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Nothing Tastes as Good as Thin Feels: Low Positive Emotion Differentiation and Weight-Loss Activities in Anorexia Nervosa

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Abstract
Positive emotion (PE) has not been well studied in anorexia nervosa. Low positive emotion differentiation (PED), which involves a diminished ability to distinguish between discrete PEs, may contribute to PE dysregulation in anorexia. Specifically, low PED may interact with elevated PE intensity to both motivate and reinforce weight-loss and evaluation behaviors. Using ecological momentary assessment, we examined PE and weight-loss behaviors reported during a 2-week period. As hypothesized, low PED predicted more vomiting, laxative use, exercising, weighing, checking for fat, and restricting. Furthermore, participants with low PED who experienced elevated average PE intensity reported even more frequent behaviors. Within-subjects analyses indicated that for participants with low PED, more weight-loss behaviors at one recording predicted elevated PE at the subsequent recording. Similarly, for participants with low PED, higher momentary PE predicted more subsequent weight-loss behaviors. Thus, low PED in anorexia may reinforce and motivate weight-loss behavior.

Keywords
anorexia nervosa, positive emotion, emotional clarity, purging, weighing

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> [Her] demonstration of strict self-control over eating was a source of pride and accomplishment.
>
> —Oltmanns, Martin, Neale, and Davison (2012, p. 224)

Anorexia nervosa is a disorder characterized by much mental and physical suffering, as exemplified by a high overall mortality rate (Papdopoulos, Ekborn, Brandt, & Ekselius, 2009) and elevated suicidal behavior (Selby et al., 2010). Accordingly, several studies have identified that eating-disordered behaviors (including binge eating, purging, and other weight-loss behaviors) may reduce negative emotion (NE) and negatively reinforce such behavior (Berg et al., 2013; Fairburn, Cooper, & Shafran, 2003; Smyth et al., 2007). However, in focusing on NE, researchers and clinicians have often overlooked the potential role of problems with positive emotion (PE) in anorexia. Empirical research has indicated that PE and NE may be more accurately described as bivariate rather than as existing on a unipolar scale (Larsen, McGraw, & Cacioppo, 2001), which suggests that even amid pervasive NE, PE can also be experienced. Along these lines, calls have been made to examine the neglected role of positive reinforcement in initiating and maintaining weight-loss activities in anorexia (Walsh, 2013). These activities include overt weight-loss behaviors, such as restriction, vomiting, laxative use, and exercise, as well as self-evaluation activities, such as weigh-ins and checking

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oneself for fat to gauge success with weight loss. These activities may be reinforced, especially in the early stages of anorexia, through the personal and social rewards commonly associated with the successful pursuit of thinness and self-control.

PE in Anorexia and Weight-Loss Activities

The notion that weight-loss behaviors in anorexia involve positive reinforcement is not a novel concept. Slade's (1982) functional model of anorexia behaviors suggested that individuals with anorexia may have a strong desire for control, and they may achieve this control through dieting. Dieting control is further reinforced through resultant feelings of success with weight loss at the initiation of the disorder, which results in intensified motivation to continue to lose weight. Slade's model is consistent with findings from other studies that have suggested that many people with anorexia believe that their ability to lose weight makes them more attractive, builds self-control, makes them feel physically fit, provides feelings of confidence, makes them feel able to do at least one thing better than other people, enhances feelings of expertise, and improves their ability to push their body further (Serpell, Teasdale, Troop, & Treasure, 2004; Serpell, Treasure, Teasdale, & Sullivan, 1999).

Another source of positive reinforcement in anorexia may be exposure to stimuli that promote extreme weight loss, such as content posted on "Pro-Ana" (Pro-Anorexia) Web sites, which feature images of thin/emaciated women and inspirational quotes for weight loss. One study of anorexic women has suggested that women who identified themselves as "pro-anorexics" reported higher average experience of PE, less anxiety, and a stronger focus on eating behaviors compared with other concerns (Lyons, Mehl, & Pennebaker, 2006). Similarly, evidence exists that female undergraduates with an elevated drive for thinness who viewed pictures of emaciated women tended to approach such material, as opposed to avoid it (Woud, Anschutz, Van Strien, & Becker, 2011). In contrast, one sample of undergraduate students with high eating-disorder symptoms reported stronger urges to vomit after they had viewed a Pro-Ana Web site (Bardone-Cone & Cass, 2007). This reaction may have been a result of negative self-evaluations, but a complementary explanation is that these images instilled motivation to engage in weight-loss behavior and to strive for extreme thinness. Finally, recent neuroimaging studies have identified that anorexic women, compared with normal weight or overweight control participants, may be more responsive to reward anticipation and reception (Frank et al., 2012), demonstrating increased ventral striatal reward responsiveness (a biological index of PE) to images of underweight women (Fladung et al., 2010).

Low Positive Emotion Differentiation and Weight-Loss Activities in Anorexia

We propose, on the basis of Slade's (1982) model of PE in anorexia, that PE may promote weight-loss behaviors in anorexia as a function of low positive emotion differentiation (PED). *Emotion differentiation* is defined as an individual's ability to successfully differentiate between discrete emotional states experienced (i.e., sad vs. anxious vs. angry), as compared with a tendency to experience emotion in a broad and general sense (i.e., upset; Barrett, Gross, Christensen, & Benvenuto, 2011). In our positive-feedback model (see Fig. 1), after initiation of a weight-loss goal, when individuals with anorexia are successful at making incremental progress toward their goal of reaching a desired body shape and weight, they experience PE, such as pride about making another step toward this difficult goal. Because of low PED, however, a PE in anorexic individuals may be enhanced in a way that triggers other PEs besides pride, such as confidence, accomplishment, attentiveness, energy, or happiness. This activation of other PEs may be a function of distorted cognitions about the positive implications of being thin, as well as implicit associations about thinness being associated with happiness or success (Henderson-King & Henderson-King, 1997). This enhanced PE may in turn motivate further weight-loss behaviors, which also are positively reinforced by success made toward reaching a weight goal (e.g., lower weight, less body fat when checking). Thus, over time, weight-loss behaviors may become further conditioned to elicit acute PE, even after weight-loss goals are met and protracted (Walsh, 2013). These notions are also consistent with recent findings of increased ventral striatal responding in response to reward stimuli in anorexia (Fladung et al., 2010; Frank

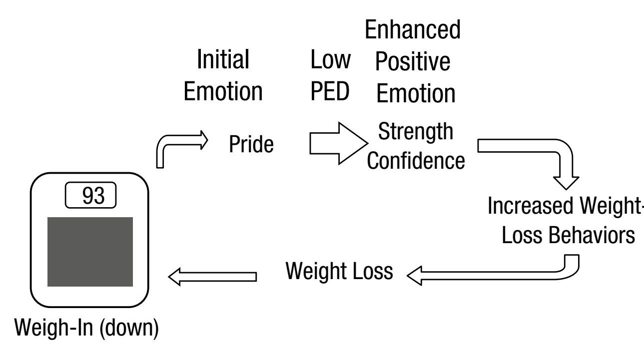

Fig. 1. Low positive emotion differentiation (PED) model of weight-loss activities in anorexia.

et al., 2012). It is important to note that this model exists within the context of NE as well, and experiences such as failing to lose weight or gaining weight may increase NE, further motivating weight-loss behaviors.

Anorexia, Emotional Distortion, and Emotion Differentiation

Previous research on emotional distortion in anorexia further highlights the potential relevance of the low-PED model of anorexia that we have proposed. Individuals with eating disorders have long been thought to experience distorted emotions, particularly in the negative realm, which may contribute to problematic eating behaviors. Researchers have found that individuals with anorexia, compared with control participants, experience difficulties identifying and describing feelings (Harrison, Tchanturia, & Treasure, 2010), recognizing facial expression of emotions (Jansch, Harmer, & Cooper, 2009), and expressing both facial and nonverbal emotion (Davies, Schmidt, Stahl, & Tchanturia, 2010; Davies, Swan, Schmidt, & Tchanturia, 2012). Studies have also shown that individuals with anorexia and bulimia experience difficulties identifying and distinguishing between various emotions and bodily sensations and have an externally oriented cognitive style—difficulties that often are conceptualized under the broad construct of *alexithymia* (Bourke, Taylor, Parker, & Bagby, 1992; de Groot, Rodin, & Olmstead, 2004; Speranza, Loas, Wallier, & Corcos, 2007). Thus, individuals with anorexia and bulimia may have difficulty making sense of their emotions; however, in most of these studies, researchers have investigated NE rather than PE.

