individual experiences negative affect, he/she must exercise more self-control to cope and inhibit immediate, nonadaptive responses to the distress, thereby further depleting self-control resources (Tice, Bratslavsky, & Baumeister, 2001). Therefore, the self-control demands associated with momentary experiences of negative emotions and dietary restraint may deplete an individual, and in that depleted state, holding the belief that eating will make one feel better or be replenishing heightens the risk for binge eating due to the failure of self-control mechanisms. However, if the individual is depleted and does not hold the momentary eating expectancy, they will be less likely to binge eat and may engage in other adaptive or maladaptive behaviors as a result of depleted self-control.

The Current Study

The current study examined the interactive relationship between within-person (momentary) negative affect, dietary restraint, and eating expectancies in relation to binge eating using EMA among adults with obesity. We hypothesized that there would be a three-way interaction between within-person levels of negative affect, dietary restraint, and eating expectancies to predict binge eating behavior. That is, we expected that participants would be most likely to binge eat at times when they report elevated levels of negative affect, dietary restraint, and eating expectancies. To our knowledge, this is the first examination of a state-based, self-control depletion model of binge eating in obesity.

Method

Participants and Procedure

Participants were fifty obese (body mass index (BMI) ≥ 30) adults recruited through advertisements and flyers in the Midwestern United States. The mean BMI was 40.3 kg/m² ($SD = 8.5$) and the mean age was 43.0 years ($SD = 11.9$). Most participants were female ($n = 42$; 84%) and White ($n = 38$; 76%). Exclusion criteria included previous gastrointestinal surgery, current pregnancy/breastfeeding, concurrent obesity treatment, inability to read and understand English, and current or past diagnosis of anorexia nervosa or BN, which was determined by the Structured Clinical Interview for DSM-IV Axis I Disorders, Patient Edition (SCID-I/P: First, Spitzer, Gibbons, & Williams, 1995), by trained interviewers. This study was approved by the University of Minnesota Institutional Review Board.

Interested participants were screened via telephone, and eligible participants scheduled an informational meeting during which they received information about the study. When participants entered the study, they provided written informed consent, completed several in-person assessments, including measurement of height and weight, and received instructions regarding completion of EMA recordings on palmtop computers. Participants completed two practice EMA days, then returned to the research lab to have practice data reviewed and to receive feedback regarding compliance rates. For the next two weeks, they completed EMA measures. During the two-week protocol, one in-person visit was scheduled for each

participant to upload data from the palmtop computers and provide feedback regarding compliance rates. Participants received \$150 as compensation and an additional \$50 for completing at least 90% of signaled assessments within 45 minutes.

Measures

Participants completed three types of EMA recordings. First, they completed recordings in response to six semi-random signals occurring every two to three hours between 8:00 AM and 10:00 PM. Second, they completed recordings before and after any eating episode. Third, they completed recordings at the end of the day before going to sleep. Only the pre- and post-eating episode recordings were used in the current study.

Pre-eating episode EMA measures.—*Restraint* was measured with one item (i.e., “I will eat less to lose weight or avoid gaining weight”), which was adapted from the well-established Eating Disorder Examination – Questionnaire (EDE-Q; Fairburn & Beglin, 1994). *Eating expectancies* were measured with one item (“If I eat this, I will feel better”), which was adapted from the well-established Eating Expectancy Inventory (EEI; Hohlstein, Smith, & Atlas, 1998). For both restraint and eating expectancies, responses ranged from 1 (Disagree Strongly) to 5 (Agree Strongly). *Negative affect* was assessed with items from the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). A total of 11 negative affect items were used (e.g., afraid, upset), with items chosen on the basis of high factor loadings and theoretical relevance to disordered eating behavior. Participants indicated how much they were experiencing each negative affective state in the moment using a 5-point scale from 1 (Not at all) to 5 (Extremely).

Post-eating episode EMA measures.—*Binge eating* was defined as eating episodes in which participants reported both overeating (“To what extent do you feel that you overate?”) and a loss of control (“While you were eating, to what extent did you feel a sense of loss of control?”). Participants responded to each item on a 5-point scale from 1 (Not at all) to 5 (Extremely). Consistent with prior work (Berg et al., 2015), episodes were coded as binge eating episodes when participants chose 3 or higher for both the overeating and loss of control items.

