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Examining the components and stability of negative affect in disordered eating frequency

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Abstract

Objective: There is a limited understanding of the unique components of negative affect that are most important to disordered eating. Our study tested the contributions and stabilities of unique components of negative affect in the frequency of both binge eating and restricted eating. We examined if: (1) symptoms of depression, anxiety and stress share unique, concurrent associations with binge eating and restricted eating, respectively, and if (2) instability of depression, anxiety, and stress predict binge eating and restricted eating, respectively.

Method: 627 first year undergraduate students completed 7 assessments of these constructs across their first academic year. Generalised multilevel modelling was employed.

Results: Higher than average anxiety, but not depression or stress, was concurrently associated with restricted eating. No concurrent associations between negative affect and binge eating were found. Instability of depression, but not anxiety or stress, predicted both binge and restricted eating.

Conclusion: Anxiety may be a more salient predictor of restricted eating than depression or stress. However, larger monthly changes in depression may confer risk for more frequent binge eating and restricted eating.

KEYWORDS
anxiety, binge eating, depression, restricted eating, stress

Highlights

- When examined together, symptoms of anxiety, but not depression or stress, shared a positive, concurrent association with monthly restricted eating frequency.
- When examined together, depression, anxiety, and stress did not share significant concurrent associations with monthly binge eating frequency.
- Instability of depression, but not of anxiety or stress, predicted both binge eating and restricted eating frequency.

1 | INTRODUCTION

Disordered eating (DE) refers to engagement in maladaptive eating behaviours (i.e., binge eating, fasting, and compensatory behaviours such as self-induced vomiting, laxative or diuretic abuse, and compulsive exercise) at a severity that does not meet diagnostic criteria for a clinical eating disorder (Perryman et al., 2018). Disordered eating affects 14%–44% of post-secondary students (Eisenberg et al., 2011; Prouty et al., 2002; Tavolacci et al., 2015), which is not surprizing given the numerous risk factors for DE (e.g., body dissatisfaction, body image concerns, depression, anxiety, stress) this population tends to experience during the transition to post-secondary settings (Acharya et al., 2018; American College Health Association, 2016; Barker & Galambos, 2007; Cooley & Toray, 2001; Delinsky & Wilson, 2008; Lowery et al., 2005; Stice & Shaw, 2002; Wolff et al., 2000). Given the serious psychological and physical consequences associated with DE (Blinder et al., 2006; Rome & Ammerman, 2003), identifying *which* students may be more susceptible to engaging in DE is crucial to informing the efficiency of interventions that aim to reduce DE.

Prominent models of DE propose that negative affect is a trigger for DE episodes, and that DE, in turn, helps individuals to regulate negative affect by providing relief from aversive internal states (Deaver et al., 2003; Heatherton & Baumeister, 1991; Lavender et al., 2016). While a meta-analytic investigation of 36 intensive sampling studies found that negative affect reliably increased in the hours preceding DE, results were mixed about whether negative affect decreased after DE engagement, providing mixed support for these models (Haedt-Matt & Keel, 2011). These mixed results may be due to differences in how negative affect was measured across these studies; the number of self-report items and scales used to assess negative affect (and therefore the operationalisation of negative affect) varied across studies (Haedt-Matt & Keel, 2011). Some research has aimed to further delineate the role of negative affect in DE by examining associations between unique *components* of negative affect and DE, such as symptoms of depression, anxiety, and stress. For example, studies that employ within-person designs have implicated depression, anxiety, and stress as both same-day correlates and prospective antecedents of DE engagement, providing a more nuanced understanding of the important components of negative affect in DE (Crowther et al., 2001; Lee & Vaillancourt, 2019; Puccio et al., 2017; Sala & Levinson, 2016; Wolff et al., 2000). However, these studies examined associations between depression, anxiety or stress and DE separately, precluding knowledge about the unique salience of depression, anxiety, and stress in DE engagement, when examined all together. To our knowledge, only one study has examined the unique contributions of depression, anxiety, and stress in DE engagement (Rosenbaum & White, 2015). When anxiety and depression were entered into a stepwise regression model, the authors found that anxiety accounted for a larger proportion of variance in binge eating than depression. Similarly, when stress and depression were entered into the same model, stress accounted for a larger proportion of variance in binge eating than depression (Rosenbaum & White, 2015), indicating that components of negative affect may differ in their contributions to DE.

