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Reciprocal Relations Between Dietary Restraint and Negative Affect in Adolescents Receiving Treatment for Anorexia Nervosa

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Recent research has identified the important but overlooked role of negative affect in the maintenance of dietary restriction. However, understanding how fluctuations in negative affect relate to symptoms of anorexia nervosa (AN) during treatment is limited. In a longitudinal study, the reciprocal associations between higher and lower order dimensions of negative affect and dietary restraint were examined in adolescents undergoing treatment for AN. The sample consisted of 107 adolescents (M_{age} = 15.5, SD = 1.5 years) who underwent family-based treatment over the course of 6 months. Self-report data assessing negative affect and dietary restraint were collected at baseline, 6 times throughout treatment, and again at the end of treatment. Findings from lagged hierarchical linear models revealed reciprocal associations between higher order negative affect and dietary restraint but unidirectional associations among some dimensions of lower order affect. Specifically, dietary restraint predicted increased guilt and hostility, whereas fear predicted increased dietary restraint. These findings highlight the importance of examining the distinct dimensions of negative emotion and the temporal role of fear in precipitating dietary restraint, and guilt and hostility in proceeding dietary restraint. Collectively, these findings emphasize the functional nature of different emotions in the process of AN remission and provide preliminary evidence of affective mechanisms related to change in symptomatology during treatment for adolescent AN.

General Scientific Summary
Affect is important in the maintenance of anorexia nervosa, but the experience of negative affect as it relates to dietary restraint is not well understood during treatment for this disorder. The results of this study indicate that adolescents undergoing treatment for anorexia nervosa feel guilty and hostile after they engage in dietary restriction and are more likely to engage in dietary restriction when they feel afraid.

Keywords: affect, emotion, family-based treatment, adolescent, anorexia nervosa

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Anorexia nervosa (AN) is a pernicious psychiatric disorder that is characterized by pervasive restriction of energy intake, physical emaciation, disturbance in the perception of one's body weight, and overvaluation of shape and weight (American Psychiatric Association, 2013). Although AN most commonly has its onset in adolescence, symptoms can be chronic and persist for several decades (Fichter, Quadflieg, Crosby, & Koch, 2017). Notably, current treatments for adolescent AN yield only modest outcomes (Brockmeyer, Friederich, & Schmidt, 2017; Murray, Quintana, Loeb, Griffiths, & Le Grange, 2018; Watson & Bulik, 2013). Indeed, family-based treatment (FBT; Lock & Le Grange, 2013) and analogues such as parent-focused treatment (PFT; Hughes, Sawyer, Loeb, & Le Grange, 2015) are considered the most efficacious treatment for medically stable AN of short duration (Brockmeyer et al., 2017). Yet approximately only 25% to 40% of those who undergo FBT will typically be remitted of symptoms by the end of treatment (Le Grange et al., 2016; Lock et al., 2010), and about one third will sustain remission at long-term follow-up (Le Grange et al., 2014). These modest outcomes likely reflect poor understanding of the psychological mechanisms that lead to symptom remission. As AN is among the most serious and lethal psychiatric disorders (Fichter & Quadflieg, 2016), targeted attempts to understand the psychological mechanisms that contribute to symptom maintenance in the context of treatment are increasingly urgent.

Within an emerging paradigm shift, Haynos and Fruzzetti (2011) proposed that affect regulation is a key deficit in AN, and that this deficit may contribute toward symptom maintenance. In this paradigm, dietary restriction is adopted as a method of managing negative emotion and thus reinforces further disordered eating behaviors. Support for this finding is documented among adults with AN in several studies with varying methodologies. For example, using ecological momentary assessment, Engel and colleagues (2013) reported that higher ratings of daily negative affect were associated with greater engagement in dietary restriction on subsequent days, and Fitzsimmons-Craft and colleagues (2015) found that negative affect increased prior to a restrictive eating episode and remained stable in the postrestrictive period. In another study examining the acute and proximal link between dietary restraint and negative affect, Haynos and colleagues (2017) reported that restrictive eating episodes function to relieve experiences of discrete affective states, such as guilt (Haynos et al., 2017). This collective evidence of momentary assessments from the adult literature suggests that negative affect may function to both acutely precipitate and proceed dietary restraint (Fitzsimmons-Craft et al., 2015; Wildes, Marcus, Bright, & Dapelo, 2012). However, much has been documented about affect as fluctuating not just moment to moment but also day to day, week to week, and month to month. Indeed, assessments of negative affect (e.g., Positive and Negative Effect Scale-Expanded [PANAS-X]) have been validated to examine affect at the momentary, daily, weekly, and monthly levels, because of the importance of considering both acute and sustained or cumulative fluctuations in affect over time. However, the temporal investigations of negative affect and eating pathology have focused exclusively on indexing moment-to-moment interactions (e.g., Berg et al., 2013; Fitzsimmons-Craft et al., 2015; Haynos et al., 2017), at the expense of understanding the cumulative effects of negative affect over discrete periods of time. Given the fluctuating nature of negative affect, and the potential for longer term sustained affective states to impact eating pathology, there is a need to examine the relationship between eating pathology and affect over varied time spans.

To date, researchers studying the affect–restraint relationship have focused exclusively on understanding the development and maintenance of adult AN outside of the treatment context. However, exploring affective experiences in the context of treatment is necessary to index the specific mechanisms that maintain eating pathology among adolescents. Indeed, negative affect has been identified as a robust predictor of eating pathology maintenance (see Stice, 2002, for review), and thus understanding more sustained chronic affective disturbances is critical to determining how persistent and lingering affective states are associated with symptom maintenance during treatment. A conceptual and empirical focus on acute affective states and eating pathology does not appropriately elucidate how the overarching affective states that linger beyond moment-to-moment fluctuations can impact eating pathology, and vice versa during the course of treatment. Understanding the affect–restraint relationship as it fluctuates in the context of treatment becomes an important consideration, as attempts to manage and reduce symptoms of eating pathology rest on the ability to identify and target the primary agents of symptomatic change. One recent study examined symptom trajectories throughout conjoint FBT and PFT for adolescent AN and found comparable trends across both treatments (Murray, Pila, Le Grange, Sawyer, & Hughes, 2017). Specifically, these data depict linear increases in weight, alongside linear decreases in both negative affect and dietary restraint, throughout the course of treatment. However, this study presented the trajectory of each symptom independently, and thus precluded understanding of the reciprocal and temporal relationship between negative affect and dietary restraint as changes unfold during treatment.

