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Relationships between eating disorder-specific and transdiagnostic risk factors for binge eating: An integrative moderated mediation model of emotion regulation, anticipatory reward, and expectancy

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Abstract

Although relationships between negative affect, emotion dysregulation, and binge eating have been well-established, the mechanisms and individual risk factors that account for this relationship have yet to be elucidated. In addition to emotion dysregulation, altered reward functioning and negative affect eating expectancies (i.e., the expectancy that eating will relieve negative affect) are factors that have been previously linked to binge eating, though theoretical frameworks have not provided an integrated conceptualization of relationships between these domains. Therefore, the present study examined an integrative moderated mediation model among a sample of 101 adults with self-reported eating disorder (ED) symptoms who completed a battery of online questionnaires. Results supported the hypothesized model, which demonstrated that eating expectancies mediated the relationship between emotion dysregulation and binge eating frequency, and there was a positive association between emotion dysregulation and eating expectancies among individuals high in anticipatory reward. These findings provide preliminary support for an integrated approach to understanding transdiagnostic and ED-specific risk factors that potentiate binge eating.

Keywords

binge eating; eating expectancy; emotion regulation; reward

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Introduction

Binge eating, defined as the consumption of an objectively large amount of food accompanied by a sense of loss of control over eating (American Psychiatric Association, 2013), is associated with a range of negative psychological and physical correlates, including emotional distress, psychiatric morbidity, and weight gain (e.g., Schmidt et al., 2016). A wealth of research has demonstrated that negative affect is broadly related to maladaptive eating, including binge-eating episodes, and that individuals who engage in binge eating have difficulty tolerating and regulating aversive emotional states (e.g., Lavender et al., 2015; Leehr et al., 2015). In line with such evidence, several theoretical frameworks posit that binge eating functions to escape from or regulate negative affective states, and is thereby maintained via negative reinforcement (e.g., Hawkins & Clement, 1984; Heatherton & Baumeister, 1991).

More recent work has advanced earlier affect regulation models of disordered eating to elucidate the important interplay of both transdiagnostic (e.g., negative emotionality) and eating disorder (ED) specific risk factors (e.g., eating expectancies, thin ideal internalization; Pearson, Wonderlich, & Smith, 2015a; Racine, Culbert, & Klump, 2015). However, given that other categories of psychiatric disorders share similar transdiagnostic factors (e.g., negative affectivity and emotion dysregulation; Aldao et al., 2010), further research is needed to elucidate the mechanisms and individual differences that predispose individuals to resort to binge eating in response to negative affect and emotion regulation deficits.

Eating Expectancies

Expectancy theory is one framework from which to understand risk for ED behaviors, which posits that individuals make decisions based on previously learned associations between behaviors and outcome, and select behaviors based on their expectations of the results of the behavior (Behan, 1953; Tolman & Postman, 1954). *Eating expectancies* refer to individuals' history of positive and negative reinforcement from eating and have been implicated in the etiology and maintenance of ED psychopathology (Bohon, Stice, & Burton, 2009; Holstein, Smith, & Atlas, 1998; Smith, Simmons, Flory, Annus, & Hill, 2007; Pearson, Combs, Zapolski, & Smith, 2012). In particular, the expectancy that eating will reduce negative affect (i.e., negative affect eating expectancy) has been shown to be associated with binge eating (e.g., Fischer, Anderson, & Smith, 2004; Hayaki, 2009; Hohlstein et al., 1998; Pearson & Smith, 2015).

In line with the affect regulation model, such expectancy may play a role in the maintenance of binge eating by conditioning individuals to expect emotional relief from such behavior. A related theory is that of the acquired preparedness model, which suggests that both dispositional characteristics and learning histories (i.e., expectancies) contribute to development of disordered eating (Pearson et al., 2012; Smith, Williams, Clyders, & Kelly, 2006). Specifically, trait-level characteristics are thought to indirectly influence risk via their effect on learning processes, in that individuals may evidence differential learning to similar events as a function of dispositional differences; in turn, these learning experiences are thought to lead to the development of specific expectancies over time.