Another explanation for mixed results pertaining to the emotion regulation model of DE may be that the association between negative affect and DE varies depending on the type of DE. While research demonstrates increases in negative affect before both binge eating and purging behaviours (e.g., Berg et al., 2015; Haedt-Matt et al., 2011; Smyth et al., 2007), very little research has investigated how the role of general negative affect may differ across additional types of DE behaviours, and how *components* of negative affect may further differ across such behaviours. Wonderlich et al. (2022) found that general negative affect, when measured several times throughout the day, was higher when binge eating occurred among those with anorexia nervosa and bulimia nervosa (BN), relative to those with binge eating disorder (BED). Haedt-Matt and colleagues (2011) concluded that type of DE diagnosis (e.g., BED vs. BN) moderated the influence of general negative affect on binge eating such that negative affect was greater prior to binge eating among those with BED relative to those with BN, providing further support that negative affect may differ across types of DE. Further, Berg et al. (2015) parsed components of negative affect and specific behaviours among those with BN, and found elevations in fear, hostility, sadness and guilt were elevated at the time of binge-only and binge/purge events, but that only fear, sadness, and guilt were elevated at the time of purge-only events. Finally, among a non-clinical sample, Heron and colleagues (2014) found that negative affect increased after eating large quantities of food, losing control while eating, restricting food intake during a meal, but not after skipping a meal. Together, these results indicate that there may be differences in the role of negative affect in DE engagement, depending on DE diagnosis and/or on the specific DE behaviours engaged in. To our knowledge, however, few studies have compared both components of negative affect (e.g., depression vs. anxiety) and types of DE (e.g., binge eating vs. restrictive eating) to clarify the most salient and relevant component(s) of negative affect in different types of DE.

Although there is a clear relation between general negative affect and DE, another unanswered question is whether *instability* of negative affect, such as instability of depression, anxiety, and stress, are associated with DE. Previous work has shown that self-reported trait affective lability is positively associated with the frequency of binge eating in female undergraduates (Benjamin & Wulfert, 2005), along with other clinical problems such as impulsive behaviour and self-harm in women with eating disorders (Anestis et al., 2009; Vansteelandt et al., 2013). This research suggests that individuals who experience more fluctuations in negative affect may engage in maladaptive behaviours to regulate and cope with their rapidly changing affect, and that both mean-levels of negative affect and fluctuations in negative affect also hold an important role in DE. There are limitations to this emerging line of research however, as prior studies mainly use cross-sectional data, which are more susceptible to recall biases. Moreover, traditional variability metrics (e.g., variance, standard deviation) do not capture the temporal ordering of scores (i.e., the magnitude of change from one time point to the next). *Stability* metrics, such as mean squared successive differences (MSSD), are more appropriate as they account for the ordering of scores, as well as their amplitude, frequency, and dispersion (Ebner-Priemer et al., 2009). To our knowledge, only one study has addressed these limitations and employed stability metrics (i.e., MSSD scores) within a longitudinal design to examine whether stability of negative affect is associated with DE. Anestis et al. (2010) demonstrated that instability of negative affect, measured across successive assessments in an ecological momentary assessment design, positively predicted global DE scores and binge eating episodes in women with BN, further supporting a role for negative affective instability in DE engagement. Further parsing negative affect, and understanding if the instability of depression, anxiety, and stress are associated with binge and restricted eating engagement, would illuminate *which* students are most susceptible to engaging in DE, thereby informing who may benefit most from DE prevention or intervention efforts in post-secondary settings.

Previous research suggests that people who experience more negative affect are more likely to experience DE (Heatherton & Baumeister, 1991), that episodes of elevated negative affect often precede DE (Haedt-Matt et al., 2011), and that larger successive changes in negative affect predict DE (Anestis et al., 2010). It remains unclear whether certain types of negative affect, for instance depressed versus anxious affect, differentially increase risk for certain types of DE, for instance binge eating versus restrictive eating. We examined these relationships using a prospective study of first year undergraduate students who completed monthly surveys on seven successive occasions. This study design was selected because (a) DE, which is prevalent but tends to occur infrequently in undergraduate samples (Lavender et al., 2010), was expected to be accurately recalled over a 1-month interval, and (b) we were interested in the associations of more chronic dysphoric states rather than acute episodes of negative mood. Below, we elaborate on our specific study aims.

2 | AIMS

To address existing research gaps, the objectives of the current study were to examine whether: (1) depression, anxiety, and stress have unique, concurrent associations with binge eating or restricted eating frequency over time (i.e., do they co-vary with DE over time) and (2) instability of depression, anxiety, or stress is associated with binge eating and restricted eating frequency among first-year undergraduate students. Based on results from Rosenbaum and White (2015), we hypothesised that anxiety, but not depression or stress, would share a significant concurrent association with binge eating when all entered into the same model. Given the paucity of research investigating these associations among restricted eating, we did not make a hypothesis for this DE behaviour. Next, and consistent with prior findings (Anestis et al., 2010; Benjamin & Wulfert, 2005), we predicted that instability of depression, anxiety, and stress would be positively associated with more frequent binge eating and restricted eating during the first year of university, when controlling for the respective within- and between-person effects of depression, anxiety, and stress.