Statistical Analysis

A generalized estimating equation (GEE) with a logistic function, including a dichotomous dependent variable (binge eating episodes versus non-binge eating episodes), was calculated in SPSS version 22.0 (IBM, 2013) to test the model. The GEE accounts for non-independence of observations in the data and accommodates data with missing time points. We also used an AR1 serial autocorrelation correction to account for the dependence within the nested data (Schwartz & Stone, 1998). Restraint, negative affect, and eating expectancies were person-mean centered and interaction terms were created using the person-mean centered predictors. The within-person main effects, all 2-way interactions, and the 3-way interaction were included in the model. This allows for the examination of momentary pre-eating episode ratings of negative affect, restraint, and eating expectancies as well as their interactions in predicting binge eating at the next eating episode. Since the theory tested is state-based (Pearson, Wonderlich, & Smith, 2015), we were only interested in the

momentary effects and interactions of these variables; as a result, we included the between-person effects of restraint, negative affect, and eating expectancies to control for individual-level differences. Significant interactions were plotted at ± 1 *SD* of the moderators to examine the nature of the interactions. This study was sufficiently powered.

Results

Descriptive Statistics

A total of 92% of participants completed the two-week protocol, with the remaining 8% terminating early due to personal circumstances or perceived burden of completing EMA recordings. These participants were included in all study analyses. Twenty-two participants (44%) earned the compliance bonus for completing at least 90% of EMA reports within 45 minutes of the palmtop signal. Of the individuals who did not receive the compliance bonus, approximately 72% of recordings were completed. Binge eating episodes were endorsed by 96% of participants. There were 395 binge eating episodes reported in total.

Results of the GEE are displayed in Table 1.

For within-person main effects, there was a significant main effect for pre-episode dietary restraint ($B = -.38, p = .01$). At moments when dietary restraint was low, there was a greater likelihood of binge eating at the next eating episode following the pre-episode ratings. Within-person main effects were not significant for pre-episode negative affect ($B = .05, p = .06$) or pre-episode eating expectancies ($B = .04, p = .74$).

There was a significant two-way interaction between within-person negative affect and within-person eating expectancies ($B = .05, p = .008$). The two-way interactions between within-person negative affect and within-person restraint ($B = .01, p = .74$) and within-person eating expectancies and within-person restraint ($B = -.06, p = .72$) were not significant. Finally, there was a significant three-way interaction among pre-episode within-person restraint, negative affect, and eating expectancies predicting the probability of binge eating at the following eating episode ($B = .07, p = .02$), suggesting that binge eating in the moment was dependent upon momentary levels of restraint, negative affect, and expectancies that eating would alleviate negative mood. The three-way interaction is displayed in Figure 1.

An examination of the three-way interaction revealed that at moments when dietary restraint was low, momentary negative affect appeared to be associated with a greater likelihood of binge eating at the following eating episode, and, this association was stronger at moments when eating expectancies were also higher. At moments when dietary restraint was high, momentary negative affect appeared to be associated with a greater likelihood of binge eating at the next eating episode only at moments when eating expectancies were also high. In addition, at moments when dietary restraint was high, lower momentary negative affect appeared to be related to lower probability of binge eating at the following eating episode in the presence of higher versus lower momentary eating expectancies.

Discussion

The current study is the first to examine a recently proposed state-based, self-control theory of binge eating (Pearson et al., 2015). We used a sample of obese adults, a population known to exhibit binge eating behavior, along with an EMA study design, to measure the momentary nature of self-control depletion and eating expectancies. Findings were partially consistent with our hypotheses. Specifically, as expected, there was a significant three-way interaction between momentary negative affect, eating expectancies, and dietary restraint. However, the greatest probability of binge eating was found following moments of high eating expectancies, high negative affect and low dietary restraint; the lowest probability of binge eating was found following moments characterized by high dietary restraint, high eating expectancies, and low negative affect.

Several specific findings are notable. First, we found support for the proposed state-based theory. Results suggest that when obese individuals in this sample intended to restrain their intake more than usual and experienced greater than their average level of negative affect, they were at increased risk of binge eating if they also more strongly endorsed the momentary belief that eating would help them to feel better. It may therefore be the case that the experience of negative affect, which may require inhibiting nonadaptive responses and using emotion regulatory strategies, along with dietary restraint, which requires inhibiting intake and cravings, deplete obese individuals' self-control resource pool. Thus, in such depleted moments, they may be more prone to binge eat if they also anticipate that eating will make them feel better, perhaps in an effort to replenish their depleted state. However, when obese individuals are in a depleted state and they do *not* believe that eating will make them feel better, their risk for a binge eating episode is lower. Therefore, self-control depletion (through negative affect and restraint) may be particularly relevant for binge eating in obese individuals at times when they endorse eating expectancies. This warrants the inclusion of expectancies in future self-control research.