Anticipatory Reward

Another factor that has been broadly implicated in binge eating is that of reward functioning, and in recent years a substantial body of research has emerged demonstrating various alterations in reward circuit functioning across ED diagnoses (for a review see Wierenga, Ely, Bischoff-Grethe, Bailer, Simmons, & Kaye, 2014). Furthermore, throughout the reward literature important distinctions have been made between anticipatory pleasure (i.e., “wanting”) from consummatory pleasure (i.e., “liking”). In particular, anticipatory reward refers to pleasure in anticipation or imagination of a stimulus (Berridge & Robinson, 2003), and may motivate individuals to seek out particular rewarding stimuli (Gard, Gard, Kring, & John, 2006).

Despite the relevance of reward functioning in binge eating, there is limited research in EDs linking anticipatory reward to the aforementioned processes (i.e., emotion regulation and eating expectancy). One neuroimaging study found that heightened negative affect seemed to enhance the anticipatory reward value of food for individuals with bulimia nervosa (Bohon & Stice, 2012). Although the process by which this occurs is unclear, these findings are in line with the revised reinforcement sensitivity theory. This theory suggests that the tendency to notice, seek out, and form reinforcing associations between eating and positive outcomes (i.e., negative affect relief) may underlie overeating behaviors (Hennegan, Loxton, & Mattar, 2013), which is consistent with findings in the addiction literature demonstrating that reward sensitivity is involved in the development of drinking expectancies (e.g., Kabbani & Kambouropoulos, 2013). Thus, it may be that individuals with higher anticipatory reward are more likely to seek out food in response to emotion regulation difficulties, and therefore develop greater eating expectancies.

The Present Study

Taken together, several transdiagnostic and ED-specific factors have been implicated in the onset and maintenance of binge eating, including emotion dysregulation, eating expectancies, and reward functioning. However, thus far, studies have not examined how these domains may be theoretically integrated to understand their combined influence on binge eating. Therefore, the present study aimed to examine an integrative moderated mediation model to elucidate risk and maintenance factors for binge eating, as shown in Figure 1. In line with the acquired preparedness model that suggests dispositional tendencies lead to differential learning histories and expectancies, it was hypothesized that individuals who have difficulty adaptively regulating aversive affective states (i.e., dispositional emotion regulation difficulties) would be more likely to hold the belief that eating provides relief from negative affect (i.e., eating expectancies). It was also predicted that that this relationship would be stronger among individuals with higher anticipatory reward, who may be more motivated to think about or seek out food in response to emotional problems. In turn, consistent line with previous research (Fischer et al., 2013), it was hypothesized that the expectancy that eating would relieve negative affect would be associated with higher binge eating frequency, and that this relationship would be stronger specifically among individuals with higher anticipatory reward.

Method

Participants and Procedure

Participants ($N = 101$; 96% female; 98% White, non-Hispanic) were recruited through flyers at community and clinical sites in a major metropolitan area in the Midwest (USA) as well as through online advertisements and social media. Inclusion criteria were age 18 or older, self-reported diagnosis of an ED or experiencing ED symptoms in the past month, and access to the web and email. Mean age of the sample was 30.29 ($SD = 10.99$; Range = 18–60) and mean BMI was 27.26 ($SD = 12.56$; Range = 12.65 – 95.69). About 61% ($n = 66$) were currently receiving treatment for an ED, and 69% were currently taking psychiatric medications. All participants had a unique IP address providing evidence that there were not duplicate participants.

When participants accessed the online survey website, they first read through the informed consent and were asked three questions about the content of the consent form to ascertain whether they read and understood the consent form. Participants were required to answer all three questions correctly to proceed with the research study. If any participant answered any of these questions incorrectly, he or she was directed back to review the consent form and to answer these questions again. After correctly answering questions regarding the consent form, participants were then able to sign the consent form electronically and proceed to the survey. Participants who completed the survey were eligible to enter a drawing to receive one of five \$40 gift cards.

Measures

Difficulties in Emotion Regulation Scale – Short Form (DERS-SF; Kaufman et al., 2016).—The 16-item short form of the DERS was used to assess emotion regulation difficulties. Participants respond to items on 5-point scale ranging from 1 (*almost never*) to 5 (*almost always*). A sample item is, ‘When I am upset, my emotions feel overwhelming.’ Higher scores indicate more difficulty regulating one’s emotions. Kaufman et al. (2016) reported that the DERS-SF has excellent psychometric properties, similar to the long form version. The Cronbach’s alpha for the current study was .92.

Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006).—The TEPS measures anticipatory and consummatory reward processes. The 10-item anticipatory reward scale subscale was used in the current study. Participants indicated on a scale from 1 (*very false for me*) to 6 (*very true for me*) how much they agreed with each item. A sample item is, ‘When something exciting is coming up in my life, I really look forward to it.’ Higher scores reflect greater tendency to anticipate reward from pleasurable activities. Gard et al. (2006) provided evidence for the construct validity of the TEPS. The Cronbach’s alphas for the current study was .70.

Eating Expectancies Inventory (EEI; Hohlstein, Smith, & Atlas, 1998).—The EEI assesses individuals’ cognitive beliefs about the effect or consequences of eating. In the current study, we used the negative affect subscale, which assesses expectancies that food will alleviate negative affect. Participants respond to eight items on a scale ranging from 1

(*completely disagree*) to 7 (*completely agree*). A sample item is, 'Eating helps me get over it, when I feel bad.' The Cronbach's alphas for the current study was .95.

ED Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994).—The EDE-Q is 28-item self-report measure of a variety of ED symptoms in the past 28 days. The Global score (which includes weight concerns, shape concerns, eating concerns, and dietary restraint), was used as a measure of ED psychopathology severity. Binge eating frequency was determined by asking respondents to report the number of times they engaged in overeating accompanied by a subjective sense of loss of control in the past 28 days.

Statistical Analysis

Descriptive statistics and bivariate correlations were calculated. Because binge eating was highly skewed, a square root transformation was applied. A mediation model including eating expectancies as a mediator of the relationship between emotion regulation difficulties and binge eating was examined. Then, a moderated mediation model was calculated adding anticipatory reward as a moderator of both the path between (a) emotion regulation difficulties and eating expectancies and (b) eating expectancies and binge eating. Age was included as a covariate. The SPSS Process macro (Hayes, 2015) was used for analysis as it allows for estimation of mediation and moderated mediation models. Bootstrapping with 5,000 bootstrap samples was used to test the indirect effect and moderated mediation effect. The bootstrap approach generally produces preferable standard errors for the indirect effect test (Preacher & Hayes, 2008). The indirect effect and moderated mediation effect were considered significant if 95% bias-corrected (BC) confidence intervals (CIs) did not include 0. For the moderated mediation model, variables were centered to reduce multicollinearity. Significant interactions were plotted at ± 1 SD of variables.

Results

The mean EDE-Q Global score was 4.16 ($SD=1.06$), indicating clinically significant ED psychopathology in this sample (Smith et al., 2017). Table 1 displays descriptives and bivariate correlations among variables. Binge eating frequency was significantly correlated with greater eating expectancies. Eating expectancies were significantly correlated with greater anticipatory reward.

Mediation Model

The indirect effect was not significant, Estimate = -0.01 , $SE = 0.17$, 95% BC CI = $[-0.71, 0.13]$. In the mediation model, emotion regulation difficulties were not associated with eating expectancies ($B = -0.01$, $SE = 0.25$, $p = .97$) or binge eating ($B = -0.29$, $SE = 0.21$, $p = .17$). Eating expectancies were significantly associated with binge eating ($B = 0.61$, $SE = 0.09$, $p < .001$) such that those with greater expectancies that eating would alleviate negative affect reported more frequent binge eating episodes.

Moderated Mediation Model

Figure 2 displays the statistical moderated mediation model. The model explained 28% of the variance in eating expectancies and 37% of the variance in binge eating frequency. In the

moderated mediation model, there was no main effect of emotion regulation difficulties on eating expectancies, $B = 0.11$, $SE = 0.22$, $p = .63$. There was a significant main effect of anticipatory reward on eating expectancies ($B = 1.01$, $SE = 0.20$, $p < .001$) as well as a significant interaction between emotion regulation difficulties and anticipatory reward ($B = 0.56$, $SE = 0.27$, $p = .04$). Figure 3 displays the interaction. At higher levels of anticipatory reward, emotion dysregulation was positively associated with eating expectancies whereas at lower levels of anticipatory reward, emotion dysregulation was negatively associated with eating expectancies. The conditional effect estimates were: +1 SD on anticipatory reward ($B = 0.58$, $SE = 0.31$), mean on anticipatory reward, ($B = 0.11$, $SE = 0.22$), and -1 SD on anticipatory reward ($B = -0.36$, $SE = 0.31$).