3 | METHODS

3.1 | Participants and procedure

All procedures were approved by our institution's Human Research Ethics Board. Participants were two cohorts of first-year undergraduate students, aged 17–25 years old, who were enroled in a larger, longitudinal study of risk-taking behaviour at a medium-sized Canadian university ($N = 704$). Sequential cohorts were enroled in the 2017–18 ($n = 356$) and 2018–19 ($n = 348$) academic years and were combined in the present analyses. There were no significant differences between cohorts with respect to gender, age, and baseline scores of depression, anxiety, or stress ($ps > 0.05$). The second cohort contained more participants who identified as a racial/ethnic minority

than the first ($\chi^2[1] = 4.07$, $p = 0.044$). The data were screened based on recommendations to remove participants who demonstrated inattentive or incomplete responding (Huang et al., 2012). If a participant failed to meet the data screening criteria for a particular month, their data was removed for that month. Because the current analyses focus on within-person changes in DE in the follow-up surveys, participants who only completed the baseline session ($n = 60$) or did not provide includable follow-up data ($n = 17$) were removed, resulting in a final sample of 627 participants (75% female, 71% White, $M_{age} = 17.97$ [$SD = 0.76$]). See Appendix A for participant demographics for both the initial and final samples (Table A), participant retention (which ranged from 53% to 91% across surveys; Table B), and survey-level missingness (which ranged from 3% to 14% within timepoints, throughout the study; Table C).

Participants were recruited via social media, flyers around campus, in-person canvassing by research assistants, and advertisements on the institution's psychology research participation portal. Interested participants completed seven online surveys, approximately every 30 days from October through April (data on DE, depression, anxiety, and stress from the September baseline testing session were not included in the present analyses as DE was measured on a different timeline at baseline relative to the follow-up surveys [i.e., past 3 months vs. past 30 days]). The follow-up surveys assessed symptoms of depression, anxiety, and stress and DE frequency. Participants were emailed every 5 days with a reminder to complete their follow-up survey until 1 week of the following month had elapsed (e.g., the March survey was no longer open for participation starting April 8th). Participants were compensated with cash, electronic gift cards, or course credit for each completed survey. More detailed information about the full study procedures can be found in Appendix A. Our detailed data cleaning procedures can be found on the Open Science Framework (https://osf.io/rjak3/?view_only=ab8a9ba9d4424e98804375f2d83e4900).

3.2 | Measures

Descriptive statistics for the measures used in our study are reported in Appendix A (Table D).

3.2.1 | Disordered eating

Participants reported how often they engaged in binge eating and restricted eating in each follow-up survey using questions adapted from the Eating Disorders Examination Questionnaire (EDE-Q; Fairburn & Beglin, 2008). We asked how often participants had engaged in binge eating (i.e., "...eaten an objectively large amount of food in a manner that felt out of control"), restricted eating (i.e., "...gone for at least 8 waking hours without eating, severely limited your calories [i.e., less than 1000 per day], or skipped 2 or more meals in a row with the goal of changing your shape or weight, not including forgetting to eat or a religiously sanctioned fast"), and compensatory behaviours (i.e., "...made yourself throw up, taken laxative/diuretics, or engaged in very intense exercise to counteract the effects of eating") over the past month. Responses options were on a 4-point ordinal scale (i.e., I have done this... "Never" [0], "Only once" [1], "2–3 times" [2], "4 or more times" [3], with an option to select "Prefer not to say" [coded as missing]). The frequency of binge eating and restricted eating within a given month served as our outcome variables. Due to low base rates of compensatory behaviours, they were not examined in the current study.

3.2.2 | Depression, anxiety, and stress

Participants completed the short form of the Depression Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is comprised of three subscales (each containing 7 items) that measure the perceived severity of depression, anxiety, and stress symptoms over the past month. Participants rated each item on a 4-point Likert scale (1 = "Did not apply to me at all", 2 = "Applied to me to some degree, or some of the time", 3 = "Applied to me to a considerable degree, or a good part of the time", 4 = "Applied to me very much or most of the time"). The depression subscale assesses feelings of worthlessness, hopelessness, self-deprecation, and anhedonia (α's = 0.86–0.92 in the current sample). The anxiety subscale assesses autonomic arousal, awareness and subjective experience of physiological arousal, nervousness, and situational anxiety (α's = 0.80–0.88 in the current sample). The stress subscale assesses difficulty relaxing, nervous arousal, irritability and impatience (α's = 0.84–0.88 in the current sample). Higher scores reflect more severe symptoms. The DASS-21 has been supported for use in clinical and non-clinical samples, has excellent internal consistency and temporal stability (across a 2-week timeframe), and shows good concurrent validity with other measures of negative affect (Antony et al., 1998; Brown et al., 1997; Henry & Crawford, 2005).