Recent research on basic emotion-regulation processes has highlighted a new construct that might aid in understanding emotional distortion in anorexia—the index of emotion differentiation. Emotion-differentiation indices are typically generated from ecological momentary assessment (EMA) data, which are obtained by having participants record emotional experiences multiple times each day during a period of days and by calculating overall individual-level patterns of internal consistency among emotional responses. High scores on an emotion-differentiation index indicate that the individual experiences emotions in a discrete manner, with a primary emotion emphasized during each experience. Alternatively, a low score indicates that during each assessment, the individual reports similar levels of multiple emotions, which suggests that either multiple emotions are experienced or the individual is unable to discretely identify emotions. Research has shown that negative emotion differentiation (NED) is a protective factor against both alcohol use (Kashdan, Ferssizidis, Collins, & Muraven, 2010) and aggressive behavior (Pond et al., 2012). Difficulties distinguishing between NEs have also been associated with elevated binging, purging, and fat-checking behaviors in nonclinical samples (Carano et al., 2006; De Berardis et al., 2007; Fink, Anestis, Selby, & Joiner, 2010). However, in other studies, researchers have not found a significant association between low NED and weight-loss behaviors (Becker-Stoll & Gerlinghoff, 2004; De Berardis et al. 2007; Rastam, Gillberg, Gillberg, & Johansson, 1997). One potential explanation for these inconsistent findings is that these researchers have all examined NED, whereas no researchers to date have examined low PED, particularly in individuals with anorexia.

Low PED may be an especially interesting trait to examine in individuals with anorexia, given that there is evidence that low PED may increase goal pursuit and reactivity of positive emotional responding in nonclinical samples. For example, a recent EMA study by Hill and Updegraff (2012) indicated that lower levels of PED were associated with increased positive emotional reactivity (r = .48, p < .001). Furthermore, using EMA, Tugade, Fredrickson, and Feldman-Barrett (2004) found that low PED (which is also commonly referred to as low *positive emotion granularity*) was associated with decreased "behavioral disengagement" as measured by the COPE scale (Carver, 1997). This finding indicated that individuals with low PED were less likely to give up or withdraw effort when stressors interfered with goals, and in the case of anorexia, low PED may contribute to the ability to persevere toward weight-loss goals. In addition, Tugade et al. found that low PED was associated with daydreaming. In individuals with anorexia, such daydreaming about the future positive consequences of attaining an ideal body weight may also be used to generate PE and motivation for weight-loss behaviors. Although PED has been examined in only a few studies to date, the existing evidence has suggested that PED may play an important role in motivating and reinforcing weight-loss activities in individuals with anorexia.

Current Study

The purpose of the current study was to examine the role of low PED in contributing to increased frequency of weight-loss activities in anorexia. For this study, we used EMA data obtained from a sample of women with current anorexia diagnoses. These women completed 2 weeks of monitoring using digital recording devices, during which they rated their emotions and recorded weight-loss and evaluation behaviors multiple times each day. The use of EMA data to investigate the role of PE in weight-loss activities allowed us to examine these behaviors with decreased recall bias; the data also allowed for the examination of emotions in close temporal proximity to these behaviors. From these data, we generated indices of PED and NED for each participant, as well as PE and NE intensity, and we examined cross-sectionally and prospectively the role of low PED and PE in predicting elevated rates of vomiting, laxative use, exercise, weighing, checking for body fat, and calorie restriction.

Our hypotheses for this study were fourfold. In Hypothesis 1, we predicted that individuals who demonstrated low PED-ability scores during monitoring would exhibit more frequent weight-loss and evaluation behaviors. In Hypothesis 2, we predicted that the association between average PE intensity during monitoring and the frequency of various weight-loss and evaluation behaviors would be moderated by PED such that participants with lower PED would have a stronger relationship between PE intensity and frequency of eating-disordered behaviors.

We tested our third and fourth hypotheses using within-subjects momentary EMA recordings of PE intensity and weight-loss behaviors. In Hypothesis 3, we predicted that on occasions in which individuals reported higher PE at one momentary recording, those individuals would be more likely to report more weight-loss and evaluation behaviors at the subsequent recording and that this association would be strongest for individuals with low PED ability. Finally, in Hypothesis 4, we predicted that the report of more weight-loss and evaluation behaviors at one momentary recording would predict increased PE intensity at the subsequent momentary recording, especially for those participants with low PED ability. Although it was not the primary focus of the current study, because NE also promotes weight-loss activities in anorexia, we also examined the role of NE intensity and NED in this study. We expected that both high NE intensity and low NED would predict increased frequency of weight-loss and evaluation behaviors reported during the monitoring period.

Method

Participants

For this study, we used data from 118 women who met current diagnostic or subclinical criteria for anorexia (as defined later in the Clinical Assessment section), were designated as either restricting subtype (n = 73) or binge-purge subtype (n = 45), and who completed an EMA protocol. A total of 601 potential participants were originally screened for eligibility via phone. Eligibility criteria for further participation in the study included female sex, minimum age of 18 years, and endorsement of at least subthreshold criteria for anorexia. Diagnoses for anorexia were modified to include the following subthreshold exceptions: (a) weight equal to 90% (rather than 85%) of ideal body weight or (b) either amenorrhea or body-image disturbance and intense fear of gaining weight. These modifications are consistent with changes to the criteria for anorexia as reflected in the current version of the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; American Psychiatric Association, 2013; Mitchell, Cook-Myers, & Wonderlich, 2005), which no longer contains the amenorrhea criterion. Of the 601 potential participants who were phone screened, 166 were further evaluated on-site to confirm the eligibility criteria. On the basis of these in-person assessments, 121 participants met eligibility criteria, provided verbal and written consent, and were enrolled in the study. Three participants had monitoring compliance rates of less than 50% and were excluded from analyses, which resulted in a final sample of 118 participants. The ages of participants ranged from 18 to 58 years (M = 25.3 years, SD = 8.4), and participants' average body mass index was 17.2 kg/m^2 (SD = 1.0, range = 13.4–18.5 kg/m^2). The sample was almost entirely non-Hispanic Caucasian (96.6%), with a small percentage of African American (2.3%) and Asian American (1.1%) participants. The total household income for 43% of the sample was more than \$40,000 annually, with 26.7% of the sample reporting a household income of less than \$10,000 annually. More than 90% of the sample had at least some college education.

Procedure

Potential participants were recruited at three coordinated sites (Fargo, ND; Minneapolis, MN; and Chicago, IL) through mailings to treatment professionals, online postings, advertisements in community and campus newspapers, and flyers posted in clinical, community, and campus settings. The institutional review board at each site approved the study. After the phone screening, participants were scheduled for two in-person clinical-assessment visits. During these assessments, written consent was provided, physical screening and laboratory tests were conducted to ensure medical stability, structured clinical interviews were conducted, and self-report questionnaires were completed. After these assessments, participants were trained on the use of a digital recording device (Handspring Visor) used for EMA. The principal investigator, or a designated representative, at each site met with participants to discuss the purpose of the study, what to expect during the data-collection period, and how to deal with any questions that might arise from the signaling of the digital recording device.

To capture a variety of mood ratings in close temporal proximity to the behaviors, we employed signal-contingent, event-contingent, and interval-contingent recording

(Wheeler & Reis, 1991). For each type of recording, participants were asked to complete ratings of their mood and behaviors. Signal-contingent recordings prompted participants to complete mood ratings six times throughout the day when the digital recording device signaled them. The device signaled participants at a semirandom time within 30 to 45 min of the anchor times: 8:30 a.m., 11:10 a.m., 1:50 p.m., 4:30 p.m., 7:10 p.m., and 9:50 p.m. For event-contingent recordings, participants were asked to complete mood ratings whenever they engaged in certain eating-disordered behaviors (e.g., vomiting, laxative use). For interval-contingent recordings, participants were asked to complete an assessment at bedtime in which they provided both an emotion rating and an assessment of degree of caloric restriction for the day.

Participants carried the digital recording device for 2 practice days, at which point they returned the device and provided the data recorded during their practice period (these data were not used in analyses). This practice period was used both to ensure that participants were familiar and comfortable with the EMA assessments and to minimize reactivity to the recording procedures (although there is little evidence of reactivity in EMA; e.g., Stein & Corte, 2003). The data from the training days were subsequently reviewed, and participants were given feedback regarding their compliance rates. Participants were then given the digital recording device to complete EMA recordings during the next 2 weeks. Attempts were made to schedule two to three visits for each participant during this 2-week interval to obtain recorded data and to minimize the amount of data lost in the event of technical problems, and participants were given feedback at each visit with respect to their compliance rates. Participants completed the study at the end of the 2-week monitoring period; they were compensated $100 per week for completing momentary assessments and were given a $50 bonus for a compliance rate of at least 80% to random signals.

