Ecological momentary assessment of affect and binge eating behavior in subclinical college students

Qi Zhu

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Supervised by:
1. Eni Becker
2. Maartje Vroling

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Abstract

Background: The affect regulation theory of binge eating suggests that negative affect is antecedent to binge eating, and binge eating functions to reduce negative affect. While negative affect is frequently followed by binge eating, evidence is mixed on whether affect is being regulated by binge eating.

Objectives: (1) To compare pre-binge positive and negative affect with their average levels on non-binge days. (2) To compare positive and negative affect before binge episodes to after binge episodes. (3) To examine positive and negative affect trajectories before and after binge eating episodes; And finally (4) to compare the trajectories of high- and low-arousal positive and negative affect.

Method: Seventeen college students with partial bulimic syndrome were asked to rate 10 affects and answer questions about binge eating several times a day over a 14-day period using an ecological momentary assessment (EMA).

Results: Negative affect was higher while PA was lower than their average levels on non-binge days. In addition, negative affect increased at an accelerated rate and positive affect decreased at a decelerated rate before binge episodes. After bingeing, negative affect was higher but PA remained the same when compared to pre-binge affect. Moreover, neither negative affect nor positive affect trajectory showed a significant upward or downward trend. By investigating dimensions of valence and arousal, both high- and low-arousal negative affect increased prior to bingeing; however, only low-arousal positive affect decreased before a binge. Following binge

episodes, none of the affect groups changed significantly .

Discussion: The study demonstrated that both increased negative affect and decreased positive affect were antecedent to binge eating episodes. However, neither negative affect nor positive affect was regulated after binge eating. Further research is needed to investigate the affect changes during a binge, or another type of reinforcement that maintains binge eating.

The investigation into dimensions of valence and arousal revealed that there was no trade-off between high- and low-arousal affects. Thus, the affect regulation theory was accounted for by valence, not arousal levels.

Introduction

Bulimia nervosa (BN) is one of the main eating disorder subtypes which involves binge eating and compensatory behaviors. The first diagnostic feature, binge eating, is characterized by repetitive episodes of consuming an unusually large amount of food, accompanied by a loss of control during such episodes. The compensatory behaviors, as another necessary diagnostic feature, are considered to be associated with body weight and shape concerns (DSM-5: American Psychiatric Association, 2013; Fairburn, 2008). People with BN usually suffer from physical and psychological comorbidities, as well as social and emotional malfunctions (Russell, 1979). Moreover, those who do not meet the full BN diagnostic criteria may also experience psychological distress and a decrease in overall life quality similar to what BN patients undergo (Ackard, Fulkerson, & Neumark-Sztainer, 2007).

Researchers have sought to understand the triggers and the underlying mechanisms of binge eating, as it is the initial stage of the bulimic behavior. Negative affect (NA), defined as "a general dimension of subjective distress and unpleasurable engagement" (Watson, Clark & Tellegen, 1988), has been proven to be associated with bulimic behavior (Haedt-Matt & Keel, 2015), and it is considered both a risk and a maintenance factor for binge eating (Stice, 2002; Dakanalis, 2017). In addition, previous research found that people who have difficulty in regulating emotions may engage in binge eating as a way of coping with their NA. Thus, how affect changes in binge eating behavior and whether NA is indeed regulated by bingeing have been investigated in multiple studies (e.g., Kjelsås, Børsting, & Gudde, 2004). This information is valuable for the treatment of BN, since understanding the affective antecedents and consequences of binge eating episodes could potentially determine the targets and the content of treatment; therefore, helping treatment planning and the intervention development.

Affect regulation theory

Affect regulation theory is one of the influential theories that explain the affect changes related to binge eating (Hawkins & Clement, 1984; Haedt-Matt & Keel, 2011). It proposes a two-part hypothesis: 1) increases in NA are proximally antecedent to binge eating behavior; and, 2) immediate decreases in NA are subsequent to binge eating behaviors (Smyth et al., 2007). This theory provides one explanation for the association between NA and binge eating behavior: NA triggers binge episodes and, binge eating is negatively reinforced by NA alleviation (Hawkins & Clement, 1984; Polivy & Herman, 1993).

The first part of the hypothesis, NA as a trigger to the onset of binge episodes, is extensively substantiated by a majority of studies (e.g. Stickney, Miltenberger & Wolff, 1999). For example, Smyth et al. (2007) found that increased NA reliably preceded binge-purge episodes on binge days, and BN patients had higher NA on binge days compared to non-binge days. In laboratory studies, participants in a negative mood condition increased their food consumption when compared to those in a neutral condition (Agras & Telch, 1998; Chua, Touyz & Hill, 2004). Furthermore, meta-analyses confirmed that NA predicted increases in bulimic symptoms (Stice, 2002), and BN patients experienced greater NA prior to binge eating when compared to their average NA levels on non-binge days (Haedt-Matt & Keel, 2011).

The second part of the hypothesis proposed that binge eating is maintained through NA mitigation as negative reinforcement. However, this assumption is not universally supported (Haedt-Matt & Keel, 2011). Among the studies which compared post-binge affect to pre-binge affect, some reported improvements in NA following binge eating (Berg, 2017; Deaver, Miltenberger, Smyth, Meidinger & Crosby, 2003; Smyth et al., 2007), while others found further deterioration in NA under the same condition (Deaver et al., 2003; etc.). In addition, a meta-analysis of 36 studies supported increases in NA after binge eating episodes in BN patients (Haedt-Matt & Keel, 2011).

If the second part of affect regulation theory is challenged, we may infer that reduced NA may not happen and is not the factor that maintains binge eating episodes. Therefore, whether or not NA decreases after binge eating suggests entirely different underlying mechanisms. The two possibilities, as a result, may have different implications for treatment. Thus, finding where the controversies lie is essential. In the following paragraphs, I will elaborate on possible reasons that may explain the inconsistent findings of NA changes after binge eating behavior.

Dimensions of affect: valence and arousal

A majority of studies relied on a global NA score (Deaver et al., 2003; Hilbert & Tuschen-Caffier, 2007; Stein et al., 2007; etc.) or aggregated types of NA (Alpers &

Tuschen-Caffier, 2001; Steiger et al., 2005; Smyth et al., 2007; etc.). However, different types of NA may have contrary or paradoxical changes. For example, anxiety decreased whereas depression increased when pre-binge and post-binge affect ratings were compared (Elmore and de Castro, 1990), and this trend continued after the binge ended (Hetherington et al., 1994). Aggregating types of affects as one score (e.g. the Positive and Negative Affect Schedule; Watson, Clark & Tellegen, 1988) may obscure internal affective state changes and render overall NA unchanged.

Kenardy, Arnow and Agras (1996) proposed a trade-off theory for affect regulation to explain such contrary changes: one type of NA gives way to another type of NA through binge episodes. Therefore, it might be the decrease of some types of NA by trade-off, instead of a net decrease in overall NA, that reinforces the binge eating behavior. The assumption of a "trade-off" pattern between types of affect was supported by several empirical studies (Elmore & de Castro, 1990; Hetherington et al., 1994; Berg et al, 2013). However, exceptional instances were occasionally seen. Corstorphine, Waller, Ohanian and Baker (2006) found that both anxiety and guilt increased from pre- to post-binge. Redlin, Miltenberger, Crosby, Wolff and Stickney (2002) showed a higher level of anger, guilt, and sadness after a binge. We proposed that the trade-off effect did not universally occur between any types of affect, but between types with certain features.

Klonsky (2009) suggested applying the dimensional theory of emotions (Feldman, 1995; Reisenzein, 1994) to reveal the nature of affective changes. He proposed that studies on affect regulation should examine two dimensions underlying affective experience: valence and arousal. Affective valence referred to the degree to which an affect is pleasant or unpleasant (i.e., positive of negative). Arousal referred to the intensity of this affect (i.e., high or low) (Russell, Weiss & Mendelsohn, 1989; Reisenzein, 1994). These two dimensions, being fundamental to affect, have been validated (Russell, Weiss & Mendelsohn, 1989; Kuppens, Tuerlinckx, Russell & Barrett, 2013), and supported by neurobiological evidence (Posner et al., 2009).

Compared to the valence dimension that was investigated by the majority of studies, the investigation of arousal levels was scarce. In a lab study comparing binge eaters to control groups, researchers found that in binge eaters, high-arousal pre-binge NAs (e.g., anger) were predominantly replaced by lower-arousal post-binge NAs (e.g., guilt) (Kenardy, Arnow, and Agras, 1996). Another study found that, for eating-disordered inpatients, only high-arousal NAs decreased after nonsuicidal self-injury (Claes, Klonsky, Muehlenkamp & Vandereycken, 2010).