3.3 | Planned analyses

We employed generalised multilevel modelling analyses using a Poisson link function in Hierarchical Linear and Nonlinear Modelling software, Version 8 (Raudenbush & Congdon, 2021). This approach enabled us to de-trend between- and within-person associations between depression, anxiety, and stress with binge eating and restricted eating, and accounted for the skewness of our data (i.e., majority of our sample did not endorse DE within a given month; see Appendix A, Table E). In concordance with Curran and Bauer's (2011) recommendations, we de-trended the effect of time within our data to obtain coefficients that represented unique between- and within-person estimates of variance for each individual. Thus, the within-person coefficient represents how much an individual's score deviates from their own unique slope in a given month, while the between-person coefficient represents an individual's intercept, relative to the average sample intercept. We used penalised quasi-likelihood estimations and interpreted results with robust standard errors for all analyses.

For Aim 1, we constructed two models to test whether monthly fluctuations in depression, anxiety, and stress, relative to a person's own average level of these negative affect components, were each positively and concurrently associated with same month binge eating and restricted eating frequency, respectively. One model used binge eating frequency as the outcome, while the other used restricted eating frequency. Within-person predictors included person-centred depression, anxiety, and stress, a linear effect of time (to control for linear trends in the outcome over time), and the within-person effect of the non-outcome eating behaviour (i.e., frequency of restricted eating, in the case of the model predicting binge eating, and vice versa). At the between-person level, we included the effects of depression, anxiety, and stress, as well as self-identified gender (dichotomously coded as female or male/other, see Croll et al., 2002), as covariates at the intercept to account for their impacts on between-person differences in initial DE frequency. Finally, at the between-person level, we included the effects of depression, anxiety, and stress as covariates on the slope of time to account for changes in these components of negative affect over time.

The Holm's Sequential Bonferroni correction method was used to determine thresholds for significance and reduce the chances of Type I error (see Eichstaedt et al., 2013 for details of the sequential method) within each of the two models. In brief, *p*-values of interest are ranked from smallest to largest, and a threshold alpha-level is calculated for each *p*-value of interest using an equation ($0.05/n - i + 1$; n is the number of *p*-values of interest and i is the rank of the current *p*-value). Given the volume of control variables in our model, we applied the correction to the focal predictors in our model (i.e., within-person effects of depression, stress, and anxiety) and accordingly, did not interpret significance for our covariates. Given that there were three *p*-values of interest in each model for Aim 1, our most stringent significance threshold was $\alpha = 0.016$ (i.e., 0.05/3).

For Aim 2, we tested two sets of models. The first set of models examined whether the stability of a person's depression, anxiety, *or* stress predicted monthly binge eating frequency, and the second set predicted monthly restricted eating frequency (six models total). The stabilities of depression, anxiety, and stress were indexed using a mean successive square differences (MSSD) score for each individual. The MSSD provides a single stability coefficient that quantifies an individual's average change in depression, anxiety, or stress from one time point to the next, across all timepoints where data was provided by the participant, while considering the amplitude, frequency, and temporal ordering of the scores (see Anestis et al., 2010 for an example). Given that there were seven timepoints where depression, anxiety, and stress were assessed, MSSD scores were calculated based on a maximum of six change scores across the academic year. Higher MSSD scores reflect more instability in symptoms of depression, anxiety, and stress.

The MSSD score was entered as the focal, between-person predictor in each of the models. For the first model, which investigated if the stability of depression predicted binge eating frequency, we included the within-person effects of time and of restricted eating, as well as the between-person effects of gender and depression at the intercept, and the between-person effect of depression on the time-related slope. The second and third binge eating models were specified using the same framework, however, these models controlled for anxiety and stress respectively (instead of depression), and these variables were entered to control for their effects at both the intercept and on the time-related slope. Given the number of control variables in our models, and that we only had one focal predictor of interest in our models (i.e., stability of depression, anxiety, or stress, respectively), we applied the Bonferroni sequential correction across the three models that were examining the same outcome variable (i.e., the binge eating frequency models). Accordingly, our most stringent significance threshold was $\alpha = 0.016$ (i.e., 0.05/3). Next, a second set of models, investigating if the stability of depression, anxiety, and stress predicted restricted eating, were specified using the same

framework, however, these models controlled for the within-person effects of binge eating, rather than restricted eating. The restricted eating models included the within-person effects of time and binge eating, as well as the between-person effects of gender and depression, anxiety, *or* stress at the intercept, and the between-person effect of depression, anxiety, *or* stress on the time-related slope. We applied the same Bonferroni sequential correction method across this set of three restricted eating models, resulting in our most stringent threshold being $\alpha = 0.016$.