Clinical assessment

We used the Structured Clinical Interview for *DSM–IV* Axis I Disorders (First, Spitzer, Gibbon, & Williams, 1995) to determine anorexia diagnoses at the full and subthreshold level as well as current and lifetime criteria for all other Axis I disorders. The Structured Clinical Interview for *DSM–IV* Axis I Disorders is a commonly used interview to diagnose anorexia (Kaye et al., 2008). A doctoral-level clinical psychologist completed the clinical interviews, which were recorded, and a second, blinded, independent assessor rated current eating-disorder diagnoses in a random sample of 25% of the total sample (n = 30). Interrater reliability for current anorexia diagnosis was very good (κ = .93).

EMA

At each EMA, participants were asked to record their current emotions as well as whether they had engaged in either weight-loss activities or caloric restriction since the previous recording.

PE and NE measures. At each of the EMAs, participants answered specific questions about PE and NE, which were generated from the Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988) as well as some items from the Profile of Mood States (Lorr & McNair, 1971). Items from the Positive and Negative Affect Scale included eight items on NE (nervous, angry at self, afraid, sad, disgusted, distressed, ashamed, and dissatisfied with self) and eight items on PE (strong, enthusiastic, happy, energetic, proud, attentive, confident, and cheerful). Seven items from the Tension/Anxiety Scale of the Profile of Mood States (on edge, restless, tense, anxious, uneasy, shaky, and panicky) were also used for NE, and one item from the Profile of Mood States (relaxed) was included as a PE item. Items from both scales were used to assess the broadest spectrum of individual emotions, which is important for examining emotion differentiation. Participants rated their current mood for each of these items on a 5-point scale ranging from 1 (*not at all*) to 5 (*extremely*). In the current study, alpha coefficients were .94 for NE and .92 for PE. These items were used to generate indices of NE and PE intensity, and they were also used in the generation of the NED and PED indices.

Weight-loss and evaluation behaviors. At each EMA, all participants also completed a checklist of common weight-loss activities, which has been used in previous EMA studies of weight-loss behaviors in eating disorders (Smyth et al., 2007). Participants were asked to report specific weight-loss and evaluation behaviors, including vomiting or laxative use for weight control, weighing-in on a scale, exercising, and checking joints and bones for fat. All participants were given clarification regarding the definitions of each activity. All activities were individually summed into total-monitoring-frequency variables averaged across 2 weeks for each participant because some participants completed fewer or more than 14 days of monitoring. For a within-subjects analysis, we also created a total-weight-loss-activities variable for any momentary recording, which summed all activities, except for daily calorie restriction, reported at that signal. Creating such a combined variable was supported by a principal component factor analysis that showed that these behaviors loaded well onto one primary factor (all factor loadings > .30) at the momentary-report level, which suggested that more than one activity was often reported at each momentary recording.

Calorie restriction. Participants were asked to report the occurrence of specific eating-related behaviors and rituals drawn from the Yale-Brown-Cornell Eating Disorder Scale (Sunday, Halmi, & Einhorn, 1995). As a part of this assessment, at the end-of-day assessment, all participants were asked whether they had limited their food intake to fewer than 1,200 calories; participants were given examples of objective amounts of food consumed to help them improve accuracy of calorie-intake estimation. This dichotomous variable was later summed across all daily observations for the study to generate a count variable for number of days out of 14 with calorie restriction.

Emotion-differentiation and intensity indices

Multiple observations of emotions and behavior were recorded each day during the 14 days of monitoring, and the use of these assessments allowed for the derivation of daily emotion-differentiation indices. In addition, aggregated indices were generated to establish average levels of emotional intensity.

PED and NED indices. To create indices measuring individual levels of emotion-differentiation ability for PE and NE during monitoring, we generated and averaged across all assessments the intraclass correlation coefficient with absolute agreement for either PE or NE items at each assessment for each participant, which resulted in an average coefficient for each participant and allowed for an empirical index of the consistency between multiple emotion ratings for each participant. We then subtracted this coefficient from 1.0 to reverse the score so that higher scores indicated better ability at differentiating between discrete emotions (e.g., pride or excitement), whereas lower scores indicated that emotions were reported in a broad, undifferentiated manner (e.g., pride and excitement and energetic). This well-validated method has been used in multiple studies to generate emotion-differentiation indices from EMA data (Hill & Updegraff, 2012; Kashdan et al., 2010; Pond et al., 2012; Shrout & Fleiss, 1979; Tugade et al., 2004).

Average PE and NE intensity. To establish NE and PE intensity levels, we respectively summed the ratings for PE and NE items for each within-subjects momentary assessment. These momentary levels of PE and NE were then averaged across all observations for each participant, which resulted in average emotional intensity ratings. For within-subjects analyses, momentary levels of PE and NE intensity were used.

Data analytic strategy

To examine our Hypotheses 1 and 2, we used generalized linear modeling. This procedure is an extension of traditional regression modeling, with the exception that the outcome variable used is not normally distributed. Rather, in this study, the total number of each weight-loss or evaluation activity reported during monitoring was a count variable. The generalized linear modeling procedure accounts for this nonnormal distribution by using a log link to transform the regression coefficient and standard error to be consistent with a Poisson distribution. The result is a more powerful and analytically appropriate approach to data analysis for number of behaviors reported (Dobson & Barnett, 2008).

For each analysis, the following variables were first examined individually in relation to each activity: PED, NED, average PE intensity, and average NE intensity. We further examined each model by including the PED by average PE intensity interaction. NED and NE intensity were included in the model because we expected that these factors would be related to weight-loss behaviors and PED and aimed to demonstrate that even when accounting for level of NE, low PED predicting weight-loss and evaluation behaviors would maintain significance. In the next step of the analysis, the interaction between PED and PE intensity was included and examined. Finally, anorexia subtype was also included as a subsequent covariate in each model to ensure that third-variable explanations were not responsible for the effects found, particularly because individuals with anorexia are likely to exhibit higher rates of some weight-loss and evaluation behaviors, such as vomiting and laxative use.

For our Hypotheses 3 and 4, we used generalized linear mixed-model analyses, which allowed for the examination of momentary observations of the emotional context surrounding weight-loss behaviors. For the first analysis (Hypothesis 3), we created a lag–PE intensity variable by taking the PE score for each person at one signal and shifting the data, thereby allowing the data to predict a behavior at the subsequent signal. The lag variables were created within each person during each day of monitoring, and the missing score at the start of each day for each participant was not included in analyses. Weight-loss and evaluation behaviors (i.e., vomiting, exercising, weighing, and checking for fat) were combined so that a count variable was created, which allowed for the engagement of multiple behaviors because there was not enough power to conduct this analysis for each weight-loss behavior separately. The data were analyzed with a two-level mixed model that accounted for observations nested within each participant; the predictor variables were entered as fixed effects, and the intercept was specified as random.

The generalized mixed-model analyses consisted of two levels: within-subjects observations each day (Level 1) and between-subjects at baseline (Level 2). The base model was

Response Distribution: Weight-Loss Behaviors$_{jk}$ | μ_{jk} ~ Poisson(μ_{jk})
Link Function: $\eta_{jk} = \log(\mu_{jk})$

Linear Predictor:
Level 1 (momentary observation): $\eta_{jk} = \beta_{0k}$
Level 2 (individual): $\beta_{0k} = \beta_{00} + u$,

where *j* refers to the momentary observation and *k* refers to each individual. The response distribution for behaviors was Poisson, which accounts for the count-nature distribution of these behaviors (μ_{jk}). The link function transforms the outcome of the identity analysis (η_{jk}) with a logarithm transformation such that it is consistent with the Poisson distribution. Level 1 assesses the momentary observations of each behavior by adjusting the individual Level 2 intercept (β_{0k}), and Level 2 assesses the between-subjects variables and includes a fixed intercept (β_{00}). The resulting final base model equation is $\text{Log}(\mu_{jk}) = \eta_{jk} = \beta_{00} + u$, which indicates an individual-level intercept for momentary behavior reports plus random error. Mixed-model analyses also have to account for autocorrelation within a model, which refers to the problems often caused by high correlation between variables that are measured closely in time. To account for the potential concerns regarding autocorrelation, we included lag time as a predictor at Level 1 of the model to account for time between observations, according to the recommendation of West and Hepworth (1991).