Taking the dimension of arousal into account, the second part of the affect regulation theory may be explained as: binge eating behavior functions to lower NA arousal levels instead of improving negative valence, in which case, the reduction of arousal level may reinforce binge eating behavior. Thus, changes in arousal levels, along with valence, accounted for the affect regulation theory. We may then redefine the two-part hypothesis of affect regulation theory: 1) Prior to binge eating, NA increases; moreover, high-arousal NAs may increase more rapidly than low-arousal NAs. 2) Subsequent to binge eating, the arousal level of NA declines, meaning high-arousal NAs may be replaced by low-arousal NAs. Although both parts of this hypothesis were supported by limited empirical studies (e.g., part 1: Berg et al., 2012; part 2: Haedt-Matt & Keel, 2001; Berg et al., 2013), studies that specifically investigate the two affect dimensions are still needed.

Purging

Purging, in order to prevent weight gain, often happens after BN patients binge. Since self-induced vomiting immediately empties stomach of the food, compared to other ways of purging (e.g. misuse of laxatives, fasting, excessive exercise, etc.), it influences the immediate affect, and is thus the most investigated purging means in affect-related BN studies (Haedt-Matt & Keel, 2015).

Studies investigating affect changes across purging behavior are much fewer than those on binge eating. However, meta-analysis (Haedt-Matt & Keel, 2015) proved that NA increased before purging and decreased afterwards. Thus, affect regulation theory may also apply to purge behavior. Corstorphine et al. (2006) assessed the affect immediately before, immediately after, and one hour after vomiting. They found an increased level of relief and a decreased level of anxiety after vomiting. Meanwhile, pre-binge and post-binge affect did not show significant differences. Thus, they proposed that vomiting may have a stronger effect on reinforcing the binge-purge episodes than bingeing did.

Therefore, if a purge happened following binge, post-binge affect was likely impacted, thus the effect of a binge in regulating NAs should be considered in a complete binge-purge episode. By incorporating pre- and post-purge affects, we could test whether purging regulated affect and whether affect regulation theory applied to the full binge-purge cycle (i.e., whether post-purge affect differed from pre-binge levels). For the remainder of this paper, “binge/purge” refers to binge or binge-purge episodes.

Positive reinforcement

Although changes in positive affect (PA) are not as extensively studied as NA in binge eating behavior (Haedt-Matt & Keel, 2011), there is evidence that PA also changes and may reinforce binge eating as well. For example, Deaver et al. (2003) found that the level of pleasantness lowered prior to binge and raised during the binge in subclinical binge eaters. They also suggested that the momentary relief may reinforce binge eating behavior. It is possible that as with the mechanism of NAs, binge eating increases PA, so patients may turn to binge eating to regulate affect. In this way, PA may influence binge eating in concert with NA.

Regarding arousal levels, there have been very limited empirical studies of PA. One study of BN patients demonstrated that PA with different arousal levels may act similarly across binge eating episodes (Becker, 2016). Another study of eating-disordered patients showed that low-arousal PA increased after nonsuicidal self-injury behavior (Claes et al., 2010). We investigated both high- and low-arousal PAs to explore whether affect regulation theory could also apply to PA. In contrast to NA, we inferred from dimensional models of emotion (Feldman, 1995; Reisenzein, 1994) and the scarce previous research (Claes et al., 2010) that compared to high-arousal PA, low-arousal PA was more susceptible to decrease prior to and increase following a binge.

Reconciling two analytic approaches

Different statistical techniques employed for analyzing the affect changes might be the last reason that account for contradictory findings on post-binge NA changes. The two most common statistical approaches are point analyses and trajectory analyses. “Point analyses” identified two single ratings of affect within the closest proximity to each binge episode. It then compared the pre-binge rating and the post-binge rating to determine whether post-binge NA was higher than pre-binge NA (e.g., Corstorphine et al., 2006; Hilbert & Tuschen-Caffier, 2007; Haedt-Matt & Keel, 2011). Alternatively, “trajectory analyses” examined all available affect ratings four hours before and after binge behaviors. All of these ratings generated a trajectory of affect preceding and following binge behaviors as time passes (e.g., Berg et al., 2013; Smyth et al., 2007; Stevenson, Dvorak, Wonderlich, Crosby & Gordon, 2018).

Hilbert and Tuschen-Caffier (2007) used “point analyses” and compared the affect ratings before, during, and after binge eating. What they found was not a decrease, but rather an increase in post-binge NA. Furthermore, Maedt-Matt and Keel (2011) aggregated 36 studies that had been analyzed using single points. They found a moderate, positive effect size comparing pre-binge NA to post-binge NA, suggesting that mean NA further increased after binge eating. These results failed to support the affect regulation theory, which hypothesizes that NA decreases following binge eating.

Contrary to the single point approach, a series of reports based on 131 women diagnosed with BN, the largest EMA study of BN to date, examined the trajectory of NA relative to binge eating. The majority of results showed significant decreases in NA as time passes after binge eating (e.g., Berg et al., 2013; Smyth et al., 2007), which substantiated the affect regulation theory.

Engel et al. (2013) compared these two analytical approaches in anorexia patients. They demonstrated a significant decrease in NA after binge eating using "trajectory analyses", but higher level of post-binge NA than pre-binge NA using "point analyses". Thus, they revealed conflicts between the two analytical approaches within one study.

Berg et al. (2017) proposed that this discrepancy may be due to the asymmetric timing of affect rating when adopting two single time points preceding and following binge eating. Specifically, pre-binge NAs were usually assessed by responses to random signals (because participants might not plan a binge eating episode), and therefore were likely not followed by a binge immediately. Hence, there were always considerable intervals between pre-binge assessments and binge eating. On the other hand, participants clearly knew the post-binge moment, and so they were likely to initiate a post-binge assessment just minutes after the binge. Even if the NA trajectory shows a downward trend after binge eating, the post-binge assessments, which are closer to the time of the bingeing, would likely be higher than pre-binge assessments. If these assumptions are true, future studies may consider assessing pre- and post-binge NA at equal intervals before and after binge eating.

The present study

The present study investigated the affect changes across binge episodes, with affect characterized based on the dimensions of valence and arousal. This study targeted a subclinical BN college population which had partial syndrome or a lower frequency of BN diagnostic symptoms than BN patients. We attempted to reveal how affect changes across binge episodes, and understand the role of affect upon the onset and maintenance of binge eating, hoping to provide information that may prevent subclinical populations from going on to develop the full BN criteria (Herzog, Hopkins & Burns, 1993).

Ecological momentary assessment (EMA) was adopted in this study. It is a repeated assessment of experiences, behavior, and psychological states of individuals in their natural daily environment (Stone & Shiffman, 1994). It assesses in real-time and thus minimizes bias due to memory loss or the influence of one's current affective state, which commonly happens in retrospective self-reports (Stein & Corte, 2003). In this study, EMA was able to record eating behavior and transitory affects at different time points across binge episodes (Haedt-Matt & Keel, 2011). This provided us with the possibility to use different analytical approaches and examine the temporal relationship between affect and binge eating behaviors. The momentary assessment also helped to distinguish specific affects, which would be difficult if those affects were not recorded as they were being experienced. This was especially facilitative in investigating the changes in affect arousal levels (e.g., anxiety was relieved but sadness intensified).

The EMA covered from four hours before bingeing until four hours after vomiting, or four hours after bingeing if vomiting did not occur by that time, following the conventions of previous studies (e.e., Berg et al., 2013; Becker, 2016). We adopted two frequently used analytical approaches: single points analyses and trajectory analyses, which have had conflicting conclusions in previous studies (Berg et al., 2017).

We first replicated previous studies, analyzing the affect changes of overall NA and PA. For pre-binge NA/PA, we made between-day comparisons to see whether it differed for the pre-binge NA/PA and average NA/PA on non-binge days. For post-binge NA/PA, we made within-day comparisons to see whether NA/PA following binge differed from NA/PA prior to binge. We then employed trajectory analyses to generate the NA/PA trajectory curves (i.e., the direction and the rates of change) with two segments based on whether they were pre- or post-binge.

We then characterized affects within the dimensions of valence and arousal, thus having four affect groups: high-arousal negative affect (HN), low-arousal negative affect (LN), high-arousal positive affect (HP), and low-arousal positive affect (LP). We analyzed the affect dimensions both preceding and following binge eating periods via the trajectory approach. Thus, we were able to compare the trajectory curves between affect groups, and determine whether or not their patterns of change were different. In this way, we could examine whether the arousal levels changed during pre-binge and post-binge periods.