4 | RESULTS

4.1 | Descriptive results

Frequencies of binge eating and restricted eating engagement at each timepoint are reported in Appendix A (Table E). When participants' frequencies of binge eating were aggregated and examined across all study months (October-April), a total of 241 participants (42.1% of the sample) reported engaging in at least one binge eating episode. When participants' frequencies of restricted eating were aggregated across all study months, results indicated that a total of 199 participants (34.7% of the sample) reported engaging in at least one restricted eating episode. Among students that engaged in binge eating, 33% reported binge eating in 1–2 follow-up surveys, while very few (2%) reported engaging in binge eating in 6 or 7 follow-ups. Similarly, among students that engaged in restricted eating, 23.4% reported restricted eating in 1–2 follow-up surveys, while very few (2%) reported engaging in restricted eating in 6 or 7 follow-ups.

4.2 | Aim 1 results

Results from the binge eating model revealed that, after the Type 1 error correction was applied, none of the within-person changes in depression, anxiety nor stress were concurrently associated with same-month binge eating frequency (see Table 1). Results from the restricted eating model revealed that within-person changes in anxiety, but not depression or stress, shared a significant, positive, concurrent association with same-month restricted eating frequency when all entered into the same model (see Table 1). This indicates that during months when a given student reported more anxiety relative to their own mean, they also reported more frequent engagement in restricted eating.

4.3 | Aim 2 results

After the Type 1 error correction was applied, instability of depression, but not of anxiety or stress, predicted frequency of binge eating (see Table 2). This indicates that students who experienced larger successive changes in depression from 1 month to the next experienced more frequent binge eating. Similarly, after the Type 1 error correction was applied, instability of depression, but not of anxiety or stress, predicted frequency of restricted eating (see Table 3). This indicates that students who experience larger successive changes in depression from 1 month to the next experienced more frequent restrictive eating.

5 | DISCUSSION

Theoretical and empirical work implicates negative affect in DE (Bennett & Cooper, 1999; Brockmeyer et al., 2014; Fairburn et al., 2003). However, there is a limited understanding of whether specific components of negative affect (e.g., depression, anxiety, and stress) are uniquely related to different types of DE (e.g., restricted vs. binge eating). This study addressed this knowledge gap by employing a longitudinal, within-person design to test the unique contributions of depression, anxiety, and stress in their concurrent association(s) to binge eating and restricted eating frequency separately, and to examine if instability of depression, anxiety, and stress predicts binge eating and restricted eating frequency. First, contrary to our hypothesis, no significant coupled association was found between anxiety (nor between depression or stress) and binge eating. Although we did not make a hypothesis related to restricted eating, we found that experiencing higher-than-usual anxiety (but not depression or stress) in a given month was associated with more frequent restricted eating within the same month. This suggests that of the three components, higher-than-usual anxiety may hold a more salient role than depression or stress in restricted eating among first-year undergraduate students. Second, in partial support of our hypothesis, instability of depression, but not of anxiety or stress, was significantly associated with both binge eating and restricted eating frequency, indicating that greater month-to-month fluctuations in depression hold a prominent role in both binge and restricted eating frequency. Together, these results underscore the nuanced relationships between components of negative affect and specific DE behaviours among first-year undergraduate students and illuminate how DE interventions that target negative affect may be most efficiently structured. Each of these findings and their implications are discussed below.

TABLE 1 Multilevel model results examining the concurrent associations between depression, anxiety, and stress and binge eating and restricted eating frequency, respectively.

Parameters	Binge eating model		Restricted eating model	
Fixed Effects	***Coefficient (SE)***	***RR (95% CI)***	***Coefficient (SE)***	***RR (95% CI)***
Intercept ($ß_{00}$)	−1.050 (0.252)	0.350 (0.213,0.574)	−0.756 (0.272)	0.470 (0.275,0.802)
Gender ($ß_{01}$)	−0.296 (0.197)	0.744 (0.505,1.095)	−0.575 (0.212)	0.563 (0.371,0.853)
Between-person Depression ($ß_{02}$)	0.034 (0.008)	1.034 (1.018,1.051)	0.022 (0.008)	1.022 (1.006,1.038)
Between-person Anxiety ($ß_{03}$)	−0.007 (0.010)	0.992 (0.974,1.012)	0.028 (0.010)	1.028 (1.009,1.048)
Between-person Stress ($ß_{04}$)	0.010 (0.011)	1.010 (0.989,1.031)	−0.010 (0.010)	0.990 (0.971,1.008)
Time ($ß_{10}$)	−0.292 (0.030)	0.746 (0.703,0.792)	−0.354 (0.031)	0.702 (0.660,0.746)
Between-person Depression ($ß_{11}$)	−0.004 (0.003)	0.996 (0.990,1.001)	−0.002 (0.003)	0.998 (0.993,1.004)
Between-person Anxiety ($ß_{12}$)	0.003 (0.003)	1.003 (0.996,1.010)	0.002 (0.003)	1.002 (0.995,1.008)
Between -person Stress ($ß_{13}$)	0.002 (0.003)	1.002 (0.996,1.009)	0.001 (0.003)	1.001 (0.982,1.019)
Within-person depression ($ß_{20}$)	0.018 (0.008)	1.018 (1.003,1.034)	0.001 (0.007)	1.001 (0.986,1.016)
Within-person anxiety ($ß_{30}$)	0.003 (0.010)	1.003 (0.983,1.023)	0.030 (0.010)**	1.030 (1.011,1.050)**
Within-person stress ($ß_{40}$)	−0.002 (0.010)	0.998 (0.978,1.018)	0.000 (0.010)	1.000 (0.982,1.019)
Restricted eating	0.492 (0.060)	1.636 (1.453,1.841)	-	-
Binge eating	-	-	0.648 (0.059)	1.911 (1.704,2.145)
Random effects		**Variance (SD)**		**Variance (SD)**
Intercept (u_{0i})		1.051 (1.03)		1.361 (1.167)
Time (u_{1i})		0.051 (0.225)		0.046 (0.215)
Depression (u_{2i})		0.000 (0.013)		0.000 (0.014)
Anxiety (u_{3i})		0.000 (0.022)		0.001 (0.028)
Stress (u_{4i})		0.000 (0.020)		0.000 (0.019)
Restricted eating		0.037 (0.191)		-
Binge eating		-		0.116 (0.340)