We then added predictors to the base model, with momentary within-subjects variables placed on Level 1 and between-subjects predictors added to Level 2:

Level 1 (momentary observation): $\eta_{jk} = \beta_{0k} + \beta_{1k}(\text{lag-PE intensity})_{j-1k} + \beta_{2k}(\text{lag-NE intensity})_{j-1k}$

Level 2 (individual): $\beta_{0k} = \beta_{00} + \beta_{01}(\text{PED})_k + \beta_{02}(\text{NED})_k + \beta_{03}(\text{anorexia-type})_k + u$

$\beta_{1k} = \beta_{11} + \beta_{21}(\text{PED})_k$

$\beta_{2k} = \beta_{12}$

Reduced Equation: $\eta_{jk} = \beta_{00} + \beta_{01}(\text{PED})_{j-1k} + \beta_{02}(\text{NED})_{j-1k} + \beta_{03}(\text{anorexia-type})_{j-1k} + \beta_{11}(\text{lag-PE intensity})_{j-1k} + \beta_{12}(\text{lag-NE intensity})_{j-1k} + \beta_{21}(\text{lag-PE intensity} \times \text{PED})_{j-1k} + u$,

where β_{00} refers to the individual intercept, β_{0n} refers to the Level 2 predictor weights, β_{1n} refers to the Level 1 variable predictor weights, and β_{21} refers to the cross-level interaction between PED and momentary PE intensity.

To test our Hypothesis 4, we again used generalized linear mixed modeling to examine whether weight-loss activities reported at one signal would predict elevated PE at the subsequent signal, especially for those participants with low PED. In this model, the same structure was used as in the previous analysis; however, because PE was a normally distributed outcome variable, a traditional linear mixed model was used (involving an identity link function and normal distribution). For this model, we generated a lag–weight-loss behaviors variable, which allowed us to examine previous reports of weight-loss behaviors in predicting subsequent PE. Level 1 predictors included lag–weight-loss behaviors and concurrent level of NE, Level 2 predictors included PED and NED, and a cross-level interaction term was included for a lag–weight-loss behaviors by PED interaction. We included concurrent level of NE in the model to account for the fact that weight-loss activities are also frequently associated with NE and because a high level of NE may influence concurrent feelings of PE. Lag time was again included to account for autocorrelation, and the model also included a fixed intercept. As a result of the multiple comparisons conducted, we used a conservative alpha of .01. All analyses were completed in SPSS version 20.

Results

Preliminary analyses

The 118 participants in this study provided a total of 15,017 momentary recordings during the monitoring period, which represented 1,767 separate participant days. Recordings included 3,445 reports of eating-relevant events, with a mean of 4.53 vomits (*SD* = 9.39), 0.62 laxative uses (*SD* = 1.93), 6.59 exercise sessions (*SD* = 8.59), 5.33 weigh-ins (*SD* = 7.62), 20.61 checks for body fat (*SD* = 26.62), and 4.03 days with fewer than 1,200 calories consumed (*SD* = 5.22; see Table 1 for means and standard deviations for key variables). Compliance rates to signals averaged 87% (range = 58%–100%); 77% of all signals were responded to within 45 min. Compliance with end-of-day ratings averaged 89%.

PED scores in the sample were generally low (*M* = .26, *SD* = .16), and as previous research has shown in a general sample (Hill & Updegraff, 2012), low PED scores were associated with elevated average PE intensity ($r = .28$, $p < .001$; see Table 1 for intercorrelations for key variables). There was also a moderate correlation between PED and NED ($r = .50$, $p < .001$), and there was no correlation between PED and NE intensity ($r = .02$, $p > .05$),

Table 1. Intercorrelations for Key Variables

Variable	1	2	3	4	5	6	7	8	9	10
1. PED	—									
2. Average PE intensity	.28***	—								
3. NED	.50***	.10	—							
4. Average NE intensity	.02	−.42***	.34***	—						
5. Vomiting	.26**	−.12	.18*	.31***	—					
6. Laxative use	.11*	−.11*	.13*	.36***	.37***	—				
7. Exercise sessions	.20*	.22**	.03	−.04	−.06	.07	—			
8. Weigh-ins	.06	−.05	−.11	.11	.04	.06	.06	—		
9. Body-fat checks	.21*	−.06	.14	.37***	.29**	.25**	.01	−.02	—	
10. Days < 1,200 calories	.08	.06	.02	.07	.04	.05	.01	.04	.11*	—
Mean	0.26	20.79	0.21	34.56	4.53	0.62	6.59	5.33	20.61	4.03
Standard deviation	0.16	5.71	0.13	13.24	9.39	1.93	8.59	7.62	26.62	5.21
Minimum	0.01	9.18	0.02	15.51	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.94	38.44	0.78	72.51	43.00	13.00	47.00	52.00	88.00	14.00

Note: $N = 118$. PED = positive emotion differentiation; PE = positive emotion; NED = negative emotion differentiation; NE = negative emotion; Days < 1,200 calories = days during which caloric intake was restricted to fewer than 1,200 calories.
*$p < .05$. **$p < .01$. ***$p < .001$.

which indicates that NED and PED may be related yet distinct constructs. The average PE intensity was 18.42 ($SD = 5.24$), whereas the average NA intensity was 18.27 ($SD = 7.47$); both were systematically distributed. With regard to anorexia subtypes, participants with anorexia binge-purge subtype demonstrated significantly lower PED scores ($M = .21$, $SD = .14$) than did participants with anorexia restricting subtype ($M = .29$, $SD = .16$), $t(1) = 2.60$, $p = .011$, $d = 0.50$. NED score did not differ by anorexia subtype, $t(1) = 1.64$, $p > .05$, $d = 0.30$.

Hypothesis 1: Main effects of low PED

Individual PED levels were significantly associated with frequency of behaviors reported during the 2-week period—vomiting: $b = -3.861$, $SE = 0.800$, $p < .001$, risk ratio (RR) = 0.02; laxative use: $b = -4.251$, $SE = 0.580$, $p < .001$, RR = 0.01; exercise sessions: $b = -1.709$, $SE = 0.275$, $p < .001$, RR = 0.18; weighing: $b = -0.423$, $SE = 0.084$, $p < .001$, RR = 0.66; checking body for fat: $b = -0.735$, $SE = 0.140$, $p < .001$, RR = 0.48; number of days with fewer than 1,200 calories consumed: $b = -0.200$, $SE = 0.063$, $p < .01$, RR = 0.82. All behaviors were higher in the context of low PED, thereby supporting our Hypothesis 1.

For NED, a less consistent pattern of association was found with weight-loss activities. There was a significant negative association with exercise ($b = -0.914$, $SE = 0.310$, $p < .01$, RR = 0.40), which indicated that less ability to differentiate NEs promoted exercise. Conversely, there was a significant positive association with weighing episodes ($b = 1.169$, $SE = 0.290$, $p < .001$, RR = 3.22), which indicated that strong ability to differentiate between NEs experienced promoted weighing. No significant relationship was found for NED and vomiting, laxative use, checking for fat, or calorie restriction.

Low average PE intensity was associated with vomiting ($b = -0.054$, $SE = 0.019$, $p < .01$, RR = 0.95), laxative use ($b = -0.064$, $SE = 0.029$, $p < .01$, RR = 0.94), checking for fat ($b = -0.014$, $SE = 0.004$, $p < .001$, RR = 0.98), and days with fewer than 1,200 calories consumed ($b = -0.055$, $SE = 0.009$, $p < .001$, RR = 0.99). Conversely, high PE intensity was associated with exercise sessions ($b = 0.034$, $SE = 0.006$, $p < .001$, RR = 1.03), and no main effect was found for PE intensity on weighing. Consistent with previous research, results showed that a general pattern of high average NE intensity was associated with all weight-loss behaviors with the exception of exercise sessions. As would be expected, individuals with binge-purge subtype, compared with individuals with restricting subtype, reported higher rates of vomiting (binge purge: $M = 10.49$, $SD = 12.11$; restricting: $M = 0.58$, $SD = 1.61$), $t(1) = 6.93$, $p < .001$, $d = 1.12$, and higher rates of laxative use (binge purge: $M = 1.24$, $SD = 2.52$; restricting: $M = 0.30$, $SD = 1.37$), $t(1) = 2.64$, $p < .01$, $d = 0.48$, but did not report higher rates of weighing, exercising, checking for fat, or restriction. When anorexia subtype was added as a covariate to the previous models, low PED predicted weight-loss behaviors beyond the effects of anorexia subtype.