Research Questions and Hypotheses

Question 1: How do overall NA and PA change prior to and following binge eating episodes?

Hypotheses:

Using point analyses:

Prior to binge episodes, 1) NA would be higher than the average level of NA on non-binge days, while 2) pre-binge PA would be lower than the average level of PA on non-binge days.

Following binge episodes, 3) NA would be higher than pre-binge NA, while 4) post-binge PA would be lower than pre-binge PA.

5) Post-purge NA would be lower than pre-binge NA, while 6) post-purge PA would be higher than pre-binge PA.

Using trajectory analyses:

Prior to binge episodes, 7) NA would increase, while 8) PA would decrease.

Following binge episodes, 9) NA would decrease, while 10) PA would increase.

Question 2: Do valence and arousal change prior to and following binge eating episodes? And, if they do change, do they change in different ways?

Hypotheses:

Prior to binge episodes, 11) both HN and LN would increase; moreover, HN may increase more rapidly (i.e. it has a steeper slope) than LN. The pre-binge trajectories of HN and LN would differ. Meanwhile, 12) both HP and LP would decrease. LP may decrease more rapidly than HP. The pre-binge trajectories of HP and LP would differ.

Following a binge, 13) HN would decrease while LN would increase. Meanwhile, 14) LP would increase while HP would decrease. Therefore, the arousal of affect would decrease following binge episodes.

This study had two goals: The first research question was to replicate previous research and reconciled the single point and trajectory approaches. The second research question examined valence and arousal changes prior to and following binge eating episodes by exploring the antecedent and consequent trajectories.

Method

Participants

We recruited undergraduate and graduate students from Radboud University Nijmegen. 983 participants participated in the prescreening. Of those, 39 students met the inclusion criteria: 1) currently experiencing binge eating episodes with a loss of control; 2) having experienced self-induced vomiting; 3) binge eating occurred at least once a week during the previous month; 4) having a BMI above 18.5.

Finally, 19 eligible students agreed to take part in the study and 17 of them completed the data collection. Of note, all participants had experienced self-induced vomiting to control weight, but some of them had stopped or only purged at a very low frequency. We did not strictly require students to be in a phase of regular purging during the selection period, because we were primarily targeting partial syndrome samples in college students. The sample consisted of eight Dutch, four Germans, and five participants from other nationalities. All of them were female, with an age of 21.9 ± 4.4. Participants were rewarded 2.5 course credits or 25 Euros for their participation.

Measures

Affects Rating

The scale was designed to assess momentary at affect over different times. It incorporated both NA and PA items. We did not use all of the items in the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988) to measure affect as most previous research did, because some items in PANAS (e.g. alert, active, strong) did not clearly represent emotions (Diener, Smith, & Fujita, 1995; Larsen & Diener, 1992), and some intense emotions in PANAS were not closely related to eating behavior (e.g. scared). Therefore, the items in our affect rating scale came from two sources: 1) the items in PANAS that had been proven to be related to binge eating. 2) the items that had been shown to have an association with binge eating in previous studies but that were not in PANAS. If several of these items indicated similar affects, only one was chosen. For example, “guilty” and “ashamed” were both closely related to binge eating, and they had a similar meaning under the “guilt” category (Watson & Clark, 1994), so only one of them would be selected for the rating scale. The final 10 selected affects consisted of five NA and five PA: anxious, angry at oneself, sad, guilty, feeling of having failed, relieved, happy, excited, calm, and feeling of being in control.

Participants rated the extent to which they currently felt each of 10 affects on a 5-Likert scale, from 1 (not at all) to 5 (very much). Ratings 2, 3, and 4 were only displayed as numbers. The 10 affect ratings were displayed one at a time in a fixed random order that was the same for all participants on all days.

Eating Behavior Checklist

A checklist with multiple selections was used to record momentary behaviors. Participants indicated whether they had binged/purged since the last assessment, whether they had planned on bingeing/purging, or whether they were currently bingeing.

Food Imagery Experience Question (adjusted from Tiggemann & Kemps, 2005)

This was a question with four choices used to measure how strong the participants' mental imagery of food and eating was. Participants indicated whether or not they were experiencing the imagery as visual, olfactory, gustatory sensations, and whether they imagined the eating activity. The final score (0-4) was summed up with one point given for each selected answer.

We initially developed the above measures in English, and translated them into Dutch and German. Dutch-English and German-English bilinguals back translated them into English and double checked their accuracy. English, Dutch and German pilot testers finally checked the equality of all three versions (Appendix B-D). Of note, since the present study was a part of a larger study, only A*ffect Rating* data and the *Eating Behavior Checklist* were analyzed for this paper.

Procedures

The study was reviewed and approved by the Ethics Committee at Radboud University Nijmegen. Participants filled out the online prescreening questionnaire through the online SONA system. The prescreening questions (Appendix A) were adjusted from the Survey for Eating Disorders (SEDs; Kjelsås, Børsting & Gudde, 2004) and the diagnostic criteria for Bulimia in DSM-5 (American Psychiatric Association, 2013). Participants who had answered yes to all four questions were invited for a face-to-face orientation meeting via email and telephone.

During the 20-minute orientation meeting, we checked their BMI (by asking weight and height) and confirmed that they were not currently undergoing any psychological diagnosis or eating disorder treatment. The participants also confirmed their applicability based on the inclusion criteria from the prescreening. After that, they signed the consent form, installed the app on their phones and received instructions regarding the study. The participants were expected to familiarize themselves with the notifications and the questionnaire content for the rest of the day. Starting the following day, participants used the mobile app for 14 consecutive days. The researcher contacted participants on the second and eighth days of data collection to check whether they had any questions or feedback. Finally, after 14 days of EMA, participants received their rewards for participation. They also received a debrief either by email or by a face-to-face meeting.

EMA schedule

EMA used sampling strategies to conduct the above measures in a daily natural setting. Participants received notifications and completed surveys with an app on their mobile phones. EMA was used with a combination of three protocols: a signal-contingent protocol, a time-contingent protocol, and an event-contingent protocol. A different survey was presented for each protocol.

The event-contingent protocol

In order to capture the discrete binge/purge behavior, participants were required to fill in this survey when they were experiencing the target behavior (i.e. a binge or a purge). Specifically, they needed to fill in the survey: 1) before a binge or plan to do so; 2) during a binge; 3) immediately after a binge; 4) before a purge or plan to do so; 5) immediately after a purge.

Participants could engage with this protocol at any time throughout a day. They indicated the eating behaviors they were experiencing (*Eating Behavior Checklist*), and then how they were feeling at that moment (*Affect Ratings*).

We expected that participants would miss some stages of the target episodes. For example, they may not actually "plan" a binge, or it might not have been convenient for them to fill in the survey during a binge. However, we highly encouraged participants to fill in this event-contingent protocol during each and every stage.

The Signal-contingent protocol

Participants received a random notification at 2.4-hour intervals between 9:00 and 21:00 (i.e. one notification between each two adjacent points in time: 9:00, 11:24, 13:36, 15:48, and 21:00), resulting in a total of five semi-random notifications each day. If participants did not respond to the notifications, they would receive a reminder every five minutes, up to three times in total. Participants would only be able to open the survey within 20 minutes of receiving the initial notification. Response time was limited to make sure that the questions were indeed completed at random times.

Each random notification started with the *Affect Ratings*, then the *Food Imagery Experience Question*, and finally the *Eating Behavior Checklist*. The data collected from random notifications served two purposes: 1) as a baseline for affects on days when participants did not engage in binge/purge behavior; 2) for the possibility of capturing the affects related to target behaviors (i.e. a binge/purge), especially before a binge, or one hour or more after a binge.

The *Eating Behavior Checklist* issued via the signal-contingent protocol was slightly different from the checklist issued via the event-contingent protocol. The signal-contingent checklist did not include the options "plan to binge" or "plan to purge". This is because we did not want the random notifications to be a reminder or a trigger for binge or purge behavior. Instead, we asked whether the participants had thought about bingeing or purging since the last notification.

The time-contingent protocol

At the end of each day, participants received a notification at a fixed time (i.e., 10 p.m.). Participants were allowed two hours to answer this survey. They received reminders at 30-minute intervals, three times in total if they did not respond to the survey. Participants rated the general emotions they were experiencing before bedtime on a 10-point scale, and then indicated whether or not they missed recordings, and how many times they had binged or purged on that day. This protocol helped to check how many binge/purge episodes occurred on each day, or to confirm if it was a non-binge/purge day.