Further, in an effort to explicate the role of negative affect in the context of treatment, Murray and colleagues (2017) focused on composite scores of negative affect without distinguishing between the discrete affective components (e.g., fear, guilt) that may be uniquely associated with dietary restraint. The decision to focus on global negative affect has been a limitation in much of the current literature in AN, with some exceptions (e.g., Haynos et al., 2017). This limited focus is restrictive because negative affect is multidimensional, encompassing higher order dimensions (i.e., global negative affect), which are comprised of several lower order dimensions (i.e., fear, sadness, guilt, hostility) that can have unique functions and relationships with psychological constructs (Watson & Clark, 1994). Indeed, Haynos and colleagues (2017) were the first to identify that specific dimensions of negative affect (i.e., guilt) were uniquely linked to dietary restriction, even if global higher order negative affect was not. Unique associations between binge eating and purging behavior and global versus discrete dimensions of negative affect have also been documented (Berg et al., 2013), suggesting that examining only global dimensions of negative affect can mask the specific functional effects of discrete affective states. Additionally, recent network analyses have identified several dimensions of negative affect, which are implicated in the network of symptoms comprising AN (Solmi, Collantoni, Meneguzzo, Tenconi, & Favaro, 2018), further evidencing that conflating various dimensions of negative affect into composite scores may lack sensitivity in delineating the distinct contributions of specific negative affective states. As such, examining both

higher order (e.g., global) and lower order (e.g., discrete) affective states in the treatment context is an important endeavor as we aim to refine our understanding of the mechanisms that link affect to symptoms of eating pathology.

The aim of the present study was to examine the reciprocal associations between higher and lower order negative affect (i.e., fear, hostility, sadness, guilt) dimensions and dietary restraint over the course of treatment for adolescent AN. Specifically, we aimed to test whether a global score of negative affect predicted increases in dietary restraint and, alternatively, whether dietary restraint predicted increases in global negative affect. Further, we also aimed to test these two purposes for lower order negative affect dimensions to determine whether each unique affective state is uniquely linked to dietary restraint. It was hypothesized that a reciprocal relationship would exist between the global higher order dimension of negative affect and dietary restraint, and that the relationship would be sustained for the unique affective states at varying magnitudes—whereby higher negative affect would be associated with higher subsequent dietary restraint, and higher dietary restraint would be associated with higher subsequent negative affect at the following assessment. Given the exploratory nature of this research, no a priori hypotheses were set for the magnitude of the relationships between discrete affective states and dietary restraint.

Method

Participants and Procedures

The sample consisted of 107 adolescents with *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; American Psychiatric Association, 2013) classified AN. Participants were drawn from a randomized controlled trial testing two formats of FBT for adolescent AN: conjoint FBT (n = 55) or a separated format of FBT called *parent-focused treatment* (PFT; n = 52). The full trial is comprehensively detailed in the protocol paper (Hughes et al., 2014) and the main outcome paper (Le Grange et al., 2016). Participants and parents completed assent and consent procedures, and the protocol received approval from the institutional research ethics board. Both interventions were delivered over the course of 6 months and spanned 18 sessions. FBT consists of mobilizing parents to support their child's weight restoration and, ultimately, to transition ownership over eating to adolescents when clinically indicated. PFT adopts similar goals but does not involve the therapist having direct contact with the adolescent; instead, the therapist works only with the parents. Detailed intervention protocols of FBT and PFT have been previously reported (Hughes et al., 2014, 2015; Le Grange et al., 2016). Participants and parents completed interviews and self-reported written assessments at baseline, throughout treatment, at end of treatment, and at 6- and 12-month follow-up. The present study focuses on self-reported questionnaires (i.e., dietary restraint, negative affect) that were completed at baseline, six assessments completed fortnightly for the first 12 weeks, and the final end-of-treatment assessment at 24 weeks, for a total of eight assessment periods. Figure 1 provides a conceptual illustration of the data measurement and analysis.

Measures

Participant characteristics. In the present investigation, participant characteristics included a range of sociodemographic variables (e.g., sex, age, ethnicity, parental education), clinician-assessed characteristics (e.g., weight), and medical history (i.e., medical or psychiatric diagnoses, medication, duration of illness).

Negative affect. The 24 negatively valenced affective states of the self-reported PANAS-X (Watson & Clark, 1994) that correspond with four lower order subscales were utilized. The PANAS-X is an expanded form of the more commonly used 20-item PANAS and includes additional items to capture lower order affective states. The negative items were utilized in the present study. Participants were asked to report the extent that they felt each index of negative affect in the past 2 weeks on a 5-point scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*). Four independent subscales of negative affect were derived: Guilt (i.e., guilty, ashamed, blameworthy, angry at self, disgusting with self, dissatisfied with self), Fear (i.e., afraid, scared, frightened, nervous, jittery, shaky), Hostility (i.e., angry, hostile, irritable, scornful, disgusted, loathing), and Sadness (i.e., sad, blue, downhearted, alone, lonely). Further, the mean score of the 24 items was assessed as a higher order measure. This composite of the four subscales was utilized to permit the relative comparison of lower and higher order affective dimensions as they relate to dietary restraint. The PANAS has well-established validity and is a commonly utilized assessment of affect in adolescents (Watson, Clark, & Tellegen, 1988). In the present study, Cronbach's alpha ranged from 0.93 to 0.98 for the higher order Negative Affect scale, 0.94 to 0.97 for Guilt, 0.88 to 0.94 for Fear, 0.80 to 0.90 for Hostility, and 0.92 to 0.95 for Sadness.