Hypothesis 2: Low PED and PE intensity

The details of the interactions between PED and PE intensity are presented in Table 2, and graphs for all interactions are displayed in Figure 2. The interactions were significant and in the hypothesized direction, with low PED and higher levels of PE predicting more weight-loss and evaluation behaviors than did high PED and high PE intensity—vomiting: $b = -0.291$, $SE = 0.028$,

Table 2. Predictors of Overall Frequency of Weight-Loss and Evaluation Behaviors in Anorexia

Behavior and predictor	*b*	*SE*	*z*	*p*	RR
Vomiting					
PED	−3.861	0.800	−23.31	< .001	0.02
NED	0.572	1.221	0.22	> .05	—
PE intensity	−0.054	0.019	−4.22	< .01	0.95
NE intensity	0.037	0.009	10.34	< .001	1.04
PED × PE Intensity	−0.291	0.028	−10.23	< .001	0.75
Laxative use					
PED	−4.251	0.580	−7.30	< .001	0.01
NED	1.383	1.354	1.04	> .05	—
PE intensity	−0.064	0.029	−4.81	< .01	0.94
NE intensity	0.047	0.012	12.01	< .001	1.05
PED × PE Intensity	−0.299	0.037	−8.02	< .001	0.74
Exercise sessions					
PED	−1.709	0.275	−38.65	< .001	0.18
NED	−0.914	0.310	−8.70	< .01	0.40
PE intensity	0.034	0.006	27.35	> .001	1.03
NE intensity	0.001	0.003	1.47	> .05	—
PED × PE Intensity	−0.400	0.083	−4.82	< .01	0.67
Weigh-ins					
PED	−0.423	0.084	−5.06	< .001	0.66
NED	1.169	0.290	16.28	< .001	3.21
PE intensity	−0.014	0.007	−3.74	> .05	—
NE intensity	0.013	0.003	19.78	< .001	1.01
PED × PE Intensity	−0.419	0.075	−5.586	< .001	0.66
Checking joints and bones for fat					
PED	−0.735	0.140	−27.38	< .001	0.48
NED	0.177	0.159	1.24	> .05	—
PE intensity	−0.014	0.004	14.78	< .001	0.98
NE intensity	0.021	0.001	214.61	< .001	1.02
PED × PE Intensity	−0.162	0.013	−12.83	< .001	0.85
< 1,200 calories over 24 hr					
PED	−0.196	0.064	−3.03	< .01	0.82
NED	0.120	0.36	0.11	> .05	—
PE intensity	−0.055	0.009	−41.33	< .001	0.95
NE intensity	0.017	0.010	27.04	< .001	1.02
PED × PE Intensity	−0.086	0.013	−6.83	< .001	0.92

Note: PED = positive emotion differentiation; NED = negative emotion differentiation; PE = positive emotion; NE = negative emotion.

$p < .001$, RR = 0.75; laxative use: $b = -0.299$, $SE = 0.037$, $p < .001$, RR = 0.74; exercise sessions: $b = -0.400$, $SE = 0.083$, $p < .01$, RR = 0.67; weighing: $b = -0.419$, $SE = 0.075$, $p < .001$, RR = 0.66; checking for fat: $b = -0.162$, $SE = 0.013$, $p < .001$, RR = 0.85; number of days with fewer than 1,200 calories consumed: $b = -0.086$, $SE = 0.013$, $p < .001$, RR = 0.92.

Simple-slope analyses were conducted to clarify the nature of the interactions. There was a positive, although nonsignificant, slope for participants with low PED and high PE intensity (slope = .04, $p > .05$, RR = 1.04) who reported more vomiting compared with individuals with low PED and low PE intensity. Conversely, participants with high PED and high PE intensity reported significantly fewer instances of vomiting (slope = −.26, $p < .01$, RR = 0.77) than did individuals with low PED and high PE intensity. There were significantly more episodes of laxative use for low-PED individuals at high PE intensity (slope = .02, $p < .001$, RR = 1.02) than for individuals with low PED and low PE intensity, and there were fewer uses for high-PED individuals at high PE intensity (slope = −.13, $p < .001$, RR = 0.88) than for low-PED individuals at high PE intensity. There were significantly more checks for body fat for participants with low PED and high PE

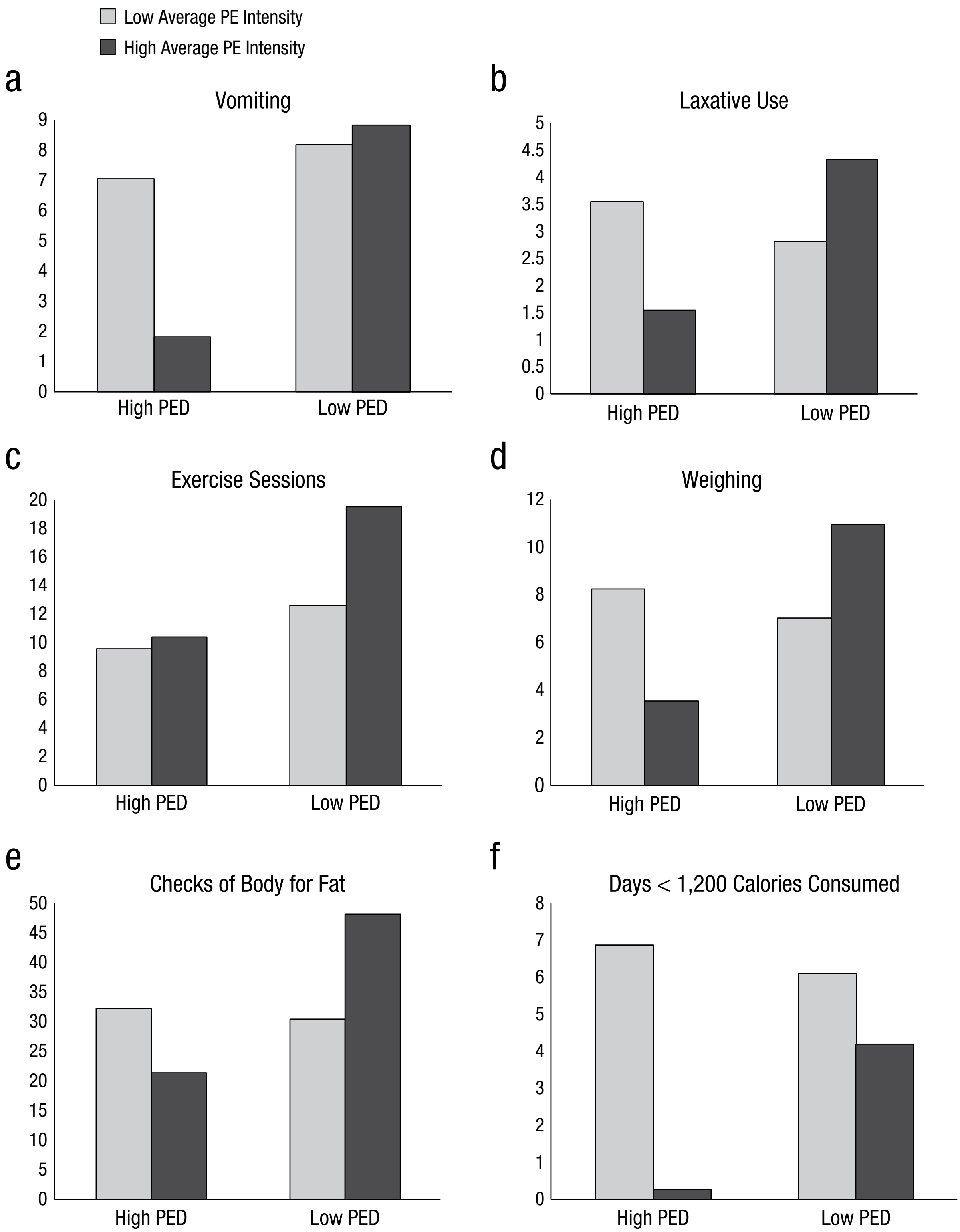

Fig. 2. Positive emotion (PE) and positive emotion differentiation (PED) predicting weight-loss and evaluation behaviors in anorexia. High and low designations respectively refer to 2 standard deviations above and below the mean. All variables were averaged across a 2-week period for each participant.

intensity (slope = .67, $p < .001$, RR = 1.95) than for individuals with low PED and low PE intensity, and there were significantly fewer checks for body fat for high-PED individuals at high PE intensity (slope = −.54, $p < .001$, RR = 0.58) than for low-PED individuals at high PE intensity. There were significantly more weigh-ins for participants with low PED and high PE intensity (slope = .13, $p < .001$, RR = 1.14) than for individuals with low PED and low PE intensity, and there were significantly fewer weigh-ins for participants with high PED and high PE intensity (slope = −.24, $p < .001$, RR = 0.79) than for individuals with low PED and high PED intensity. With regard to exercise sessions, as expected, there were more sessions for participants with low PED and high PE intensity (slope = .05, $p < .01$, RR = 1.05) than for individuals with low PED and low PE intensity and fewer sessions for high-PED individuals at high PE intensity (slope = −.13, $p < .01$, RR = 0.88) than for low-PED individuals at high PE intensity. Finally, although the highest number of days with fewer than 1,200 calories consumed was found for participants with low PED and low PE intensity relative to participants with low PED and high PE intensity (slope = −.09, $p < .001$, RR = 0.91), participants with high PED and high PE intensity reported fewer restricting days (slope = −.33, $p < .001$, RR = 0.72) than did individuals with low PED and high PE intensity.