For all of the above protocols, survey questions were presented one at a time. Participants were required to answer each question before going on to the next one. They could not go back once a question was completed. If they stopped in the middle of a survey, they had to continue from where they left off when they reopened the survey. A continuous Internet connection was not necessary for receiving notifications and completing the surveys, as the app would store necessary information while offline and upload it automatically once a connection to the Internet was reestablished.

EMA Data Aggregation

For each participant, all records from event-contingent surveys and signal-contingent surveys were included and ordered based on the time each survey was completed. We identified each target behavior (i.e. a binge/purge episode) and labeled all binge/purge-related records. We included a binge/purge-related record from the signal-contingent surveys as long as it was answered within our expected intervals (i.e., from four hours before to four hours after binge), even if participants indicated that nothing had happened. In rare situations, if more than one binge/purge episode were reported within a ±4-hour time frame, we only used the first episode, and only included affect ratings that were reported before the second episode. This was to avoid any confusion between antecedent and consequent affects.

It was possible that some episodes did not have records for both pre- and post-binge stages. In addition, on rare occasions, participants failed to complete a survey in full, resulting in part of the survey being filled out at Time X and the remaining part being completed at Time Y. This may have rendered a few pieces of missing data. However, we did not impute missing data or delete any records of unanswered items on the affect scale, as the analytical methods we adopted were able to use all available data and were tolerant of missing data.

Data used for comparisons of pre-binge versus post-binge NA/PA (i.e., point analyses) was a subset of the data used for the trajectory analyses. This subset included one pre- and one post-binge affect ratings that were each completed within the closest proximity to the occurrence of a binge. For between-day comparisons, we looked at all pre-binge ratings completed within four hours before binge, and compared them with the affect ratings on non-binge days, as followed in previous research (Engelberg, Gauvin, & Steiger, 2005).

Grouping of affects

10 affects were grouped into four categories based on their valence (positive or negative) and arousal (high or low), following the affect-states grid proposed by Klonsky (2009). This categorization has also been used in other affect studies of eating-disordered patients (Becker, 2016; Claes, et al., 2010). In particular, previous studies showed discrepant opinions on the arousal level of "guilt" (Klonsky, 2009; Reisenzein, 1994). We finally classified guilt as high-arousal NA for two reasons: A confirmatory factor analysis of binge-event NA revealed that guilt should be clustered together with anger at self, and not together with sadness (Berg et al., 2013). Moreover, in an EMA study of binge eating, the researcher categorized guilt as high-arousal NA after consulting with an expert in moral emotions (Becker, 2016). Eventually, we grouped the 10 affects into four categories: high-arousal negative affect (HN), low-arousal negative affect (LN), high-arousal positive affect (HP), and low-arousal positive affect (LP). HN included anxiety, guilt, anger at oneself, and feeling of having failed; LN included sadness; HP included happiness and excitement; LP included relief, calmness, and feeling of being in control. The score of each affect category was the mean of its individual affects. Additionally, the overall NA and overall PA scores were the mean of their five constituent affect types.

Statistical models

The study employed two of the most commonly used analytic approaches in previous research. One approach, called point analyses, compared affect ratings in two conditions (e.g., pre-binge vs. post-binge). Another approach, trajectory analyses, attempted to show the trajectory of affect changes over time across binge episodes.

Both point analyses and trajectory analyses used generalized linear mixed models (GLMMs). Mixed models are especially suitable for analyzing non-independent repeated measures provided by the same participants, which was the situation in our study. In addition, this approach allows for each participant to contribute a different number of observations.

Point analyses

To explain point analyses, I will use the pre-binge and post-binge affect comparison as an example. The analyses could be expressed as follows:

$$Y_{ij} = b_0 + b_1 \times \mathit{Stage}_{ij} + u_{0j} + u_{1j} \times \mathit{Stage}_{ij} + \varepsilon_{ij},$$

where Y_{ij} is the outcome (i.e. the overall NA or PA) at *Stage* i of participant j. Stage_{ij} is the value of the *stage* predictor (i.e., a dichotomous variable, 0 = pre-binge, 1 = post-binge) for participant j at *stage* i. b_0 is the overall intercept; b_1 is the overall slope, i.e., expected changes in the overall NA/PA as the predictor s*tage* changes from 0 (pre-binge) to 1 (post-binge). u_{0j} and u_{1j} are the random intercept and random slope, respectively. They express the deviation of participant j's intercept from the overall intercept (i.e., the affect score when *stage* is 0), and the deviation of participant j's slope from the overall slope (i.e., the effect of *stage* on the affect score), allowing the intercepts and slopes to vary across participants. ε_{ij} is the residual that expresses the difference between the fitted trajectory of participant j and the observed data (i.e. NA or PA) of participant j at stage i.

In our analyses, we used separate models for NA and PA. All the data was nested within participants, with a random slope of S*tage* variable and correlated random intercept of each participant. The aim of the analyses was to reveal whether there was an increase or decrease (i.e. a positive or negative slope) from pre- to post-binge affect.

When comparing pre-binge affect and affect on non-binge days, the only difference was the code of *Stage* (i.e., 0 = non-binge days; 1 = pre-binge). The analyses would reveal whether there was an increase or a decrease from non-binge days to pre-binge moments.

Trajectory analyses

With trajectory analyses, we tested one separate model for each affect group. The predictor *Hour* was a continuous variable. It indicated how many hours passed between the time of completing a survey and the time at which a binge episode occurred. The time at which binge episodes occurred was designated as *Hour* = 0. All ratings preceding a binge had negative *Hour* values (e.g., - 3.5, - 0.2) and all ratings following had positive *Hour* values (e.g., + 1.5, + 4). This allowed for ease of interpretation and the generation of trajectory graphs (Becker, 2016). The ratings completed within the *Hour* values of -4 to 4 were considered binge-related, in accordance with methods used in previous studies.

Except for linear change, we were interested in the quadratic trends. Therefore, we squared *Hour*, and included both *Hour* and $Hour^2$ as predictors in the model. The linear affect trends indicated whether the slope of the curve was increasing, decreasing, or flat. The quadratic trends revealed whether the linear slope deflected upward or downward, which represented whether the rate of affective change was accelerating or decelerating.

In addition, we expected two segments for each single trajectory curve, respectively describing the changes of pre- and post-binge affects. To explain it concisely, I wrote formulas with only fixed effects:

$$\begin{cases} Y_0 = b_0 + b_1 \times Hour + b_2 \times Hour^2 + \varepsilon_0; \quad Hour < 0 \\ Y_1 = b_0 + b_3 \times Hour + b_4 \times Hour^2 + \varepsilon_1; \quad Hour > 0, \end{cases}$$

where Y_0 is the pre-binge affect and Y_1 is the post-binge affect. b_0 is the intercept. We forced a common intercept for the two segments of a trajectory, because we expected *Hour = 0* (i.e. the intercept) to be the breakpoint in the trajectory. Its two segments needed to be connected, so that the trajectory curve was continuous.

Next, we created two dummy-coded variables D_1 and D_2. For pre-binge records (i.e., *Hour* < 0), $D_1 = 1$, $D_2 = 0$; and the inverse for post-binge records (i.e., *Hour* > 0). We then multiplied *Hour* and $Hour^2$ by one of the dummy variables so that *Hour* was recoded as “pre-binge *Hour*” or “post-binge *Hour*”. We were then able to combine the two trajectory segments into one model by entering four products as predictors:

$$Y = b_0 + b_1 \times (D_1 \times Hour) + b_2 \times (D_1 \times Hour^2) + b_3 \times (D_2 \times Hour) + b_4 \times (D_2 \times Hour^2) + \varepsilon$$

$$\begin{cases} D_1 = 1, D_2 = 0; & Hour < 0 \\ D_1 = 0, D_2 = 1; & Hour > 0 \end{cases}$$

When *Hour* < 0, the formula was $Y_0 = b_0 + b_1 \times Hour + b_2 \times Hour^2 + \varepsilon_0$, describing the pre-binge segment of the trajectory; when *Hour* > 0, the formula was $Y_1 = b_0 + b_3 \times Hour + b_4 \times Hour^2 + \varepsilon_1$, describing the post-binge segment.

With this model (a.k.a. the piecewise growth curve model), we acquired the estimates b_0, b_1, b_2, b_3, and b_4, and tested whether their values were different from zero. b_0 was the intercept, indicating the affect rating at *Hour* = 0 (i.e., during binge). b_1 and b_3 were linear changes, indicating whether the affect changed during pre-binge and post-binge; b_2 and b_4 were quadratic changes, indicating whether their rates of change, if any, increased or decreased. In addition, since we designated *Hour* = 0 during bingeing, all linear and quadratic components were centered on the time at which a binge occurred.