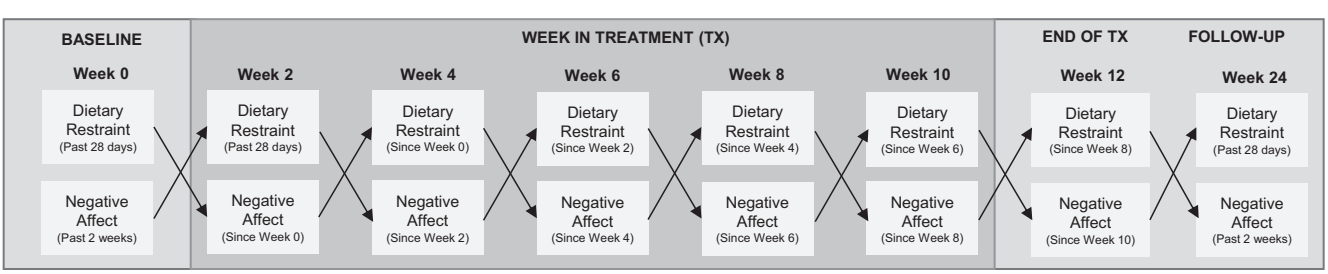

Figure 1. Conceptual illustration of model that tests dietary restraint (over past 28 days) as a predictor of subsequent negative affect (over past 2 weeks), and separate model illustrating negative affect (over past 2 weeks) in predicting subsequent dietary restraint (over past 28 days). Models include temporal overlap of measured constructs.

Dietary restraint. The five-item Dietary Restraint subscale of the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Belgin, 2008) was utilized to assess attempts to restrict dietary intake. Ranging from a scale of 0 (*no days*) to 6 (*every day*), participants rated the frequency of their engagement over the past 28 days. Dietary restraint was assessed as a proxy of eating disorder psychopathology, given strong psychometric similarities with the full EDE-Q (Mond, Hay, Owen, & Beumont, 2004) and with the goal of reducing participant burden throughout treatment. The Cronbach's alpha for the items in the Dietary Restraint subscale ranged from 0.89 to 0.92. Further, the Restraint subscale demonstrated high concordance with the clinician-administered Eating Disorder Examination (EDE; Cooper & Fairburn, 1987), which was conducted at baseline.

Analytic Strategy

Descriptive statistics, bivariate correlations, and intraclass correlations were calculated for the main study variables using SPSS Version 20. Hierarchical linear modeling techniques were employed using HLM 7.0. Multilevel modeling uses maximum likelihood analysis and is therefore appropriate in managing missing or unbalanced data when there are varied numbers of observations over time. In other words, this method allows an examination of negative affect relative to dietary restraint, even when participants report differing numbers of observations of each variable of interest (e.g., complete the affect assessment but not the restraint assessment), as may occur in longitudinal treatment studies. Based on recommendations by Singer and Willett (2003) for reciprocal associations, lagged hierarchical linear models with time-varying covariates were estimated. First, separate *N*–1 lagged time-varying covariate models were estimated to test whether higher order negative affect (i.e., composite score averaging guilt, fear, hostility, sadness) predicted future increases in dietary restraint over the treatment period, and whether dietary restraint predicted future increases in higher order negative affect across treatment. Then, separate follow-up models were conducted with each lower order dimension of fear, guilt, sadness, and hostility. All models controlled for baseline percent median body mass index (BMI) at the between-person level. Specifically, each model estimated the within-person variability in the dependent variable, as a function of participants' previous assessment of the independent variable, controlling for time (i.e., weeks in treatment), and the autoregressive effects of the dependent variable.

Models were also initially tested with a treatment term (i.e., FBT or PFT), and a Time × Treatment interaction effect, to parse out the potential time varying effects of treatment type on affect and dietary restraint. The treatment term and interaction were retained in the model if significant. Additionally, interaction effects between lagged affect and dietary restraint were also tested to examine synergistic effects between variables in predicting subsequent affect or dietary restraint. The interaction terms were retained in the model if significant. Estimated models utilized the following equation format, displayed as a sample, whereby dietary restraint *i* for person *j* (Dietary Restraint$_{ij}$) was modeled at the within-person level,

$$\begin{aligned}\text{Dietary Restraint}_{ij} = {} & \beta_{0j} + \beta_{1j}(\text{Time}_{ij}) \\ & + \beta_{2j}(\text{Lag Dietary Restraint}_{ij}) \\ & + \beta_{3j}(\text{Lag Fear}_{ij}) + \beta_{4j}(\text{Treatment}_{ij}) \\ & + \beta_{4j}(\text{Treatment}_{ij} \times \text{Time}_{ij}) \\ & + \beta_{5j}(\text{Lag Dietary Restraint}_{ij} \times \text{Lag Fear}_{ij})\ e_{ij},\end{aligned}$$

and between-person level,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Baseline \%Med BMI}) + e_{0j},$$

whereby γ_{00} represents the expected level of dietary restraint for the average person in the sample, and γ_{01} indicates the between-person associations of participant baseline weight and dietary restraint.

Main models included each time assessment (i.e., Weeks 0, 2, 4, 8, 10, 24) and are illustrated in Figure 1. Given the temporal overlap of the selected measures, supplemental analyses were conducted testing only nonoverlapping time assessments (i.e., Weeks 0, 4, 8, 12, and 24) and are represented in Figure 2. All models utilized raw scores of time, whereby time represents the number of weeks in treatment; meanwhile, affect and dietary restraint measures were centered on each individual's baseline scores before the start of treatment (i.e., Week 0). As such, the Level 1 intercept represents each patient's baseline score on the dependent variable, and the slope represents a patient's degree of deviations from their baseline score of the independent variable. The Level 1 intercept was treated as random, thus representing an individual's variation on the levels of the dependent variable, and all slopes were treated as fixed effects to prevent a constant sigma squared value. At Level 2, the predictors were grand-mean cen-