Note: Results reflect the concurrent associations between depression, anxiety, and stress and binge eating and restricted eating frequency while controlling for the within-person effects of time, as well as the between-person effects of gender and depression, anxiety, and stress at the intercept, and depression, anxiety, and stress over time.

Abbreviations: 95% CI, 95% Confidence Interval; RR, Event Rate Ratio; SD, Standard Deviation; SE, Standard Error.

*** indicates $p < 0.001$, ** indicates $p < 0.01$, and * indicates $p < 0.05$ after a Bonferroni sequential correction was applied.

Although past research shows that depression, anxiety, and stress hold important cross-sectional and prospective roles in DE (Crowther et al., 2001; Lee & Vaillancourt, 2019; Puccio et al., 2017; Sala & Levinson, 2016; Wolff et al., 2000), our results provide novel contributions to the literature by illuminating which components of negative affect co-vary with binge eating and restricted eating over time, when examined together. Our results revealed that although each of depression, anxiety, and stress have been supported to hold a role in DE, when these components are entered into the same model to examine each of their unique contributions to DE, a mixed picture emerges. Our results contrast prior studies showing associations between stress with binge eating (e.g., Rosenbaum & White, 2015). One possible explanation for the discrepant findings is that, unlike prior work, our binge eating model controlled for the frequency of restrictive eating, and included all three components of negative affect within the same model. Given DE behaviours commonly co-occur, and that components of negative affect also commonly co-occur (e.g., depression, anxiety and stress), we used this more conservative model to parcel out several unique associations. With this conservative approach, associations between depression, anxiety, or stress and binge eating did not emerge. Moreover, the discrepant findings could be owing to our examination of within-month, coupled associations, rather than between-person (or mean-level) associations, between negative

TABLE 2 Results from multilevel models examining the associations between the stability of depression, anxiety, *or* stress symptoms and binge eating frequency.

Parameters	Depression stability model		Anxiety stability model		Stress stability model	
Fixed Effects	***Coefficient (SE)***	***RR (95% CI)***	***Coefficient (SE)***	***RR (95% CI)***	***Coefficient (SE)***	***RR (95% CI)***
Intercept ($ß_{00}$)	−1.007 (0.248)	0.365 (0.225,0.595)	−0.995 (0.248)	0.370 (0.227,0.602)	−1.028 (0.246)	0.358 (0.221,0.580)
Gender ($ß_{01}$)	−0.343 (0.198)	0.709 (0.481,1.047)	−0.299 (0.198)	0.742 (0.503,1.094)	−0.347 (0.195)	0.707 (0.482,1.036)
Between-person Dep, Anx or Stress ($ß_{02}$)	0.037 (0.006)	1.038 (1.025,1.051)	0.029 (0.006)	1.029 (1.017,1.041)	0.033 (0.006)	1.034 (1.021,1.046)
Time ($ß_{10}$)	−0.296 (0.029)	0.744 (0.703,0.787)	−0.299 (0.028)	0.741 (0.702,0.783)	−0.290 (0.029)	0.748 (0.707,0.792)
Between-person Dep, Anx or Stress ($ß_{11}$)	−0.004 (0.002)	0.996 (0.992,1.000)	0.001 (0.002)	1.001 (0.996,1.005)	−0.001 (0.002)	1.000 (0.996,1.005)
Dep, Anx, or Stress Stability ($ß_{12}$)	0.001 (0.000)**	1.001 (1.000,1.002)**	0.000 (0.001)	1.000 (0.999,1.001)	0.000 (0.001)	1.000 (0.999,1.002)
Restricted Eating ($ß_{20}$)	0.502 (0.062)	1.651 (1.460,1.867)	0.445 (0.065)	1.561 (1.375,1.772)	0.569 (0.057)	1.767 (1.579,1.977)
Random effects	**Variance component (SD)**		**Variance component (SD)**		**Variance component (SD)**	
Intercept (u_{0i})	1.061 (1.030)		1.098 (1.048)		1.175 (1.084)	
Time (u_{1i})	0.049 (0.221)		0.049 (0.222)		0.051 (0.225)	
Restricted eating ($u2_i$)	0.038 (0.194)		0.037 (0.198)		0.041 (0.202)	