The fixed effects were determined a priori based on previous research and the theoretical background related to our research questions. In order to replicate and reconcile results from previous research, we performed confirmatory significance tests, and did not analytically determine the fixed effects post hoc in an exploratory way.

There were two levels of random effects in this model. First, all data was nested within a *day* (i.e. from *day* 1 to *day* 14), then each day was nested within each *participant* (i.e., first level = momentary data, second level = day, third level = participant). Random effects in the model included the random slopes of *Hour* and *Hour*^{2} variables, the random intercepts of *day* and *participant* variables, and the interactions between *participant* and *day*. This allowed the intercepts and slope of *Hour* and *Hour*^{2} to vary across each day within each participant.

We conducted our analyses using R, version 3.4.2 (R Core Team, 2017). The main models were analyzed via the lmer() function in the lme4 package (Bates, Mächler, Bolker & Walker, 2015), using restricted maximum likelihood (REML), as REML models produce a lower Type I error rate than ML (maximum likelihood) models, especially for small sample sizes (Luke, 2017). We acquired confidence intervals with the built-in confint() function in the same package. To determine the *p* values, we computed Type 3 conditional F tests with Kenward-Roger approximation for degrees of freedom (KR F test), as this approximation produces acceptable Type I error rates for small samples (Luck, 2017). This was implemented with the Anova() function in the car package (Fox & Weisberg, 2011), which in turn called the KRmodcomp function in pbkrtest package (Halekoh & Højsgaard, 2014).

Power analysis

Since the number of observations (i.e., the affect ratings related to our target binge/purge behavior) would largely vary between participants, it was especially complicated to do a priori power analysis for our mixed effect models. Thus, we took the suggestion from Kreft and de Leeuw (1998) that the number of highest level of groups (i.e., in our study, participants) should be at least 20 to achieve sufficient power to detect cross-level effects. In the meantime, we used restricted maximum likelihood estimation, which would generally yield the lowest probability of making a type I error (Kreft & de Leeuw, 1998).

Results

Compliance with EMA protocol

During the 14-day study period, each participant received 70 random notifications (5 times a day × 14 days) and 14 end-of-day notifications. Overall, participants completed these ratings sufficiently well. 64% of the participants responded to 79% or more of the random signals, and 86% of the participants responded to the end-of-day surveys on 13 or all 14 days. In addition, compliance rates towards random notifications did not differ much across the anchored time throughout the day (time point 1 = 68%, time point 2 = 77%, time point 3 = 75%, time point 4 = 74%, time point 5 = 75%). The descriptive results of compliance are shown in Table 1, with the mean and SD for each participant.

Table 1 Descriptives of compliance with EMA protocol

	Signal-contingent (random notifications)		Time-contingent (end-of-day)		Event-contingent	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Number of records	52.0	16.0	11.9	3.1	5.2	2.9
Response rate	74.3%	0.23	85.3%	0.22	-	

For the main analyses, we identified 85 binge episodes, Mean = 5, SD = 4.3.

However, only two participants reported purge behavior with a total of 16 records. Data related to purging was not sufficient to be analyzed. Finally, our trajectory analyses were based on 253 binge-related records. Among them, we selected 153 records that were in closest proximity to each binge episode for point analyses.

Correlations between affect groups

The intra-individual correlations between each pair of affect groups were calculated via the rmcorr() function in the rmcorr package (Bakdash & Marusich, 2018). This function is suitable for repeated-measures correlation, as it statistically removes variance between participants by ANCOVA, and produces best fit parallel regression lines with varying intercepts for each participant (Bakdash & Marusich, 2017).

Table 2 shows the intra-individual correlations between affect groups based on all affect ratings, N = 995, and the descriptive statistics of these affect groups. Overall, all affect groups were moderately or highly correlated. The highest correlations were seen between overall NA and PA, $r = -.670$, $p < .001$.

Affect groups of opposite valence were negatively correlated, regardless of whether their arousal levels were high or low. Affect groups of the same valence were positively correlated. The correlation between HN and LN was higher than that of between HP and LP. In addition, Cronbach's alpha showed that the internal consistencies of positive affect groups were lower than those of negative affect groups.

Table 2 Affect groups: correlations within participants and descriptive statistics

Variables	HN	LN	HP	LP	NA	PA
HN	-	-	-	-	-	-
LN	.614***	-	-	-	-	-
HP	-.501***	-.553***	-	-	-	-
LP	-.584***	-.516***	.527***	-	-	-
NA	-	-	-.554***	-.613***	-	-
PA	-.626***	-.607***	-	-	-.670***	-
M	2.37	2.24	2.61	2.77	2.34	2.71
SD	1.14	1.23	1.00	.89	1.09	.82
Cronbach's alpha	.886	-	.615	.626	.890	.731

Notes: N = 955, HN: high-arousal, negative valence; LN: low-arousal, negative valence; HP: high-arousal, positive valence; LP: low-arousal, positive valence; NA: negative affect; PA: positive affect. ***p < .001.

Point analyses

Between-day comparisons

The results of NA/PA on between-day comparisons for pre-binge and non-binge days are shown in Table 4. As hypothesized, pre-binge NA was significantly higher than the average NA on non-binge days, $F(1, 13.501) = 7.131$, $p < .019$, and pre-binge PA was significantly lower than the average PA on non-binge days, $F(1, 13.945) = 10.792$, $p < .005$. The results suggests that both higher NA and lower PA were antecedent to binge eating episodes.

Table 4 Comparisons of pre-binge affect and affect on non-binge days

	Pre-binge			Non-binge days			KR F tests	
	M	SD	N	M	SD	N	*F* (df)	*p*
Negative Affect	2.43	0.91	70	2.06	0.96	542	7.131 (1, 13.501)	.019*
Positive Affect	2.46	0.75	70	2.88	0.76	542	10.792 (1, 13.945)	.005**

Notes: N: the number of records. *$p < .05$, **$p<.01$.

Within-day comparisons

The results of within-day comparisons for pre- and post-binge NA/PA are given in Table 5. It shows that post-binge NA was higher than pre-binge NA, $F(1, 13.965) = 9.055$, $p = .009$, which means that the immediate post-binge NA deteriorated as opposed to pre-binge NA. However, post-binge PA did not differ from pre-binge PA, $F(1, 10.718) = 0.900$, $p = 0.364$, suggesting that PA did not increase or decrease from pre-to post-binge. The PA result did not support our hypothesis that PA would decrease. However, as expected, we did not find any evidence that supported affect improvement from pre- to post-binge.

Table 5 Comparisons of pre-binge affect and post-binge affect

	Pre-binge			Post-binge			KR F tests	
	M	SD	N	M	SD	N	*F* (df)	*p*
Negative Affect	2.55	.92	54	3.15	1.23	78	8.694 (1, 13.959)	.011*
Positive Affect	2.46	.83	53	2.36	.86	78	.872 (1, 10.728)	.371

Notes: N: the number of records. *$p < 0.05$

Trajectory analyses

overall NA and overall PA

Table 6 shows the results of trajectory analyses for NA and PA. Consistent with our hypotheses, NA showed a positive linear slope, estimate = 1.085 (.166), $F(1, 119.120) = 36.456$, $p < .001$, suggesting that NA increased before bingeing. We also observed a quadratic trend component, estimate = .286 (.064), $F(1, 72.309) = 18.466$, $p < .001$. This revealed that the rate of pre-binge NA's change accelerated as the proximity to binge eating grew closer.

Meanwhile, PA had a negative linear slope, estimate = -.573 (.151), $F(1, 115.557) = 11.873$, $p < .001$, and the rate of change decreased, estimate = -.127 (.053), $F(1, 60.524) = 4.387$, $p = .040$. This means that PA decreased at a decelerating rate prior to a binge.

Following binge eating, however, we did not observe significant changes in either NA or PA. This suggests that, contrary to our hypotheses, the affect neither improved nor deteriorated after binge eating.

Comparing the timing of the average proximal pre-binge and post-binge affect ratings, we found that the pre-binge affect was assessed 82.89 minutes (SD = 106.34 min) before a binge episode, and the post-binge affect was assessed 34.45 minutes (SD =36.41 min) after a binge-eating episode. Thus, we agreed with Berg et al. (2017) that in point analyses, there was a longer interval between pre-binge assessments and binge eating than post-binge assessments.