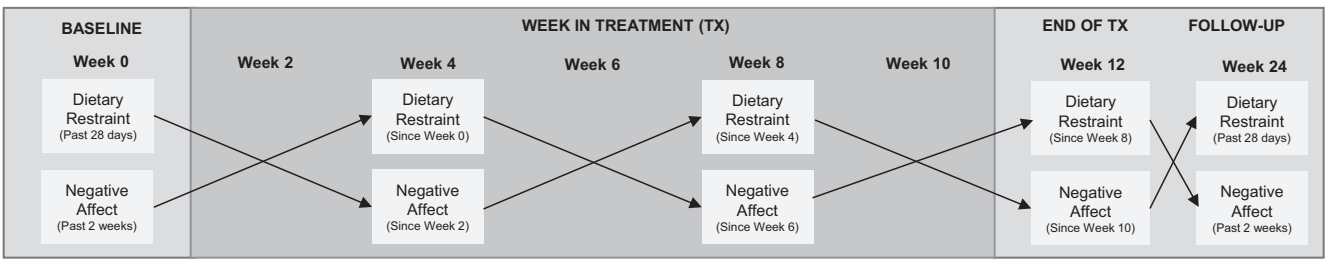

Figure 2. Conceptual illustration of models that test the relationship between dietary restraint and subsequent negative affect, and alternatively, negative affect with subsequent dietary restraint. Models represent only limited assessments and illustrate the relationships without temporal overlap of measured constructs.

tered, thereby allowing for baseline weight comparisons between individuals. Standard z scores of baseline weight were utilized to aid interpretation. All models used restricted maximum likelihood estimation and robust standard errors were reported.

Results

Study Participants

The sample participants were between the ages of 12 and 18 years (M = 15.5, SD = 1.5), predominantly female (87.7%), Australian-born (92.5%), and from intact families (63.2%). Diagnosis type was predominantly AN-restricting type (74.8%), followed by subthreshold AN (23.4%), and AN-binge-eating/purging type (1.9%), with an overall mean duration of illness of 10.5 months (SD = 8.8). Participants had a percent median BMI of 81.9 (SD = 6.1), ranging from 69.7% to 81.9%, and a mean EDE Global Score of 2.15 (SD = 1.68). The majority of the sample (63.2%) presented with a comorbid psychiatric diagnosis (i.e., mood disorder, anxiety disorder, suicidality, OCD, behavioral disorder), and 7.5% were taking psychiatric medication. The majority of participants (84.9%) completed treatment (i.e., at least 50% of the prescribed dose of sessions). Across time points and assessments, data were missing between 12.1% and 49.5%, with the specific number of observations noted in Table 1. Further descriptive statistics of the main study variables are presented in Table 1, and bivariate correlations and intraclass correlations are presented in Table 2.

Interaction Effects

There was an emergent nonsignificant interaction term for the effect of treatment across all models. Further, given previous research showing no effect of treatment type on the temporal trends of dietary restraint or negative affect in this sample (see Murray et al., 2017), variables related to treatment type were subsequently removed for parsimony and not reported in the final results. Similarly, there were nonsignificant interaction effects among lagged variables across models, suggesting that there were no observed synergistic effects between previous assessment's dietary restraint and negative affect in predicting subsequent affect or dietary restraint (ps = .05 to 0.93). As such, the interaction terms were removed from the models for parsimony.

Table 2
Bivariate Pearson's for Main Study Variables at Baseline

Measure	1	2	3	4	5	6
1. Median % BMI	—					
2. Dietary restraint	.24*	—				
3. Guilt	.27*	.67**	—			
4. Hostility	.18	.42**	.75**	—		
5. Sadness	.24*	.53**	.81**	.74**	—	
6. Fear	.15	.47**	.74**	.65**	.68**	—
7. Negative affect[a]	.22*	.61**	.92**	.86**	.91**	.87**

Note. BMI = body mass index.
[a] Negative affect represents a composite score of Guilt, Hostility, Sadness, and Fear subscales.
* $p < .05$. ** $p < .001$.

Dietary Restraint Predicting Negative Affect

Complete data for Level 1 and Level 2 models are reported in Table 3. Controlling for the effects of time in treatment and the autoregressive effects of the dependent variable, the within-person association between past restraint and current negative affect dimensions were significant for global negative affect, guilt, and hostility. Specifically, when participants experienced higher dietary restraint than their personal baseline over the past 4 weeks, they reported increased subsequent levels of global negative affect, guilt, and hostility in the following 2 weeks. This pattern of effects was mirrored in the supplemental analyses testing only nonoverlapping time assessments, whereby higher dietary restraint over the past 4 weeks predicted increased subsequent levels of negative affect, guilt, and hostility 2 weeks later (see Table 4).

Further, the analysis for global negative affect, guilt, fear, hostility, and sadness confirmed significant variability around the average intercept (variance component = 0.17 to 0.32, χ^2 = 320.23 to 430.25, $p < .001$), indicating interindividual variability in both higher and lower order dimensions of negative affect at treatment onset. In the Level 2 models, there was no significant variability in the intercepts or slopes for any of the negative affect

Table 1
Means and Standard Deviations of Main Study Variables Across Treatment

Time point	$M \pm SD$ (number of observations)					
	Dietary restraint	Negative affect	Guilt	Hostility	Sadness	Fear
ICC	.68	.67	.60	.45	.48	.56
Week 0	2.98 ± 2.12 (91)	2.63 ± 1.01 (85)	2.70 ± 1.13 (84)	2.23 ± .90 (81)	2.54 ± 1.11 (94)	2.50 ± 1.12 (89)
Week 2	1.89 ± 1.82 (77)	2.58 ± 1.07 (81)	2.50 ± 1.21 (87)	2.38 ± .90 (81)	2.64 ± 1.08 (81)	2.37 ± .77 (81)
Week 4	1.63 ± 1.86 (70)	2.40 ± 1.11 (70)	2.43 ± 1.17 (70)	2.26 ± .86 (70)	2.52 ± 1.08 (70)	2.24 ± .72 (70)
Week 6	1.45 ± 1.83 (62)	2.32 ± 1.05 (64)	2.25 ± 1.14 (64)	2.15 ± .85 (64)	2.28 ± .99 (64)	2.34 ± .69 (62)
Week 8	1.15 ± 1.68 (61)	2.04 ± .92 (62)	1.97 ± .86 (62)	1.82 ± .71 (62)	1.89 ± .84 (62)	2.07 ± .59 (61)
Week 10	1.02 ± 1.67 (54)	2.04 ± 1.07 (54)	1.94 ± 1.02 (54)	1.77 ± .66 (54)	2.00 ± 1.04 (54)	2.22 ± .83 (54)
Week 12	1.18 ± 1.77 (62)	2.01 ± 1.01 (62)	1.95 ± .95 (62)	1.78 ± .65 (62)	2.00 ± .93 (62)	2.11 ± .71 (62)
Week 24	1.10 ± 1.72 (73)	1.93 ± .88 (71)	1.77 ± .83 (71)	1.64 ± .64 (71)	1.93 ± .92 (71)	2.02 ± .57 (73)