There was no main effect of emotion regulation difficulties on binge eating, $B = -0.36$, $SE = 0.21$, $p = .10$. There was a significant main effect of eating expectancies on binge eating ($B = 0.65$, $SE = 0.10$, $p < .001$); no significant main effect of anticipatory reward on binge eating ($B = -0.17$, $SE = 0.21$, $p = .42$); and no significant interaction between eating expectancies and anticipatory reward ($B = 0.14$, $SE = 0.10$, $p = .17$).

Discussion

The present study sought to examine relationships between transdiagnostic and ED-specific factors to further determine the relationship between emotion dysregulation and binge eating. Results demonstrated support for most of the hypothesized relationships within the moderated mediation model (Figure 1), such that eating expectancies mediated the relationship between emotion dysregulation and binge eating, though the moderating effect indicated this model was only significant among individuals high in anticipatory reward. These findings highlight the complex interplay between these domains in relation to binge eating, and results are generally consistent with the hypothesized causal processes. However, due to the cross-sectional nature of the study, the present analyses cannot test causal or directional relationships. Nevertheless, results provide a conceptual framework for future prospective studies to examine whether individuals with greater emotion regulation deficits may be more likely to learn through experiences that eating provides relief from negative affect, and that those expectancies in turn may lead to binge eating over time. Moreover, findings are supported by previous prospective research supporting the hypothesized links within the model. That is, studies have shown emotion-related impulsivity (i.e., negative urgency) is predictive of negative affect eating expectancies (Pearson, Zapolski, & Smith, 2015b), eating expectancies are related to subsequent binge eating (Pearson & Smith, 2015; Pearson et al., 2015b), and eating expectancies mediate prospective relationships between dispositional characteristics (e.g., ineffectiveness, negative urgency) and binge eating (Combs, Smith, Flory, Simmons, & Hill, 2010; Pearson et al., 2012, 2015).

More specifically, results indicated that greater emotion regulation difficulties were related to higher eating expectancies, specifically among individuals who reported greater anticipatory reward. This finding is consistent with a previous cross-sectional study of college women, which found that eating expectancies mediated relationships between reward sensitivity and emotional eating (Hennegan et al., 2013), as well as neurobiological evidence suggesting that individuals with overeating behavior exhibit altered anticipatory

reward responses to food cues (Wierenga et al., 2014). It is also important note that anticipatory reward is distinct from consummatory reward (i.e., the experience of pleasure from a stimulus; Gard et al., 2006), yet theoretical and empirical literature suggests that these processes work together to determine the reinforcing value of food (Berridge, 1996). With respect to binge eating, it has been posited that elevated responsivity to food cues may initially predispose individuals to excess food consumption, though over time, down-regulation of striatal dopamine receptors may lead to hypo-responsivity of this system, thereby leading individuals to consume increasing quantities of palatable foods (e.g., Balodis et al., 2014; Smith & Robbins, 2013). Thus, given that binge eating may be maintained by both aberrant anticipatory and enhanced consummatory responses to food cues (Wierenga et al., 2014), continued research is warranted to examine the significance of temporal distinctions in reward processing in relationship to binge eating.

It is also worth noting that the hypothesized moderating effect of anticipatory reward on the association between eating expectancies and binge eating was non-significant, indicating that levels of anticipatory reward had little impact on this association in this sample. Consistent with prior theory (Pearson et al., 2015a), one possibility is that through negative reinforcement processes, individuals who have previously developed disordered eating behavior (as is the case in the present sample) have already formed strong associations between the expectancy that eating will help alleviate distress and binge eating. Thus, the strength of this previously established association may evidence little variation among samples of individuals who already engage in such behaviors. Therefore, it may be that anticipatory reward is a more salient factor in determining how or whether individuals with emotion regulation difficulties develop cognitive expectancies that eating will alleviate negative affect, rather than how or whether individuals with such expectancies respond via binge eating.

Future Directions

Results of this study highlight several areas for future research. This study utilized one ED-specific risk factor (i.e., eating expectancies), although recent literature suggests that other ED-specific factors (i.e., appearance pressures, thin-ideal internalization, body dissatisfaction, dietary restraint) moderate relationships between eating expectancies and dysregulated eating (Racine & Martin, 2017). Thus, it is important for future studies to assess how other ED-specific risk factors may influence relationships within this model, and in the prediction of other ED symptoms besides binge eating. Notably, the majority of previous research examining the acquired preparedness model in EDs has focused on the role of negative urgency, which has demonstrated that eating expectancies mediates the association between negative urgency and ED behaviors (e.g., Pearson et al., 2012; Racine & Martin, 2017). Future longitudinal studies employing multidimensional measures of emotion regulation as well as negative urgency would be helpful to elucidate the direction of influence of these constructs on eating expectancies and ED behaviors. Lastly, while the present study examined trait levels of constructs, it would be useful for future research to examine how state- and trait-levels of anticipatory reward and expectancies influence affect and binge eating at the momentary level using ecological momentary assessment methods

(EMA), which some recent studies have begun to explore (e.g., Fischer et al., 2018; Pearson et al., 2018).