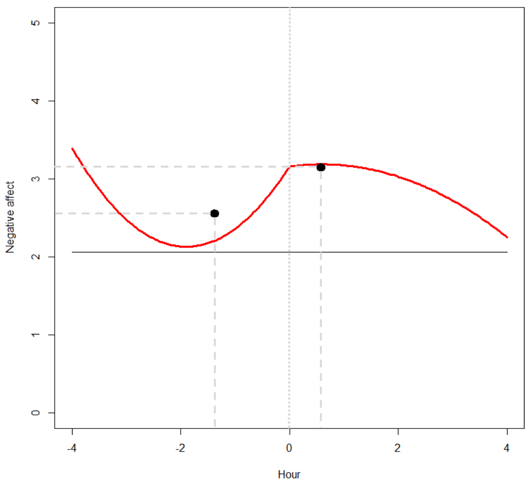
Figure 1 and Figure 2 are visual comparisons of results acquired from point analyses and trajectory analyses for NA and PA. The red curved lines depict the results of trajectory analyses. They show the levels of NA and PA with the temporal change related to binge episodes. The black dots depict the results of point analyses. The x-axis values of these dots represent the average time at which the ratings were completed. The y-axis values represent the average pre-binge and average post-binge ratings of NA and PA. The horizontal solid lines represent NA and PA levels on non-binge days.

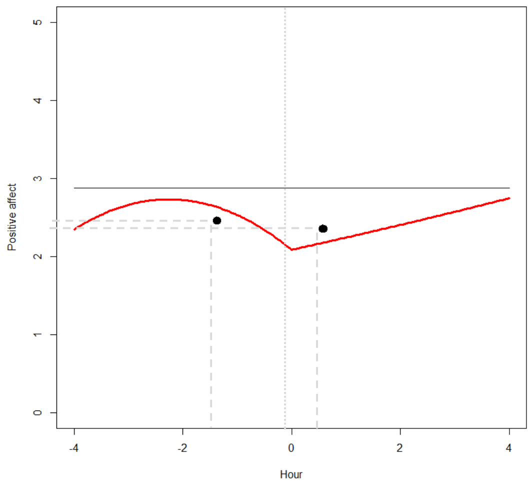
Table 6 Models for binge episodes with overall negative and positive affect

Variable	Negative Affect				
	Est	SE	KR F tests	*p*	95% CI
Intercept	3.158	.220	*F* (1, 17.109) = 204.473	<.001	2.728, 3.588
$D_1 \times Hour$	1.085	.166	*F* (1, 119.120) = 36.456	<.001	.760, 1.410
$D_1 \times Hour^2$	.286	.060	*F* (1, 72.309) = 18.466	<.001	.168, .404
$D_2 \times Hour$	.098	.145	*F* (1, 158.086) = .396	.530	-.185, .381
$D_2 \times Hour^2$	-.081	.044	*F* (1, 89.781) = 2.718	.103	-.168, .006

Variable	Positive Affect				
	Est	SE	KR F tests	*p*	95% CI
Intercept	2.086	.129	*F* (1, 18.955) = 250.905	<.001	1.833, 2.339
$D_1 \times Hour$	-.573	.151	*F* (1, 115.557) = 11.873	<.001	-.869, -.277
$D_1 \times Hour^2$	-.127	.053	*F* (1, 60.524) = 4.387	.040*	-.232, -.023
$D_2 \times Hour$	.153	.130	*F* (1, 148.343) = 1.134	.289	-.102, .409
$D_2 \times Hour^2$	.003	.038	*F* (1, 83.027) = .006	.940	-.070, .077

*Notes: *p < .05, **p < .01*





(Left) Figure 1 Level of negative affect over time in relation to binge episodes.

Notes: Horizontal solid line represents the average level of NA on non-binge days.

(Right) Figure 2 Level of positive affect over time in relation to binge episodes.

Notes: Horizontal solid line represents the average level of PA on non-binge days.

Arousal-valence affect groups

Table 7 shows the results of the trajectory analyses of four affect groups. Figure 3 and Figure 4 are their graphical representations. As hypothesized, both HN, estimate = 1.167(.171), $F(1, 120.225) = 39.563$, $p < .001$, and LN, estimate = .702 (.237), $F(1, 111.298) = 7.126$, $p = .009$, demonstrated a significant and positive linear slope prior to binge episodes, suggesting that both HN and LN rose significantly. Moreover, there were no observed differences in their linear slopes, as the confidence intervals of their linear coefficient estimates overlapped.

Moreover, pre-binge HN showed a significant and positive quadratic component, estimate = .306 (.062), $F(1, 72.164) = 19.886$, $p < .001$, indicating that the rate of HN's increase accelerated with a closer proximity to binge episodes. However, pre-binge LN did not show a similar quadratic trend, estimate = .176 (.080), $F(1, 57.899) = 3.622$, $p = .062$. In addition, the overlapping confidence intervals of their intercepts showed that the magnitudes of HN and LN did not differ at the start of a binge episode.

Furthermore, and as expected, prior to binge episodes, LP decreased significantly, estimate = -.725 (.177), $F (1, 102.767) = 13.369$, $p < .001$, and the rate of its decrease decelerated as the proximity to binge eating grew closer, estimate = -.158 (.059), $F(1, 48.018) = 5.088$, $p = .029$. However, pre-binge HP did not change significantly, estimate = -.344 (.188), $F (1, 116.147) = 2.758$, $p = .099$. In addition, the confidence intervals for the intercepts of HP and LP overlapped, indicating that their magnitudes did not differ at the start of a binge episode.

Consequent to binge eating, none of the four affect groups changed. This was contradictory to our hypotheses. However, these results were in line with the results of overall post-binge NA/PA we tested before.

Table 7 Models for binge episodes with arousal-valence affect groups

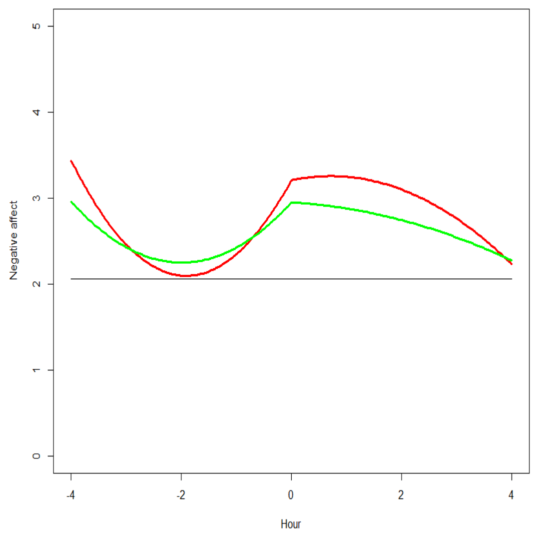
Variable	High-arousal negative valence (HN)				
	Est	SE	KR F tests	*p*	95% CI
Intercept	3.208	.227	*F* (1, 17.113) = 197.639	<.001	2.763, 3.653
$D_1 \times Hour$	1.167	.171	*F* (1, 120.225) = 39.563	<.001	.831, 1.503
$D_1 \times Hour^2$	.306	.062	*F* (1, 72.164) = 19.886	<.001	.184, .427
$D_2 \times Hour$	.136	.149	*F* (1, 159.929) = 0.723	.396	-.155, -.427
$D_2 \times Hour^2$	-.095	.045	*F* (1, 90.764) = 3.540	.063	-.184, -.006

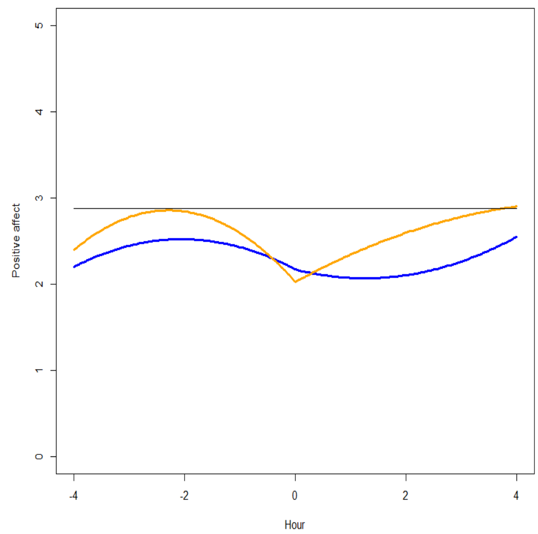
Variable	Low-arousal negative valence (LN)				
	Est	SE	KR F tests	*p*	95% CI
Intercept	2.950	.245	*F* (1, 18.477) = 141.334	<.001	2.469, 3.430
$D_1 \times Hour$	.702	.237	*F* (1, 111.298) = 7.126	.009**	.238, 1.167
$D_1 \times Hour^2$	.176	.080	*F* (1, 57.899) = 3.622	.062	.019, .332
$D_2 \times Hour$	-.037	.222	*F* (1, 154.978) = 0.022	.881	-.472, -.399
$D_2 \times Hour^2$	-.033	.066	*F* (1, 90.220) = 0.196	.659	-.162, .096