Note. Dietary restraint scores ranged from 0 to 6, and all dimensions of negative affect ranged from 1 to 5. Negative affect represents a composite score of Guilt, Hostility, Sadness, and Fear subscales. ICC = intraclass correlations accounting for all assessment points.

Table 3
Multilevel Models Testing the Effects of Dietary Restraint on Subsequent Negative Affect

Dependent variable	Intercept β (*SE*)	Time β (*SE*)	Lagged affect β (*SE*)	Lagged restraint β (*SE*)
NA				
Level 1	.08 (.06)	−.02 (.01)	.44 (.09)**	.08 (.03)*
Level 2				
% Med BMI	−.13 (.07)	.01 (.01)	.05 (.07)	.01 (.03)
Guilt				
Level 1	.05 (.07)	−.02 (.01)*	.39 (.06)**	.09 (.03)*
Level 2				
% Med BMI	−.07 (.08)	.01 (.01)*	−.01 (.06)	.02 (.03)
Fear				
Level 1	−.05 (.07)	−.01 (.01)*	.47 (.06)**	.04 (.03)
Level 2				
% Med BMI	−.09 (.07)	.01 (.01)*	.12 (.05)*	.02 (.03)
Hostility				
Level 1	.18 (.07)*	−.02 (.01)**	.33 (.07)**	.07 (.03)*
Level 2				
% Med BMI	−.08 (.08)	.01 (.01)	.05 (.07)	.02 (.03)
Sadness				
Level 1	.09 (.08)	−.02 (.01)**	.35 (.08)**	.06 (.03)
Level 2				
% Med BMI	−.19 (.09)*	.01 (.01)	.05 (.06)	−.02 (.04)

Note. Level 1 model degrees of freedom (*df*s) ranged from 372 to 376. Level 2 *df*s ranged from 104 to 106. Med BMI = median body mass index; NA = negative affect; *SE* = standard error.
* $p < .05$. ** $p < .001$.

dimensions related to baseline percent median BMI, except for sadness, suggesting that participants with higher BMI scores at baseline report lower overall experiences of sadness, but no other dimension of negative affect, throughout the course of treatment. Further, there was a significant three-way interaction effect between time, BMI, and guilt, and time, BMI, and fear, and a three-way interaction effect between lagged negative affect, dietary restraint, and BMI—suggesting that the relationship between time and guilt, time and fear, and previous negative affect and restraint differs as a function of participants' baseline BMI.

Negative Affect Predicting Dietary Restraint

Data for Level 1 and Level 2 models are reported in Table 5. Controlling for the effects of time in treatment and the autoregressive effects of the dependent variable, the within-person association between negative affect and dietary restraint was significant for global negative affect ($p = .01$) and fear ($p = .01$) but not guilt ($p = .059$). Specifically, when participants experienced higher global levels of negative affect and fear than their personal baseline over the past 2 weeks, they reported increased levels of dietary restraint in the following assessment 2 weeks later. Because the dietary restraint assessment spanned the past 4 weeks, this represents a mixed concurrent-predictive association between negative affect and dietary restraint (e.g., negative affect measured at Week 6 represents affect from Week 4 to Week 6, and is associated with dietary restraint from Week 4 to Week 8 (measured at Week 8). In supplemental analyses without overlapping assessments (see Table 6), negative affect and fear were no longer significant predictors of dietary restraint (e.g., negative affect from Week 2 to Week 4 did not predict subsequent dietary restraint from Week 4 to Week 8).

Further, the analysis for dietary restraint confirmed significant variability around the average intercept (variance component = 0.96 to 1.16, $\chi^2 = 557.40$ to 743.20, $p < .001$), indicating interindividual variability in dietary restraint at treatment onset. In the Level 2 models, there was significant variability in dietary restraint related to percent median BMI in all affect models, thereby suggesting that individuals with higher baseline BMI reported less dietary restraint over the course of treatment. Unlike the alternate models, baseline BMI did not contribute any additional variability in the relationships between dietary restraint and subsequent affect (with the exception of global negative affect), and there were no significant cross-level interaction effects.

Discussion

The present study examined the reciprocal associations between higher and lower order dimensions of negative affect and dietary restraint over the course of two forms of FBT for adolescent AN. In support of the hypothesis for higher order negative affect, there was a bidirectional relationship between negative affect and dietary restraint, whereby higher dietary restraint was associated with increased negative affect in subsequent assessments, and alternatively, higher negative affect was associated with increased dietary restraint in subsequent assessments. Notably, this bidirectional relationship was not observed among each of the distinct dimension of negative affect, nor was it observed in follow-up supplemental analyses that did not include overlapping time points. Contrary to the hypothesis, only unidirectional relationships were found for the lower order dimensions of negative affect, whereby higher dietary restraint was associated with increased

Table 4
Model Testing the Effects of Negative Affect as Dependent Variable With Nonoverlapping Assessment Points