Note: Results reflect associations between the stability of each of depression, anxiety, and stress symptoms and binge eating frequency when controlling for the within-person effect of time and restricted eating, as well as the between-person effects of gender and depression, anxiety *or* stress (respective to the model) at the intercept, and the between-person effect of depression, anxiety *or* stress (respective to the model) over time.

Abbreviations: 95% CI, 95% Confidence Interval; Anx, Anxiety; Dep, Depression; RR, Event Rate Ratio; SD, Standard Deviation; SE, Standard Error.

*** indicates $p < 0.001$, ** indicates $p < 0.01$, and * indicates $p < 0.05$.

affect and binge eating. Lastly, our unexpected pattern of results for binge eating may be related to the fact that this sample was comprised exclusively of first-year undergraduate students, whose experiences of binge eating may be influenced by environmental factors (e.g., food choices at dining halls), in addition to psychological and affective processes. While our findings regarding binge eating diverge from Rosenbaum and White's (2015), which found that anxiety and stress accounted for more variance in binge eating than depression, we reach a similar conclusion with respect to restricted eating. That is, our results suggest that anxiety plays a unique role, above and beyond the contributions of depression and stress, in predicting monthly frequency of restricted eating. Together, results suggest that specific components of negative affect, rather than general negative affect, may be more relevant to DE engagement, and that future research should continue to parse these components of negative affect, and examine them within the context of specific DE behaviours, to update emotion regulation models of DE.

Our study also provides important contributions to the literature by highlighting that increases from one's *own* average symptoms of anxiety, regardless of their average level relative to others', is an important correlate of restricted eating frequency. This underscores the value of assessing not only a student's depression, anxiety, and stress relative to established norms, but also tracking their change in depression, anxiety, and stress over time. Departures from a student's own trajectory, particularly for anxiety, could signal a period of elevated risk for restricted eating, or, that restricted eating may result in elevated anxiety within the same month. Importantly, this study did not examine why these risks co-occur. It may be that students engage in restricted eating when they are experiencing higher-than-usual anxiety to their regulate negative affect (Dingemans et al., 2017; Haedt-Matt & Keel, 2011; Lavender et al., 2016), or it may be that DE leads to higher anxiety (Engel et al., 2013; Goldschmidt et al., 2012; Haedt-Matt & Keel, 2011). Untangling the sequencing of affective and behavioural changes might be best accomplished in future research by using a more frequent assessment schedule (e.g., several times per day).

In partial support of our second hypothesis, instability of depression (but not anxiety or stress) was associated with both binge eating and restricted eating frequency across the academic year. Emerging research suggests that

TABLE 3 Results from multilevel models examining the associations between the stability of depression, anxiety, or stress symptoms and restricted eating frequency.

Parameters	Depression stability model		Anxiety stability model		Stress stability model	
Fixed Effects	*Coefficient (SE)*	*RR (95% CI)*	*Coefficient (SE)*	*RR (95% CI)*	*Coefficient (SE)*	*RR (95% CI)*
Intercept ($ß_{00}$)	−0.624 (0.264)	0.536 (0.319,0.900)	−0.812 (0.271)	0.443 (0.260,0.757)	−0.688 (0.270)	0.502 (0.295,0.854)
Gender ($ß_{01}$)	−0.674 (0.205)	0.510 (0.341,0.762)	−0.532 (0.214)	0.588 (0.386,0.894)	−0.641 (0.211)	0.526 (0.348,0.797)
Between-person Dep, Anx or Stress ($ß_{02}$)	0.032 (0.005)	1.033 (1.022,1.044)	0.038 (0.006)	1.039 (1.027,1.051)	0.031 (0.006)	1.031 (1.019,1.043)
Time ($ß_{10}$)	−0.369 (0.030)	0.691 (0.651,0.734)	−0.358 (0.030)	0.699 (0.660,0.741)	−0.371 (0.032)	0.690 (0.648,0.734)
Between-person Dep, Anx or Stress ($ß_{11}$)	−0.001 (0.002)	0.999 (0.995,1.003)	−0.000 (0.002)	1.000 (0.996,1.005)	−0.002 (0.002)	1.001 (0.997,1.006)
Dep, Anx, or Stress Stability ($ß_{12}$)	0.001 (0.000)**	1.001 (1.000,1.001)**	0.000 (0.000)	1.000 (1.000,1.001)	0.000 (0.000)	1.000 (0.999,1.001)
Binge Eating ($ß_{20}$)	0.674 (0.059)	1.962 (1.747,2.204)	0.689 (0.054)	1.991 (1.790,2.215)	0.674 (0.057)	1.963 (1.753,2.197)
Random effects	**Variance component (SD)**		**Variance component (SD)**		**Variance component (SD)**	
Intercept (u_{0i})	1.396 (1.182)		1.422 (1.192)		1.443 (1.201)	
Time (u_{1i})	0.045 (0.221)		0.043 (0.207)		0.045 (0.213)	
Binge eating ($u2_i$)	0.128 (0.357)		0.104 (0.322)		0.095 (0.308)	