Variable	High-arousal positive valence (HP)				
	Est	SE	KR F tests	*p*	95% CI
Intercept	2.169	.149	*F* (1, 19.910) = 204.438	<.001	1.877, 2.460
$D_1 \times Hour$	-.344	.188	*F* (1, 116.147) = 2.758	.099	-.712, .025
$D_1 \times Hour^2$	-.084	.066	*F* (1, 61.334) = 1.242	.269	-.214, .046
$D_2 \times Hour$	-.161	.168	*F* (1, 162.231) = .775	.380	-.490, .168
$D_2 \times Hour^2$	.064	.050	*F* (1, 91.651) = 1.288	.259	-.033, .161

Variable	Low-arousal positive valence (LP)				
	Est	SE	KR F tests	*p*	95% CI
Intercept	2.025	.160	*F* (1, 19.252) = 155.077	<.001	1.711, 2.338
$D_1 \times Hour$	-.725	.177	*F* (1, 102.767) = 13.369	<.001	-1.071, -.379
$D_1 \times Hour^2$	-.158	.059	*F* (1, 48.018) = 5.088	.029*	-.275, -.042
$D_2 \times Hour$	.351	.161	*F* (1, 154.202) = 3.889	.050	-.035, .667
$D_2 \times Hour^2$	-.033	.047	*F* (1, 85.795) = 0.372	.543	-.124, .058

*Notes: *p <.05, **p < .01.*





(Left) Figure 3 Trajectories of high arousal negative valence affect (HN) and low arousal negative valence affect (LN).

Notes: Red = HN affect, Green = LN affect; horizontal solid line represents the average level of overall NA on non-binge days.

(Right) Figure 4 Trajectories of high arousal positive valence affect (HP) and low arousal positive valence affect (LP).

Notes: Blue = HP affect, Orange = LP affect; horizontal solid line represents the average level of overall PA on non-binge days.

Discussion

The purpose of this study was to gain a better understanding of the temporal relationship between affect and binge eating episodes, addressing gaps in the literature. In particular, while NA has been established as an antecedent to binge eating, mixed findings were reported on the affect changes after binge episodes. The first aim of the present study was to replicate previous research (e.g., Smyth et al., 2007) by examining the overall NA and PA before and after binge eating episodes, as well as their average levels on non-binge days. This investigation adopted two commonly used analytical approaches to see if the statistical strategies were one reason for controversial results. The second aim of this study was to apply the dimensional theory of emotions (Feldman, 1995; Reisenzein, 1994) to trajectory analyses of affect before and after binge eating, determining whether trajectories of affect with different arousal levels differed across binge eating episodes.

To address these questions, we measured 10 individual affects using a 14-day EMA among a sample of 17 college students with subclinical BN syndromes. We analyzed overall NA and PA by grouping these affects. We also generated four affect groups (HN, LN, HP, and LP) according to the valence-arousal dimensional theory of emotions (Feldman, 1995; Reisenzein, 1994).

NA and PA prior to binge

Replicating previous research, our results demonstrated that pre-binge NA was significantly higher than its average level on non-binge days, and pre-binge PA was significantly lower than its average on non-binge days. Moreover, as the proximity to binge eating grew closer, we found a pattern of increasing NA and decreasing PA. Furthermore, as expected, the trajectory of affective changes were not linear. The rates of change were accelerated for NA and decelerated for PA.

These NA results were consistent with previous research. A majority of studies with point analyses found that pre-binge NA was higher than the NA level on non-binge days (Engel et al., 2005; Haedt-Matt & Keel, 2001; Smyth et al., 2007; Stein et al., 2007). On rare occasions, pre-binge NA was unchanged compared to non-binge days. The few exceptions were mainly due to these NA being measured a substantial amount of times prior to binge eating (Dopp, 1995; Haedt-Matt & Keel, 2011). Furthermore, our findings related to the increased trajectory of pre-binge NA was consistent with previous research as well (Berg et al., 2015; Engel et al., 2013; Smyth et al., 2007; Witt, 2015). Therefore, we confirmed the first part of affect regulation theory: NA is an antecedent to binge eating episodes.

The PA results were in line with previous research as well, though studies of PA were not as extensive as of NA. Deaver et al. (2003) and Wegner et al. (2002) demonstrated that pre-binge PA was lower than the level on non-binge days. Smyth et al. (2007) and Witt (2015) were in agreement with increased trajectory of pre-binge PA. In accordance with their findings, we once again proved that lower PA was related to binge eating. Although a decelerated rate of PA's changes may imply that the association between PA and binge eating may not be as strong as NA, the linear relationship has shown that lower PA was an antecedent to binge eating. Thus, the first part of affect regulation theory also applied to PA.

It should be noted that we were unable to conclude that worsening affect (i.e., more NA or less PA) was an antecedent specifically to binge eating. Previous studies showed that BN participants generally experienced higher NA prior to all eating episodes, including regular eating not involving a loss of control or a large consumption of food (Wilfley, Schwartz, Spurrell & Fairburn, 2000). A few studies further proved that pre-binge affect and pre-regular eating affect were not different

(Engelberg, Steiger, Gauvin & Wonderlich, 2007; Wegner et al., 2002). Thus, it is necessary to distinguish the influence of binge eating and regular eating. In future research, we may ask participants to report affect before any eating episodes, and indicate whether it is a binge or regular eating episode.

Moreover, in our study, we did not know whether the pre-binge NA/PA trajectories were impacted by the anticipation or planning of binge episodes. It was possible that the awareness of imminent binge intensified NA (e.g., anxiety), so we were unable to conclude whether intensified NA was causally linked to subsequent binge episodes. This question was also raised in previous research but was insufficiently investigated. In this study, we did not have enough data to compare the pre-binge affective records in which participants did or did not indicate that they were about to binge, but future studies using this comparison could examine whether the pre-binge NA/PA trajectories differ when participants are or are not anticipating binge episodes.

NA and PA subsequent to binge

Addressing the gaps in the literature on controversial post-binge affect changes, we replicated previous research with two analytical approaches to compare post- versus pre-binge affect and to observe the trajectory of post-binge affect. Using point analysis, we found that post-binge NA was significantly higher than pre-binge NA, which followed our hypothesis. This result was in line with multiple EMA studies using the same point analytical approach (Berg et al., 2017; Engel et al., 2013; Hilbert

& Tuschen-Caffier, 2007; Maedt-Matt & Keel, 2011; Wegner et al., 2002). Although a few earlier studies with retrospective questionnaires found a lower level of post-binge NA (Abraham & Beumont, 1982; Hsu, 1990), Stickney and Miltenberger (1999) proved that the reported reduction in NA actually did not occur, and retrospective recall bias may explain this. In addition, a meta-analyses (Haedt-Matt & Keel, 2011) aggregated retrospective studies and confirmed an increased post-binge NA. Therefore, our results were consistent with previous findings in post-binge NA. We proved that binge eating episodes did not improve NA, which failed to support the second part of affect regulation theory.

Contrary to our expectations, post-binge PA did not differ from pre-binge PA. This finding was in line with previous studies (Deaver et al., 2003; Wegner et al., 2002). The research on post-binge PA using point analyses were not extensive, but we have not seen contrary results. Our results showed that the second part of affect regulation theory could not apply to PA.

For trajectory analyses, neither NA nor PA showed a significant slope after binge eating episodes, which means that neither of them changed significantly. This result was inconsistent with three previous studies of binge eating using trajectory analyses. Berg et al. (2015) found a decrease in NA after binge eating. Smyth et al. (2007) and Witt (2015) both supported a decreased trajectory for post-binge NA and an increased trajectory for post-binge PA.

First of all, it is possible that our study was statistically under-powered so that the post-binge affect did not show significant changes. Next, we noticed that there were several discrepancies in this relatively new analytical strategy that may lead to conflicting results. For example, Witt (2015) created models in an exploratory way and determined the fixed effects post hoc, removing the insignificant predictors in the model (e.g., equivalent to *Hour*^{2} in my study). If we followed the same exploratory way (i.e., removing the insignificant predictor of post-binge *Hour*^{2}), we would find a significant negative slope for post-binge *Hour* (i.e., the post-binge NA would significantly decrease). Nevertheless, we determined the fixed effects a priori, as was suggested for confirmatory hypothesis testing in multilevel models (Bates, Kliegl, Vasishth & Baayen, 2015).