Hypothesis 3: PE and prediction of subsequent weight-loss activities

We predicted that elevated PE intensity at one momentary signal would predict more total weight-loss behaviors recorded at the subsequent signal, particularly for participants with low PED. Results showed that with regard to autocorrelation, lag time was a significant predictor of weight-loss and evaluation behaviors (lag time = .003, *SE* = .001, $p < .001$, RR = 1.003); accordingly, lag time was retained in subsequent analyses to account for autocorrelation. In support of our Hypothesis 3, and as shown in Figure 3, there was a significant interaction effect for PED and lag–PE intensity to predict an elevation in subsequent number of weight-loss behaviors engaged in ($\beta_{21} = -0.085$, *SE* = 0.017, $p < .001$, RR = 0.92). With regard to other predictors, there were main effects for PED score ($\beta_{01} = -1.009$, *SE* = 0.105, $p < .001$, RR = 0.36) and for lag–PE intensity ($\beta_{11} = -0.02$, *SE* = 0.002, $p < .001$, RR = 0.98). Lag–NE intensity was also a significant predictor of weight-loss behaviors ($\beta_{12} = 0.018$, *SE* = 0.001, $p < .001$, RR = 1.02), which indicated that high NE predicted increases in these behaviors, and increased NED was a significant positive predictor of anorexic behaviors ($\beta_{02} = 1.067$, *SE* = 0.146, $p < .001$, RR = 2.91). Furthermore, anorexia subtype was a significant predictor of increased weight-loss behavior at any signal ($\beta_{03} = 0.177$, *SE* = 0.022, $p < .001$, RR = 3.24), with participants with binge-purge subtype experiencing more behaviors.

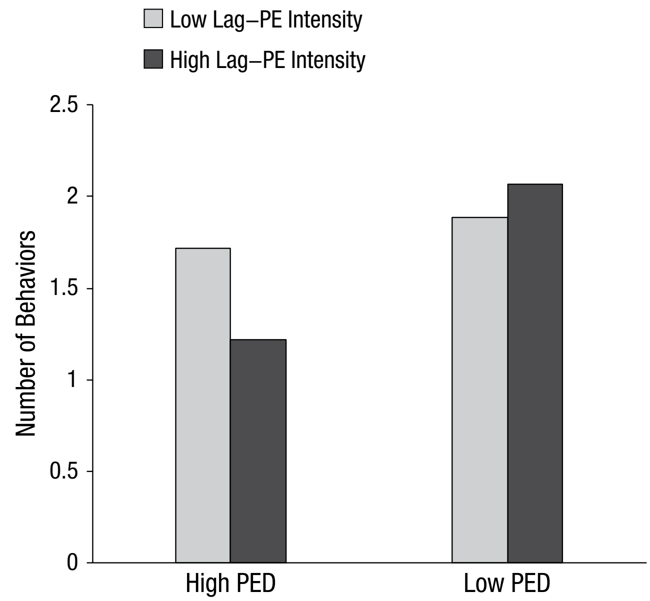

Fig. 3. Previous positive emotion (PE) level predicting subsequent weight-loss activities in anorexia. The graph shows the interaction between positive emotion differentiation (PED) and momentary PE intensity at one signal predicting the number of weight-loss and evaluation behaviors engaged in at a subsequent signal. High and low designations refer to 2 standard deviations above and below the mean, respectively.

Hypothesis 4: Weight-loss activities and prediction of subsequent PE

For this model, we expected that elevated weight-loss activities reported at one signal would predict elevated levels of PE at the subsequent signal, with a more pronounced effect for participants with low PED. Again, the lag time variable indicated a significant autocorrelation effect and was retained, $\beta = 0.002$, *SE* = 0.001, $p = .001$, RR = 1.002. The results of this model indicated that the interaction between PED and previous weight-loss and evaluation behaviors was a significant predictor of subsequent PE intensity, $\beta = 2.172$, *SE* = 0.739, $p = .003$, RR = 8.76. When graphed (see Fig. 4), the interaction indicated support for Hypothesis 4. There were significant main effects for PED, lag–weight-loss behaviors, NED, and concurrent NE—PED: $\beta = -8.486$, *SE* = 0.379, $p < .001$, RR = 0.0002; lag–weight-loss behaviors: $\beta = 0.235$, *SE* = 0.106, $p = .027$, RR = 1.26; NED: $\beta = -8.502$, *SE* = 0.419, $p < .001$, RR = 1.26; concurrent NE: $\beta = -8.502$, *SE* = 0.419, $p < .001$, RR = 0.0002. The interaction maintained significance when anorexia subtype was included as a covariate, although anorexia subtype was not a significant predictor.

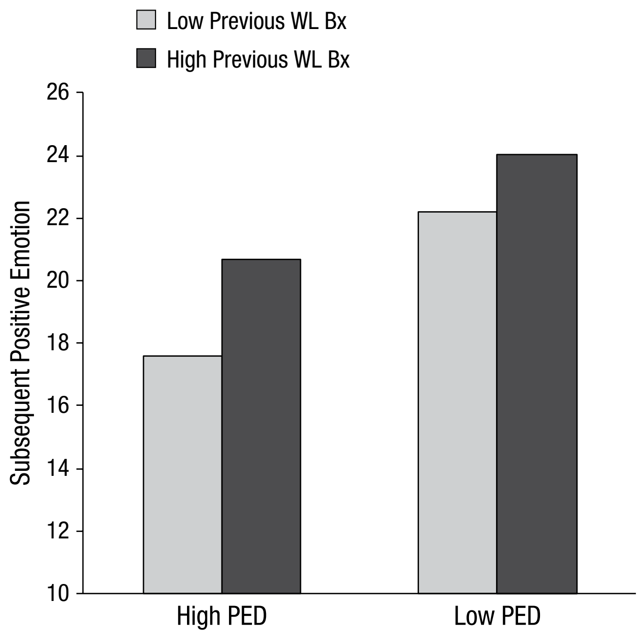

Fig. 4. Previous weight-loss and evaluation behaviors predicting subsequent level of positive emotion in anorexia. Interaction between positive emotion differentiation (PED) and previous weight-loss and evaluation behaviors (WL Bx) at one signal predicting elevated positive emotion reported at the subsequent signal. High and low designations refer to 2 standard deviations above and below the mean, respectively.

Discussion

Although many researchers have examined the role of NE in facilitating weight-loss and evaluation behaviors in anorexia, few researchers have examined the potential role of PE. The goal of the current study was to examine the role of low PED in weight-loss activities in anorexia. We hypothesized that participants who exhibited lower levels of PED in combination with higher average levels of PE intensity would exhibit the highest frequency of weight-loss and evaluation behaviors. Across all activities examined, low PED was found to be a significant and consistent predictor; furthermore, low PED interacted with increased PE intensity to predict more frequent vomiting, laxative use, exercising, weighing, and checking for fat and more days with fewer than 1,200 calories consumed. Furthermore, we examined the interaction of momentary PE before and after weight-loss activities with a participant's PED level. We found evidence that low PED level interacted with high momentary PE intensity at one signal to predict the occurrence of more weight-loss and evaluation behaviors at the subsequent signal. In addition, we found that for participants with low PED, engaging in more weight-loss behaviors predicted subsequently elevated levels of PE. These findings collectively suggest that although individuals with anorexia may experience abundant NE, which influences weight-loss behavior, they may also experience maladaptive PE that both motivates and reinforces weight-loss behaviors in a positive-feedback loop. It is important to note that these findings held beyond the effects of NE, NED, and anorexia subtype.

How does low PED develop in anorexia?

The experience of low PED in anorexia likely has some biological contributions, given that there are increasing findings of biological vulnerability to anorexia (Bulik et al., 2006). As mentioned earlier, neuroimaging research has indicated that individuals with anorexia display heightened reward responding in the ventral striatum in response to rewarding stimuli, such as pictures of underweight women (Fladung et al., 2010). This biologically heightened reward responding may have important implications for the phenomenological experience of PE, such that rewards result in more PE, which potentially diminishes the differential effects of discrete PEs when experienced.