Note: Results reflect associations between the stability of each of depression, anxiety, and stress symptoms and restricted eating frequency when controlling for the within-person effect of time and binge eating, as well as the between-person effects of gender and depression, anxiety *or* stress (respective to the model) at the intercept, and the between-person effect of depression, anxiety *or* stress (respective to the model) over time.

Abbreviations: 95% CI, 95% Confidence Interval; Anx, Anxiety; Dep, Depression; RR, Event Rate Ratio; SD, Standard Deviation; SE, Standard Error.

*** indicates $p < 0.001$, ** indicates $p < 0.01$, and * indicates $p < 0.05$.

instability of negative affect, when assessed using the negative affect subscale from the Positive and Negative Affect Schedule multiple times throughout the day, predicts global DE scores and binge eating (Anestis et al., 2010). Our results extend these findings by parsing specific components of negative affect and then examining how the stability of each contribute to both binge eating and restricted eating, providing a more nuanced understanding of these associations. These results support the hypothesis that people who experience large fluctuations in negative affect (particularly depressive symptoms) may engage in more frequent DE in an effort to regulate unstable negative affect and achieve emotional homoeostasis. Unstable negative affect may indicate that a persons mood is especially sensitive or responsive to external stressors, as well as to uplifts. Specifically, our results suggest that larger successive changes in dysphoric or anhedonic mood, rather than negative affective states associated with tension or arousal, predict greater engagement in DE. Given this study is only the second, to our knowledge, to examine the role of negative affective instability in DE using a metric that accounts for temporality: replication is needed.

5.1 | Limitations

Strengths of the current study include its large and relevant sample, monthly longitudinal design, and decomposition of within- and between-person associations between negative affect and DE. Nevertheless, there are several limitations to consider. First, although students undergoing the transition to postsecondary are relevant due to their increased risk for engagement in maladaptive coping behaviours (Caldeira et al., 2008; Delinsky & Wilson, 2008; Greenbaum et al., 2005; Grossbard et al., 2010), our sample had relatively low base rates of DE behaviours and accordingly, our results may not generalise to other subclinical populations or clinical samples who exhibit more frequent and persistent DE behaviours. Next, our measure of depression, anxiety, and stress symptoms heavily focussed on the physical symptoms, including trembling, shortness of breath, and agitation, with comparatively fewer items tapping into cognitive features. Using a measure that also assesses the subjective and cognitive experiences of depression, anxiety, and stress, as well as number and perceived burden of stressors, may be more appropriate for an

undergraduate sample, particularly for those with DE who may have limited interoceptive awareness (Bernatova & Svetlak, 2017). Third, although the binge and restricted eating variables used in our study provides more information regarding these behaviours than a dichotomous variable (yes/no), using a non-standardized, single item to measure binge and restricted eating may have limited construct validity. Including more indicators of severity of DE (e.g., associated distress, physical and social consequences, body image disturbances), as well as a higher ceiling on DE frequencies to identify students who are engaging in very frequent binge and restricted eating, may further contextualise engagement, enhance power, and bolster construct validity. Finally, assessing depression, anxiety, and stress and DE over 30-day intervals, rather than using more intensive sampling limited our ability to disentangle the temporal sequencing of negative affect and engagement in DE, capture changes in negative affect that are more proximal to DE engagement, and assess the stability of negative affect over tighter time frames (e.g. hours or days).

These limitations notwithstanding, this study illustrates the importance of decomposing components of negative affect to better understand their role in distinct types of DE, and how stability of these constructs is important to DE. Future research further disentangling the contributions of specific negative affective states and DE behaviours is critical in informing effective early intervention and prevention of DE in student populations.

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CONFLICT OF INTEREST STATEMENT

None to declare.

DATA AVAILABILITY STATEMENT

Cleaning procedures and sample characteristics for this dataset are pre-registered on the Open Science Framework. Data may also be made available upon request from the corresponding author.

INFORMED CONSENT

Informed consent was obtained at all timepoints and from all individual participants included in the study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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