Limitations

Several limitations are worth noting. Because the sample was limited to primarily Caucasian women, these findings may not generalize to other demographic groups. The sample was also drawn from both clinical and community settings, and while this may enhance generalizability, there may be differences in symptomatology and/or demographics between these settings. Notably, the cross-sectional nature of this study prevents evaluation of temporal relationships, and future research is needed to examine the directionality of the observed associations using longitudinal designs. In addition, assessments were limited to self-report measures, which did not provide rigorous diagnostic assessment of the sample, and which may yield different results compared to semi-structured interview assessments of ED behaviors (Berg, Peterson, Frazier, & Crow, 2012). Also, given that binge eating presents across multiple ED diagnoses (e.g., anorexia nervosa binge-purge subtype, bulimia nervosa, binge eating disorder), further study is needed to examine the extent to which the observed relationships may vary across ED subtypes, and the potential influence of weight status (i.e., BMI). Finally, future multimethod research is warranted to incorporate behavioral or neurobiological assessments of constructs included the present model (e.g., reward circuit functioning), as well examine this model in relation to other ED behaviors (e.g., purging, dietary restriction).

Conclusions and Implications

In sum, the present findings illustrate relationships between transdiagnostic and ED- specific factors that together may potentiate binge eating, and which help to refine our understanding of the associations between emotion dysregulation and disordered eating behaviors. Future investigations are necessary to assess these relationships using prospective designs and expanded assessment methods, as well as examine potential differences between diagnostic categories. Although additional study is needed, these findings may ultimately help identify individuals who are most likely to develop particular eating expectancies (i.e., those high in both emotion dysregulation and anticipatory reward). Thus, identifying and targeting multiple high-risk traits in the context of prevention and intervention efforts may be particularly effective for these individuals.

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Highlights

- Emotion regulation (ER), anticipatory reward (AR), and negative affect eating expectancies (EE) have been previously linked to binge eating but have not been conceptually integrated.
- The present study examined a moderated mediation model predicting binge eating frequency among adults with eating disorder symptoms.
- Results indicated that EE mediated the relationship between ER and binge eating, and AR moderated the relationship between emotion regulation and eating expectancies.
- Together these findings demonstrate relationships between transdiagnostic and eating disorder-specific factors that together may potentiate binge eating.
- Future prospective research is necessary to examine temporal relationships between these constructs and in the context of additional eating disorder behaviors.

Figure 1.

Hypothesized moderated mediation model predicting that negative affect eating expectancies would mediate the relationship between emotion regulation difficulties and binge eating, and that anticipatory reward would moderate paths between emotion regulation difficulties and eating expectancies (*a*), and between eating expectancies and binge eating (*b*).

Figure 2.

Statistical moderated-mediation model with unstandardized estimates. Solid lines represent $p < .05$, and dashed lines represent $p \geq .05$. Age is included as a covariate. Together results demonstrated that negative affect eating expectancy mediated the relationship between emotion dysregulation and binge eating, though the interaction between anticipatory reward and emotion regulation difficulties indicated this model was only significant among individuals high in anticipatory reward.

Figure 3.

Interaction between emotion regulation difficulties and anticipatory reward in relation to negative affect eating expectancies.

Table 1.

Descriptive Statistics and Bivariate Correlations for Study Variables

Variable	1	2	3	4
1. Emotion regulation difficulties	-	-0.11	-0.06	-.06
2. Anticipatory reward		-	0.42*	0.17
3. NA eating expectancies			-	.53**
4. Binge eating				-
<i>M</i>	3.31	3.60	3.55	8.51
<i>SD</i>	0.78	0.84	1.92	10.95
Minimum	1.44	1.40	1.00	0.00
Maximum	5.00	5.50	7.00	60.00
Skewness	-0.26	-0.30	0.07	1.66
Kurtosis	-0.55	0.15	-1.27	3.62