Dependent variable	Intercept β (*SE*)	Time β (*SE*)	Lagged affect β (*SE*)	Lagged restraint β (*SE*)
NA				
Level 1	−.05 (.08)	−.01 (.01)	.49 (.12)**	.07 (.03)*
Level 2				
% Med BMI	−.30 (.08)**	.01 (.01)*	.05 (.11)	−.04 (.03)
Guilt				
Level 1	.04 (.10)	−.01 (.01)*	.40 (.12)*	.10 (.03)*
Level 2				
% Med BMI	−.15 (.11)	.01 (.01)	.05 (.12)	−.01 (.03)
Fear				
Level 1	−.18 (.10)	−.01 (.01)	.39 (.07)**	.05 (.03)
Level 2				
% Med BMI	−.30 (.11)*	.01 (.01)*	.06 (.06)	−.03 (.03)
Hostility				
Level 1	.11 (.09)	−.01 (.01)*	.22 (.10)*	.09 (.03)*
Level 2				
% Med BMI	−.29 (.11)*	.01 (.01)	.13 (.12)	−.04 (.03)
Sadness				
Level 1	.01 (.09)	−.02 (.01)*	.26 (.11)*	.05 (.03)
Level 2				
% Med BMI	−.31 (.10)*	.01 (.01)	.06 (.12)	−.06 (.03)

Note. Level 1 model degrees of freedom (*df*s) ranged from 214 to 220. Level 2 *df*s ranged from 74 to 80. Med BMI = median body mass index; NA = negative affect; *SE* = standard error.
* $p < .05$. ** $p < .001$.

Table 5
Multilevel Models Testing the Effects of Negative Affect on Subsequent Dietary Restraint

Independent variable	Model	Intercept β (*SE*)	Time β (*SE*)	Lagged restraint β (*SE*)	Lagged affect β (*SE*)
NA	Level 1	−.98 (.13)**	−.01 (.01)	.44 (.06)**	.27 (.11)*
	Level 2				
	% Med BMI	−.18 (.14)	.01 (.01)	−.04 (.06)	.10 (.07)
Guilt	Level 1	−.95 (.14)**	−.01 (.01)	.46 (.06)**	.16 (.08)
	Level 2				
	% Med BMI	−.18 (.14)	.01 (.01)	−.01 (.05)	−.01 (.07)
Fear	Level 1	−.93 (.13)**	−.01 (.01)	.46 (.05)**	.24 (.09)*
	Level 2				
	% Med BMI	−.17 (.14)	.01 (.01)	−.03 (.06)	.04 (.09)
Hostility	Level 1	−.94 (.13)**	−.01 (.01)	.48 (.05)**	.17 (.10)
	Level 2				
	% Med BMI	−.18 (.14)	.01 (.01)	−.03 (.05)	.06 (.07)
Sadness	Level 1	−.92 (.13)**	−.01 (.01)	.49 (.06)**	.10 (.09)
	Level 2				
	% Med BMI	−.17 (.14)	.01 (.01)	−.02 (.05)	.01 (.07)

Note. Level 1 model degrees of freedom (*df*s) ranged from 372 to 376. Level 2 *df*s ranged from 105 to 106. Med BMI = median body mass index; NA = negative affect; *SE* = standard error.
[a] Affect refers to the dimension of negative affect that is entered as a predictor in the models for dietary restraint.
* $p < .05$. ** $p < .001$.

guilt and hostility in subsequent assessments, a pattern that was sustained regardless of overlapping time periods. Meanwhile, higher fear was associated with increased dietary restraint, but this effect was not sustained over subsequent weeks, when tested without overlapping time periods. These findings serve to delineate the unique functions of specific emotions in the affect–restraint relationship, and underscore the importance of examining discrete lower order affective states as they relate to dietary restraint, in addition to higher order global affect, given that composite scores of negative affect may mask the unique functional effects of distinct affective states such as guilt, hostility, and fear. Further, there is merit in considering how the affect–restraint relationship changes across more acute versus distal time spans. Overall, the present investigation contributes toward uncovering the overlooked mechanistic pathways between affective and behavioral components of AN in adolescents, with both conceptual and practical implications for the understanding and treatment of adolescent AN.

The present study is novel in examining the temporal relationships between affect and dietary restraint among individuals receiving treatment for AN. The finding that higher order negative affect and dietary restraint were reciprocally related is a notable finding, and suggests that experiencing global states of negative affectivity may both proceed and precede dietary restraint. Specif-

Table 6
Multilevel Models Testing Negative Affect on Subsequent Dietary Restraint With Nonoverlapping Assessment Points

Independent variable	Model	Intercept β (*SE*)	Time β (*SE*)	Lagged restraint β (*SE*)	Lagged affect β (*SE*)
NA	Level 1	−1.26 (.19)**	.01 (.01)	.36 (.05)**	.16 (.22)
	Level 2				
	% Med BMI	−.27 (.21)	.01 (.01)	.01 (.08)	.01 (.17)
Guilt	Level 1	−1.23 (.19)**	.01 (.01)	.36 (.06)**	.08 (.16)
	Level 2				
	% Med BMI	−.32 (.21)	.01 (.01)	.04 (.07)	−.10 (.13)
Fear	Level 1	−1.23 (.19)**	.01 (.01)	.37 (.05)**	.10 (.14)
	Level 2				
	% Med BMI	−.31 (.22)	.01 (.01)	.03 (.06)	−.11 (.13)
Hostility	Level 1	−1.23 (.20)**	.01 (.01)	.38 (.05)**	.08 (.19)
	Level 2				
	% Med BMI	−.35 (.21)	.01 (.01)	−.01 (.06)	.16 (.15)
Sadness	Level 1	−1.23 (.19)**	.01 (.01)	.36 (.05)**	.11 (.14)
	Level 2				
	% Med BMI	−.33 (.22)	.01 (.01)	.03 (.07)	−.05 (.12)

Note. Med BMI = median body mass index; NA = negative affect; *SE* = standard Error. Level 1 model degrees of freedom (*df*s) ranged from 207 to 218. Level 2 *df*s ranged from 75 to 78.
[a] Affect refers to the dimension of negative affect that is entered as a predictor in the models for dietary restraint.
** $p < .001$.