Interestingly, and contrary to our theory, it appears that obese individuals are at particular risk for binge eating when they are not engaging in dietary restraint. This is consistent with a daily diary study of college women, which found that on days when women reported less restraint, they reported higher binge eating (Mason, Heron, Braitman, & Lewis, 2016). While greater tendencies for restraint are often associated with binge eating in BN and BED, this broad association does not appear to hold true at a momentary level in this sample of obese individuals. This finding may indicate problems with inhibitory control. That is, when obese individuals are not attempting to control their food intake, they may binge eat in a conceding way (e.g., "I couldn't control myself even if I tried"). Thus, the discrepancy between the current findings and findings from traditional cross-sectional research indicating restraint as a risk factor for binge eating may suggest that, at a momentary level, restraint may reduce the likelihood of binge eating, but with repeated restraint overtime, may have a cumulative effect on promoting risk of future binge eating. This is consistent with research demonstrating positive associations between repeated episodes of fasting and risk of binge eating (e.g., De Young et al., 2014).

While eating expectancies have typically been thought of as a between-person variable (e.g., Holzhstein et al., 1998), it appears that they can be measured in a momentary fashion and do, in fact, fluctuate within an individual. This is the first study to examine this, thus further research is needed to fully understand this construct and its function in binge eating and obesity.

These findings have important clinical implications for obese individuals who binge eat. First, these findings are consistent with approaches that focus on meal planning and commitment to behavioral changes, and also allow for some balance and not eliminating certain foods entirely. Similarly, psychoeducation about times when obese individuals may be particularly vulnerable for binge eating, such as when they are in a depleted state and believe that eating will make them feel better, may be valuable. Second, the current study suggests that interventions that focus on teaching skills to cope with these vulnerabilities may be particularly useful. For example, it may be beneficial to incorporate skills designed to regulate affect, such as those in Dialectical Behavior Therapy (DBT; Linehan, 2014). Though these skills are often included in treatments for eating disorders, they are often omitted from obesity treatments. Third, it also seems particularly important for interventions to focus on reducing affect-related eating expectancies. One strategy would be to utilize CBT techniques (Fairburn, 2008) to challenge the specific belief that eating will help one feel better. Lastly, it may also be important to teach skills related to recognizing one's current internal experiences and signs of depletion, perhaps through mindfulness (e.g., Kabat-Zinn, 2009), though further research is needed in this area.

This study has several strengths, including being the first study to test the state-based, self-control theory for binge eating (Pearson et al., 2015) as well as the first study to test eating expectancies in a momentary fashion. However, there are also certain limitations. First, momentary eating expectancies and dietary restraint were each assessed using a single item to reduce participant burden. Though the items are face valid and were adapted from established measures, it is possible that we would have found different results had we included more assessment items. Second, not all participants endorsed binge eating episodes ($n = 10$; 20% reported no binge eating); therefore, these results are based on a subset of the full sample. Third, though this study is mostly consistent with the state-based, self-control theory for binge eating, we did not include any direct measures of self-control depletion. Therefore, we do not know for certain if participants experienced self-control depletion when they endorsed higher levels of dietary restraint and negative affect. Future work with obese individuals should directly assess self-control depletion using EMA.

In conclusion, we found support for the state-based, self-control theory for binge eating in obese individuals, suggesting that higher momentary levels of negative affect and restraint (e.g., a depleted state) increase risk for binge eating only when there is a greater momentary expectancies that eating will make one feel better. However, contrary to expectations, we also found evidence that obese individuals are at particular risk for binge eating when they are not restraining their food intake, especially in moments when they also endorse negative mood and expectancies about eating. These findings (a) suggest the utility of examining self-control-related constructs and momentary eating expectancies in samples of individuals who

binge eat and (b) implicate the importance of carefully targeting these constructs, especially dietary restraint, in treatments for obesity.

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Figure 1.
Three-way within-person interaction among negative affect, dietary restraint (DR), and eating expectancies (EE).

Table 1.

GEE Model of the Interaction of Negative Affect, Dietary Restraint, and Eating Expectancies Predicting Binge Eating

Parameter	B	SE	Wald	p
Within-Subjects Effects				
Pre-episode NA	.05	.02	3.49	.06
Pre-episode EE	.04	.11	.11	.74
Pre-episode DR	-.38	.15	6.59	.01 *
Pre-episode NA X EE	.05	.02	7.07	.008 **
Pre-episode NA X DR	.01	.03	.11	.74
Pre-episode EE X DR	-.06	.17	.13	.72
Pre-episode NA X EE X DR	.07	.03	5.15	.02 *
Between-Subjects Effects				
Pre-episode NA	.16	.03	23.82	<.001 **
Pre-episode EE	-.22	.32	.46	.50
Pre-episode DR	-.26	.20	1.70	.19

Note.

* $p < .05$;

** $p < .01$;

NA = negative affect; EE = eating expectancies; DR = dietary restraint