Low PED may also be driven, at least in part, by cognitive distortions. For example, Serpell et al. (2004) found that some individuals with anorexia viewed their success with weight loss as leading to elevated feelings of confidence, expertise, and being better at something than other people. Although success with diet and consistent exercise are valuable for building confidence and self-esteem in many people, individuals with anorexia may inflate the importance of these skills. People with anorexia not only may view their weight-loss skills as a source of pride but they may also associate such skills with a broader range of PEs, such as strength, joy, and happiness. Many of these distorted cognitions and their associations with PE may occur at the implicit level for individuals with anorexia (Henderson-King & Henderson-King, 1997). Although few researchers have examined implicit associations between thin body image and PE, Ahern, Bennett, and Hetherington (2008) found that undergraduate women who placed a higher importance on thin ideals had stronger positive implicit associations with eating-disorder behaviors and images of underweight fashion models. Thus, distorted thoughts and beliefs about thin ideals may be associated with a blurring between the boundaries of discrete PEs.

Social, cultural, and media influences may also contribute to the development of low PED. Media often depict thin women as flourishing in other areas of their lives beyond ideal body appearance—career, wealth, romance, and family life. As a result, media sources may strengthen cognitive and implicit associations between thinness, happiness, and success, which essentially erodes the distinctions between discrete PEs in people with anorexia. Accordingly, individuals with anorexia may experience success with weight loss not only as success with a specific goal but also as an indicator of broader success with increased attractiveness, happiness, and perceptions of success. Potential examples of this effect can be observed in Pro-Ana Web sites, which frequently display quotes such as, "being thin and not eating are signs of true willpower and success," and "what the scale says is the most important thing" (Costin, 2011). Thus, many factors may contribute to the development of low PED, which may ultimately play a role in the development and maintenance of anorexia.

Low PED and low PE intensity

Also of note, and as Figure 2 shows, participants exhibiting low PED and low PE intensity reported frequent weight-loss activities. For example, although our hypothesized interaction between low PED and high PE intensity predicted restricting behavior, the low PED and low PE intensity combination predicted the highest level of restriction. In this condition, participants indicated having primarily low or absent PE at most observations. This scenario presents an alternative perspective for the role of PED and suggests that low PED may also contribute to diminished experience of PE in some cases, perhaps in a manner similar to anhedonia in major depression. PED essentially may also inhibit or diminish PE for some individuals, thereby resulting in the discounting of positive emotional experiences, which may fuel additional weight-loss behaviors for negative reinforcement purposes. It is also likely that experiencing a dearth of PE goes hand in hand with experiencing elevated NE. This relationship may explain why many people with anorexia and eating disorders experience eating-disorder symptoms despite having loving and caring families (Casper & Troiani, 2001) and demonstrating academic/occupational achievement (Thompson-Brenner, Eddy, Satir, Boisseau, & Westen, 2008). These findings suggest that in studying the role of PE in anorexia, it may be important to examine both maladaptive elevations in PE and maladaptive decreases in PE, especially in conjunction with NE.

NED and weight-loss behaviors

Although our primary focus was on low PED and the promotion of weight-loss behaviors, we found that increased average NE intensity was also a consistent and prominent predictor of weight-loss behavior. However, unlike low PED, low NED was an inconsistent predictor of weight-loss behaviors in our study, which adds to previously mixed findings from other studies on negative emotional clarity in eating-disordered behavior (De Berardis et al., 2007). We found that low NED predicted increased exercise sessions, whereas high NED predicted more weighing. There were no NED associations with other weight-loss behaviors. This differential association of NED and various weight-loss behaviors is interesting but currently difficult to explain. The association also suggests that individuals with anorexia may not necessarily have difficulties differentiating all emotions and that difficulties with differentiation may be more relevant to PEs. More work is needed to determine what role NED plays in weight-loss activities and whether a combination of low NED and PED promotes weight-loss activities.

Low PED and NE intensity in anorexia

The current study provides evidence that some individuals with anorexia may experience PE in a maladaptive manner, and this maladaptive PE may promote weight-loss activities and reinforce them in a vicious feedback loop. Although these findings may initially seem inconsistent with the experience of NE in anorexia (i.e., How can someone experience elevated PE when NE is such a pervasive problem?), the PED model proposed here does not construe these as conflicting forces. Although low PED may enhance PE in a way that promotes and reinforces weight-loss behaviors, the desire to lose weight and an exaggerated focus on ideal body shape and image may result as a function of NE intensity. In addition, struggles with weight loss or weight gain may further prompt NE and motivate weight-loss behaviors for negative reinforcement purposes. NEs in anorexia may also be a result of interference with weight-loss goals and in some ways may be viewed as a product of the maladaptive association between weight loss and PE in these individuals.

The potential for combined and high levels of both PE and NE dysregulation in anorexia may result in a perfect storm of motivation for weight-loss activity, thereby leading to weight loss well beyond what is healthy or attainable for most people. Recent research has shown that the more people overvalue happiness, the more likely they are to feel unhappy even when happiness seems within reach (Mauss, Tamir, Anderson, & Savino, 2011). These conflicting feelings may involve disappointment with how happiness feels when goals are reached, relative to how it was expected to feel. Such may be the case with anorexia, in which progress toward goals may result in PE, but on reaching a larger goal, many things remain at issue (e.g., "I'm thinner, but still unhappy with my life"). This may result in ever-increasing weight-loss goals and attempts to find an elusive happiness wherein the pursuit of happiness results in more PE than does the actual achievement of the primary goal and yet ultimately leads to more and pervasive unhappiness.

Differential effects of low PED also may exist during the development and maintenance of anorexia. Our PED model may be particularly relevant at the initial development of anorexia nervosa, during which positive motivation and positive reinforcement may be primary. However, over time, more NE may prompt increased engagement in negatively reinforcing weight-loss activities, and the role of low PED and positive reinforcement may decrease in a manner consistent with previous theoretical models (Fairburn et al., 2003). However, given that many people with anorexia have difficulty terminating weight-loss activities, some of these individuals may continue to experience dysregulated PE and the rewarding effects of weight-loss behaviors as the disorder increases in severity. This result may be a function of PE becoming conditioned to weight-loss behaviors over time, which makes these behaviors become inherently rewarding even when weight loss is no longer visible. Such a process would be consistent with Walsh's (2013) view that anorexic behaviors become habitual over time.

Limitations

This study has several limitations. First, although we found evidence that elevated PE and weight-loss behaviors temporally predicted each other for participants with low PED, these findings do not speak to the causal role of PE in motivating or reinforcing weight-loss and evaluation behaviors. For example, it is possible that NE is still the primary original motivator of weight-loss activities, and after taking part in weight-loss activities, individuals with anorexia may feel relieved as a function of negative reinforcement of NE resulting from the behaviors, rather than PE and reinforcement. Thus, responses to weight loss and weight-loss behaviors may need to be further refined to determine whether it is acute increases in PE that are reinforcing the behavior or negative reinforcement of aversive experiences (e.g., making them a little less miserable). Second, because our sample comprised a highly symptomatic group of women with anorexia, the possibility exists that there is a restriction of range for some variables. For example, because such an impaired sample was used, many of our participants may have had low NED, as demonstrated by a range of .02 to .78; this range is in contrast to the range for PED, which was .01 to .94. Low variation in NED scores may partially explain the null and inconsistent findings for this variable in predicting weight-loss activities in this study. Future research should compare individuals with anorexia either with other eating-disordered participants or with healthy controls to determine whether there are significant group differences in PED and whether those differences predict elevated weight-loss behaviors. Finally, because this sample primarily was composed of non-Hispanic Caucasians (96.6%) and comprised only women, these findings may not generalize to other groups (e.g., men with symptoms of anorexia).

In addition to these concerns, future researchers should attempt to tease apart the multiple motivations for weight-loss behavior in anorexia. In the research reported here, we found that both high NE and high PE, in the context of low PED, were highly associated with weight-loss behaviors. Thus, a good day with weight goals may promote continued weight-loss behaviors, but similarly, a bad day may spur such behaviors to make up for weight gain. Teasing apart the differential effects of PE and NE on weight-loss behaviors could provide further insights into anorexia. Furthermore, it is important to note that the role of PE in anorexia should be clarified, potentially by using experimental and psychophysiological methods, with regard to whether there is actual distortion in the experience of PE or whether distortion pertains to the way PE is differentiated.