ically, when individuals experience overall higher symptoms of dietary restraint during the preceding month compared with the start of treatment, they subsequently report higher generalized negative affectivity over the following 2 weeks, an effect that was maintained 2 weeks later. This longer term sustained effect of dietary restraint in impacting global sustained states of negative affectivity is highly relevant to the treatment context because elevated symptoms of eating pathology may have longer term consequences in affective functioning, which may then further perpetuate elevated symptoms—beyond the documented acute and proximal links between affect and restraint (e.g., Engel et al., 2013; Fitzsimmons-Craft et al., 2015; Haynos et al., 2017). Indeed, there is preliminary evidence that the relationship between global negative affect and dietary restraint is reciprocal, whereby elevated global negative affect in the past 2 weeks, compared with baseline, is concurrently associated with increased dietary restraint; however, this effect is not sustained over subsequent weeks. Based on these findings, it is possible that negative affect functions to impact symptoms of eating pathology more proximally, and that persisting states of negative affect do not impact future engagement in cognitions or behaviors associated with dietary restraint. Given the observational nature of this study, it is not possible to determine if the concurrent, but not distal, effect of dietary restraint on negative affect is related to the biological effects of starvation, to the elevated cognitions about body dissatisfaction, to the response to treatment efficacy, or to a large range of other mechanistic possibilities. Despite this, the present findings are novel in underscoring that there is a relationship between sustained levels of dietary restraint and global affective states, and extend the dominant literature on the acute relationship between affect and restraint using ecological momentary assessments (Engel et al., 2013; Fitzsimmons-Craft et al., 2015) or experimental designs (Wildes et al., 2012). These findings warrant further investigation into the distal roles of negative affect in dietary restriction, which may be uniquely distinct or interact with state or momentary assessments.

The finding that dietary restraint was associated with subsequent experiences of guilt warrants further discussion. Guilt is a unique self-conscious emotion that is associated with negative evaluations of one's behavior when it does not align with social norms and self-relevant goals. Indeed, guilt has been previously associated with disordered eating (Berg et al., 2013; Berghold & Lock, 2002; Burney & Irwin, 2000) and, in the present study, could indicate that when adolescents engage in dietary restriction during FBT (i.e., a behavior that is contrary to the main goal of treatment), they may experience subsequent feelings of guilt for undermining their treatment progress. This finding may be unique to patients undergoing treatment, given that past research using acute momentary assessments in adults with AN who were not engaged in treatment found a contrary function of guilt (cf. Haynos et al., 2017). Specifically, Haynos and colleagues (2017) reported that guilt increases before, and decreases following, a restrictive eating episode, suggesting that adults may engage in dietary restriction to decrease feelings of guilt in the short term. The present findings that elevated and sustained states of guilt *follow* restriction, and are sustained over proceeding weeks, during treatment may signify a disruption in the emotional mechanism that maintains eating pathology and may also likely reflect a difference in the functional nature of guilt when it is sustained over a longer period of time (i.e., Haynos et al.'s [2017] study assessed short-term acute relationships; the present study was focused across a longer time span of several weeks). Indeed, other findings from the current adolescent sample of participants have found that dietary restraint decreases linearly across the course of treatment (Murray et al., 2017). Relatedly, guilt was not significantly associated with subsequent dietary restraint throughout treatment, therefore further identifying the disrupted function of dietary restraint in regulating uncomfortable experiences of guilt (cf. Haynos et al., 2017) in adolescents undergoing treatment. Thus, as adolescents reduce engagement in pathological eating throughout the course of treatment, there may be a shift in the extent to which dietary restraint is used as a guilt-regulating strategy, suggesting a unique mechanistic function of guilt in the maintenance and treatment of AN.

Similarly, the present study found that dietary restraint was positively associated with subsequent hostility during treatment. Hostility is characterized by a highly activated state of anger, irritability, disgust, and loathing, and when conceptualized within the framework of expressed emotion in the family dynamic, has been consistently identified as a predictor of poor treatment outcome (Allan, Le Grange, Sawyer, McLean, & Hughes, 2018; Eisler et al., 2000; Le Grange, Eisler, Dare, & Hodes, 1992; Le Grange, Hoste, Lock, & Bryson, 2011; Rienecke, Accurso, Lock, & Le Grange, 2016). Given the interpersonal nature of hostility, it is possible that the reemergence of AN behaviors in treatment (i.e., dietary restraint) are met with negative familial reactions, in turn leading to increased, and sustained, levels of hostility from both the family members and the adolescent (Treasure & Schmidt, 2013). For example, engaging in higher levels of dietary restraint over the past month may be met with increased parental supervision and control over eating, thereby provoking more hostile emotions within the adolescent that are sustained over weeks. Given the poor treatment outcomes associated with hostility (Allan et al., 2018; Le Grange et al., 2011; Rienecke et al., 2016), the study findings highlight the need to identify processes for preventing or mitigating hostility following a lapse in pathological eating cognitions or behaviors during treatment.

The finding that fear predicted dietary restraint is noteworthy, but should be interpreted cautiously, given that the effect was not sustained over subsequent weeks. Within a treatment context, affective experiences of fear may relate to fear of weight gain, fear of food, and fear of loss of eating disorder identity. Because fear is a basic emotion—and, as such, is elicited from primal threat-based antecedents—it is likely that fear is at least in part experienced with regard to weight gain, a hallmark characteristic of AN (American Psychiatric Association, 2013). These findings are novel in implicating fear as a correlate of dietary restriction in AN, and although fear may be a potential antecedent, more time-sensitive studies are needed to determine the temporal precedence during treatment. Previous research has suggested that fear in AN is elicited by the presentation and impending consumption of food, which portends a fear of weight gain, which, in turn, triggers a fear of exponential and uncontrollable weight gain (Murray, Loeb, & Le Grange, 2016; Murray, Treanor, et al., 2016). The present findings lend indirect support to this assertion, in that it is possible that heightened dietary restriction (which may also accompany avoidance of food consumption) stems from elevations in fear, which could possibly serve to mitigate and control this fear. However, because of the overlapping time lapses in the model testing fear as a precursor to dietary restraint, the present findings

ought to be cautiously interpreted. Drawing on frameworks from acute or moment-to-moment associations between affect and restraint, future research should focus on examining how dietary restraint may function to regulate negative affective states over longer periods of time and understand how sustained states of fear may negatively reinforce the utility of disordered eating behaviors (Haynos & Fruzzetti, 2011). This potential finding that fear is a correlate of dietary restraint also has important implications for treatment, in that it suggests that reducing fear could to be a specific target in the treatment of AN (Strober, 2004). The current study highlights the need to better understand the experience of fear in those with AN, with specific attention paid to the temporal experience of affective states, so that interventions can be developed that more effectively target affective states that endorse pathological eating behaviors.

Several noteworthy implications for clinical practice emerge from the present investigation. As the first study to examine the temporal associations between eating pathology and specific negatively valenced emotions during treatment, these findings highlight the important function of unique emotions as antecedents (i.e., fear) or consequences (i.e., guilt, hostility) of dietary restraint. Specifically, identifying and alleviating fear during treatment is a worthwhile target to reduce consequent episodes of dietary restraint. This assertion lends support to models of emotion regulation in adult AN (Haynos & Fruzzetti, 2011), and advances these conceptualizations to include the mechanistic functions of emotion during the course of treatment. Moreover, it suggests that behaviorally focused treatments like FBT and PFT may benefit from more actively addressing affective mechanisms that promote the maintenance of eating pathology. Additionally, these findings enhance knowledge of the role of pretreatment weight status in the relationship between affect and dietary restraint. Specifically, baseline weight did not markedly impact the affect and dietary restraint relationship, nor was it associated with affective trajectories throughout treatment. This underscores the universality of negative emotion in maintaining eating pathology across degrees of AN severity. Combined with evidence that, unlike other clinical symptoms, emotional regulation does not improve despite weight restoration (Haynos, Roberto, Martinez, Attia, & Fruzzetti, 2014), there is now preliminary evidence to suggest the importance of targeting negative emotion, and broadening targets of remission beyond weight status, to also include emotional functioning. Finally, the present findings were observed in an amalgamated sample of adolescents receiving either FBT or PFT and revealed no treatment-specific differences in the temporal associations, which further underscores the importance of negative emotion in the progression of treatment for AN.

The present findings ought to be interpreted in light of several noteworthy limitations. First, because the present study was a secondary analysis of clinical trial data, there are some notable temporal restrictions regarding the overlapping timespans of the survey instructions for negative affect and dietary restraint that may limit the interpretation of the results. Supplemental analyses with nonoverlapping assessments were included to address this limitation, but future research is needed to validate the EDE-Q for shorter time frames to promote the examination of the affect–restraint relationship over weeks. Second, although the repeated assessment and reciprocal multilevel modeling of study variables allows greater ability to infer temporal relationships between affect and dietary restraint, the data are still observational in nature and preclude a definitive understanding of causality. Relatedly, although these data were intended to allow for assessment of the temporal associations between dimensions of negative affect and dietary restraint, the necessary time lag in this methodology cannot control for the influence of moment-to-moment fluctuations in negative affect between measurement points or the influence of other affective states on dietary restraint. As such, appropriate caution is warranted in interpreting the findings. Alternate methodologies, such as longer term ecological momentary assessments utilizing distal temporal modeling, may allow for a deeper understanding of the nuanced interactions between affect and dietary restraint over longer spans of time. Third, the assessment of dietary restraint represents self-reported cognitive and behavioral indices of restriction and precludes an understanding of objective restricted behavior. Similarly, because affective assessments were global in nature and not contextualized to any domains or eliciting antecedents, it is possible that an array of other AN-related or unrelated stimuli elicited the affective responses. Future research ought to utilize more objective assessments of dietary restriction and domain-specific emotions (e.g., fear related to weight gain, guilt related to relapse) in explicating the associated affective experiences that precede or follow behavioral episodes of restriction during treatment. Relatedly, the measure of guilt in the PANAS bears phenomenological semblance to the construct of shame given the self-focused nature of the descriptors (i.e., angry at self, disgusted with self, dissatisfied with self). In combination with evidence that the prevalence of self-hate (i.e., a shame experience) is the parameter of guilt that is most relevant in adolescents with AN (Berghold & Lock, 2002), future studies ought to assess unique affective experiences of shame, in addition to guilt. Fourth, because the data collection schedule did not allow for tracking weight restoration as it precisely coincided with self-reported dietary restraint and negative affect, future research should assess weight at simultaneous assessments to explicate the role of weight restoration as it relates to affective functioning throughout the course of treatment. Fifth, data was collected across eight unequally spaced assessments throughout treatment, and although multilevel modeling can manage unequal intervals between data points, the time span between assessments impedes an understanding of critical points during treatment, given the scheduled nature of FBT and PFT. Future studies should focus on scheduling assessments at clinically relevant points (e.g., prior to and proceeding weight restoration) during treatment to better elucidate the role of emotion in maintaining pathology and promoting symptom remission. Finally, the present study did not set out to examine the potential confounding role of AN subtype (Haynos et al., 2017), nor the presence of co-occurring psychiatric disorders. Although beyond the scope of the present study, the examination of how co-occurring disorders impact the relationship between negative affect and dietary restraint warrants further investigation, given that the presence of specific affect-laden conditions (e.g., anxiety and mood disorders) may differentially impact how symptoms of eating pathology and unique affective states (e.g., guilt, shame, fear, hostility) are related.

In conclusion, the present study tested reciprocal associations between indices of negative affect (PANAS-X) and dietary restraint (EDE-Q) over the course of treatment for adolescent AN. Distinct unidirectional relationships were found, which empha-

sized the functional nature of different emotions in the process of AN symptom remission and uncover the mechanistic pathways between affective and cognitive–behavioral components in the treatment of AN. Specifically, these findings highlight the role of fear in precipitating, and guilt and hostility in proceeding, eating pathology. The collective findings provide preliminary evidence of affective mechanisms related to change in symptomatology during treatment, and are thus an important step forward in exploring options to maximize the effectiveness of current treatment approaches for adolescent AN.

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