Future directions

There are numerous ways in which the findings of the current study can be extended to provide further insights into the role of PE and low PED in anorexia. One important research direction would be to use experimental methods, such as experimental PE inductions in which participants with anorexia would complete writing tasks or view film clips designed to elicit PE, to examine the hypothesis that weight-loss activities are positively reinforcing in anorexia. Such inductions could aim to induce anorexia-salient PEs or PEs highly related to positive motivations for anorexia (vs. anorexia-neutral PEs). For example, participants with anorexia could be randomized to one of three positive writing tasks: (a) an anorexia-salient task in which participants are asked to write about their successful strategies for weight loss, (b) an anorexia-neutral task in which participants are asked to write about a favorite movie, and (c) a neutral writing task in which participants are asked to write about the importance of a strong math education. PEs would be assessed before and after such tasks, and reactivity of PE during the task could be compared across conditions. On the basis of the model in our study, those individuals in the anorexia-salient condition would likely exhibit the largest increases in PE. Furthermore, PED indices could be generated from PE ratings both before and after completion of the task, and low PED could be examined as a moderator of PE reactivity. Writing tasks could be compared with film-based inductions to compare methodological reactivity of PE.

Further research could also examine the hypothesis that PE serves as a motivator for anorexic behavior by using computer-based effort-expenditure tasks. Multiple computer tasks have been generated to examine how much effort people are willing to exert for a specific reward, usually monetary, and the more effort they put into the task, the greater the reward (Klein et al., 2010; Treadway, Buckholtz, Schwartzman, Lambert, & Zald, 2009). These tasks could be modified so that rather than examining effort exerted to receive money, researchers could examine how much effort individuals with anorexia would exert to receive money toward anorexia-relevant rewards. For example, money could be earned toward gift cards that were one of three types: anorexia salient (e.g., a fitness-exercise-related reward, such as fitness equipment), anorexia neutral (e.g., a bookstore gift card), or anorexia aversive (e.g., a food-related gift card). In such an experimental paradigm, it is likely that participants in the anorexia-salient tasks would exert more effort, earn more rewards, and rate more PE than would individuals in anorexia-neutral or anorexia-aversive tasks.

Clinical implications

Although more research is needed to better understand the role of PE and PED in anorexia, a richer understanding of the role of PE in motivating weight-loss behaviors may enhance insight into and treatment of anorexia. In addition to the current evidence-supported practices of increasing food consumption, reducing weight-loss behaviors, and reducing NE (Wilson, Grilo, & Vitousek, 2007), a novel complementary approach may involve addressing dysregulated positive emotional responding, which could be accomplished in two potential ways: by attempting to improve PED, and by attempting to capitalize on the effects of low PED and thereby encourage a shift from weight-loss activities to other rewarding activities that are not primarily weight related. Furthermore, these strategies may be enhanced when viewed from the perspective of self-determination theory (Ryan & Deci, 2000). Self-determination theory is a theoretical approach to human motivation that highlights three necessary, interrelated elements for the generation of intrinsic motivation and PE: facilitating autonomy, building competence, and encouraging relatedness. *Autonomy* is defined as the universal urge to be the causal agent in one's own life and to act consistently with one's values. *Needs for competency*, conversely, refers to seeking to control the outcome and experience of mastery through skills development. Finally, *feelings of relatedness* refers to a universal desire to want to interact with, be connected to, and experience caring for others (Baumeister & Leary, 1995). Anorexia may partially fulfill these elements in a maladaptive way through weight-loss activities, which individuals with anorexia often view as something that they are in control of (autonomy), that requires extensive effort and learned skills (competency), and that may facilitate relatedness, potentially by identifying other people with interests in weight loss or connecting through Pro-Ana communities. By finding alternative ways to enhance these elements in place of weight-loss activities, it may be possible to shift the motivation of individuals with anorexia away from weight loss and toward alternative activities.

The first approach in addressing dysregulated positive emotional responding—increasing discrimination among PEs—may be accomplished by integrating supportive and open discussion about the rewarding aspects of weight-loss and evaluation behaviors into psychotherapy for anorexia. This practice may involve the inclusion of techniques from acceptance and commitment therapy (ACT) in treatment for anorexia (Hayes, Strosahl, & Wilson, 1999; Orsillo & Batten, 2002). A major focus of ACT involves addressing desires for control and focusing on life values in relation to goal achievement. ACT may help determine what values are most important to individuals with anorexia and what role weight-loss activities play in enacting these values. Increasing engagement in value-directed activities rather than in goal-directed activities, and cultivating awareness of the different PEs elicited by each activity, may improve the ability of individuals with anorexia to understand and appreciate different PEs. For example, although they may feel pride or excitement about weight-loss activities, do they feel content or satisfied with their relationships? What other things in their lives are they grateful for, and what other areas of their lives could be improved by changing weight-loss behaviors? Disentangling PEs may help individuals with anorexia realize that although they may be experiencing success in weight-loss goals, such success does not necessarily generalize to fulfillment of other life values. Alternative approaches to improving emotion differentiation could include providing patients with psychoeducation about PEs and emotion regulation, as well as teaching them healthy ways to cultivate PE and life satisfaction. Finally, adapting EMA protocols to clinical assessments of PE may be helpful. Clinicians could use such assessments to help patients examine and identify times when they felt PE and investigate the factors that surrounded it, with the goal of promoting adaptive positive emotional understanding and responding.

The second approach focuses on harnessing the effects of low PED and increased sensitivity to rewards in anorexia (Fladung et al., 2010; Frank et al., 2012), and it could be implemented while patients work on developing emotion-differentiation skills. This approach may involve channeling the motivation for weight-loss activities into new activities that facilitate autonomy, competency, relatedness, and the formation of a new identity. Such activities may include reward/reinforcement-oriented activities from various areas, including arts, humanities, and recreational activities, and these activities may simultaneously improve ability to cope with NE.

When selecting alternative activities, a focus on activities that are incrementally rewarding as a function of effort may be important for building competence. Allowing the patient to choose the activity may also facilitate autonomy, and activities that involve interacting with others may enhance feelings of relatedness. Possible activities may include facilitating artistic skills (Frisch, Franko, & Herzog, 2006) or recreational activities such as horseback riding, climbing, team sports, and balancing exercises (Duesund & Skarderud, 2003). Substantial debate continues about whether exercise activities should be allowed during treatment for anorexia; however, finding ways to balance exercise with appropriate nutritional intake has some empirical support (Moola, Gairdner, & Amara, 2013; Zunker, Mitchell, & Wonderlich, 2011). The exercise activities favored by individuals with anorexia are often heavily focused on rote aerobic exercise, such as running and walking, with the primary goal of burning calories (Long & Smith, 1993); such exercise should probably be discouraged during treatment. However, in cases in which the patient has demonstrated progress toward weight normalization and has expressed a desire to exercise, rather than strictly prohibiting exercise, there may be benefits to encouraging the patient to select exercise that is highly skill focused and of mild to moderate intensity. Doing so would alter the focus of physical activity from burning calories to building skills.

One such form of exercise may be yoga, which involves building strength and improving skills as opposed to raw energy expenditure and which has been shown to reduce eating-disorder symptoms beyond standard care (Carei, Fyfe-Johnson, Breuner, & Brown, 2010). Another example exercise may be participation in martial arts training, which not only involves physical fitness but also requires building muscle strength (vs. pure leanness), participating in stages of progression indicating competency (e.g., progressing up the belt-color hierarchy), and interacting with other people, potentially facilitating relatedness. Clinical evidence has suggested that martial arts training can enhance self-regulation and relatedness in children and adolescents (Diamond & Lee, 2011; Lakes & Hoyt, 2004). However, physical activities should be carefully monitored to ensure that they do not interfere with weight normalization. Although many of these clinical suggestions are preliminary and require further empirical support, incorporating novel additions to current treatments may increase both motivation for treatment and successful outcomes for individuals with anorexia.

Author Contributions

E. A. Selby conceptualized the study, analyzed the data, and drafted the manuscript. S. A. Wonderlich facilitated data collection, assisted with conceptualization of the study, and contributed to the drafting and revision of the manuscript. R. D. Crosby facilitated data collection, assisted with data analyses, and edited the manuscript. S. G. Engel facilitated data collection, assisted with conceptualization of the study, and contributed to the drafting and revision of the manuscript. E. Panza assisted with conceptualization of the study and contributed to the drafting and revision of the manuscript. J. E. Mitchell, S. J. Crow, C. B. Peterson, and D. Le Grange facilitated data collection and assisted with manuscript edits and revisions.

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The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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