Furthermore, in some studies, the models were created to test "the difference between the antecedent and consequent linear slopes", but the researchers interpreted the estimate of the slope as the change in post-binge NA (e.g., Becker, 2016; Witt, 2015). If we created the model in their way, we would find that the post-binge NA would significantly decrease and the post-binge PA would significantly increase at a significance level of 0.01. However, we considered that those significant results indicated the changes between post-binge and pre-binge affect (i.e., the difference between the slope of pre-binge affect and the slope of post-binge affect), not post-binge affect itself.

In addition, we forced a common intercept when generating the trajectory, which thus connected pre-binge and post-binge segments. This followed the same technique that Berg et al. (2015) and Smyth et al. (2007) used. However, Witt (2015) separated the trajectory into two segments with respective intercepts for pre- and post-binge, and found a large vertical gap between the intercepts of the two segments. The level of NA at the beginning of the post-binge segment was 20% higher than the end point of the pre-binge segment. With an elevated starting point, the post-binge trajectory curve would have a higher chance of exhibiting a negative slope. Since the vertical gap between the intercepts of pre- and post-binge affect may reflect the affective changes during binge, the analytical strategy of separating intercepts was justifiable.

These inconsistent analytical and interpretation details may explain inconsistent findings. More evidence is needed for any solid conclusions. Also, unifying analytical details in future research may help to solve discrepancies.

The results from both analytic approaches supported the fact that the post-binge affect did not improve. Specifically, post-binge NA was higher compared to pre-binge NA, and post-binge NA did not decrease as the proximity to the binge grew larger (i.e., further away in time). These results did not support the second part of affect regulation theory.

We agreed with Berg et al. (2017) that in point analyses, there was a longer interval between pre-binge assessments and binge eating than post-binge assessments (Figure 1 & 2). However, this might not explain why post-binge NA was higher than pre-binge NA, because we did not observe a declining trend for post-binge NA. A few previous studies provided supporting evidence. For example, a 1-hour delayed post-binge affect may be the same as (Corstorphine et al., 2006) or even worse than an immediate post-binge affect (Sherwood, Crowther, Wills, &

Ben-Porath, 2000). Thus, it was possible that post-binge NA was consistently higher than pre-binge NA. Therefore, binge eating was not maintained by an eventual decrease in NA.

Since binge eating was not associated with improved affect, neither via NA reductions nor via PA gains, it seemed that binge episodes were not maintained by post-binge reductions in NA. An possible alternative explanation is that binge eating improved affect during binge, but this improvement deteriorated after the binge. This assumption was supported by several studies. For example, a number of affects (e.g., anxiety, anger, frustration, sadness, guilt, agitation) temporarily decreased during a binge eating episode, but increased again afterwards (Redlin et al., 2002). Another study found that PA during a binge was higher than both pre- and post-binge (Deaver et al., 2003).

Heatherton and Baumeister (1991) proposed the escape theory and specified that NA reduces during, rather than after, binge eating. This occurred because participants shifted their attention onto immediate stimuli (i.e., food) by binge eating, and this allowed them to escape from high self-awareness and the accompanying NA. Thus, the decrease of NA during binge episodes served as the negative reinforcement for maintaining binge eating behavior. A study of 129 non-clinical women (Blackburn, Johnston, Blampied, Popp & Kallen, 2006) substantiated binge eating as providing a means of escape from NA, but more studies are needed to further verify this theory. The affective changes during binge eating are especially important if we consistently find that the post-binge affect was not regulated, since it is possible that it could be the affect regulation during binge eating that reinforces maladaptive eating behavior.

A few studies did not support escape theory and found that affect improved during the binge eating period. Trajectory analyses revealed that NA increased (Witt, 2015) and PA decreased (Deaver et al., 2003; Witt, 2015) during binge eating. If affect is not regulated throughout binge episodes, we may consider an alternative possibility that may explain the maintenance of binge episodes.

Expectancy theory (Hohlstein, Smit & Atlas, 1998) proposed that binge eating was maintained through the belief that binge eating would reduce NA or would be rewarding, and this reinforced the occurrence of binge episodes. The existence of biased expectancy was supported by a finding that showed the decrease in NA during binge eating on the retrospective questionnaires actually did not occur (Stickney & Miltenberger, 1999). In addition, there has been evidence that eating expectancies were linked to the later development and maintenance of bulimic symptoms (Bohon, Stice, & Burton, 2009). If the second part of affect regulation theory is not proven, we may need to consider further investigation into expectancy theory. This would help to determine whether misbelief should be one of the targets in bulimic treatment.

Valence-arousal affect groups

As a preliminary investigation, we examined whether the pattern of change for high- or low-arousal affect differed throughout binge eating episodes, and tested the hypothesis that high-arousal NAs would be exchanged for low-arousal NAs so that binge eating would be maintained by this “trade-off”.

The results showed that before binge eating, both HN and LN increased with similar slopes. Moreover, their magnitudes at the end of a pre-binge period were similar. Thus, neither affect group was found to take a dominant role. The only difference was that HN increased at an accelerated rate, while LN did not. We may thus infer that as the proximity to binge eating grew closer, the influence of HN may become stronger. The results showed that the dimension of negative valence, rather than arousal level, was related to binge eating, which was consistent with previous research focusing on overall NA.

On the other hand, LP decreased but HP stayed the same before binge, so lower LP was dominantly related to binge eating. Therefore, for PA, arousal levels along with valence accounted for the first part of affect regulation theory. In addition, the decelerated LP rates of change and the accelerated HN rates of change may suggest that negatively valenced affects were more strongly related to binge eating episodes than positively valenced affects were.

The trajectories of post-binge affect were unexpected. None of the affect group trajectories showed an upward or downward trend. Since each affect group was an independent subset of the affects that constituted overall NA/PA, the reason why they were contradictory to our hypotheses was similar to those for unchanged overall NA/PA trajectories, as discussed above. Therefore, in our study, we failed to support the second part of affect regulation theory by dividing affect into the dimensions of valence and arousal.

In summary, the investigation into the dimensional theory of emotion with regard to binge eating revealed that "trade-off" did not occur between high-arousal and low-arousal affects, and valence was more likely to trigger binge eating episodes than arousal levels.

Strengths

The first part of the present study replicated previous EMA studies. It was the first time that two analytical approaches reconciled for both NA and PA in binge eating behavior. Point analyses directly compared pre- and post-binge affect, while trajectory analyses revealed continuous pre- and post-binge affect changes. We proved that they did not render contradictory results; instead, they were complementary in revealing the temporal relationship between affect and binge eating behaviors. This suggested that future studies could apply both analytical approaches. In addition, this study verified that the affect regulation theory applied to pre-binge affect, but not to post-binge affect. These results may guide future studies to investigate the escape theory regarding affect changes during bingeing, and the expectancy theory of binge eating.

The second part of this study uniquely applied the dimensional theory of emotions to investigate whether arousal changes accounted for affect regulation theory. The results did not support a trade-off between high- and low-arousal affects. Thus, this study substantiated that the valence dimension was more related to binge eating episodes than arousal was.

This study had several clinical implications. Firstly, the results provided support for the idea that increases in NA may trigger binge episodes, this suggested using strategies to intervene early to regulate the affect when NA begins to rise. Secondly, although we did not find support for affect regulation after binge eating, we cannot rule out the presence of affect improvement during a binge. In addition, alternative behaviors that provide reinforcement may also need to be considered (e.g., the expectancy effect of binge eating). Finally, by using dimensions of valence and arousal, it was revealed that lower LP and all NA were related to binge eating. This provided an accurate target that showed which affects should be given more attention for prevention and treatment.

Limitations

Limitations in this study included statistical power, samples, affect groups, coding data, and statistical analyses. First of all, this study was probably underpowered; because of this, we should consider the results with some reservations. Additional data or a replicated study would be needed for more solid conclusions.

Regarding the sample, only two students reported purging behavior, thus we failed to incorporate the pre-purge and post-purge affect to study the complete binge-purge cycle. It was partially because the prescreening questions were not accurate enough to find participants with definite and existing purge episodes. However, even if we had loosened the standard as “having experienced purging”, only around 4% students met this criterion. Among the 4% within the college population, nine out of ten had stopped purging. Thus, we consider that college students might not be a target population for studies on purging behavior. In addition, since our sample was a college population with partial bulimic syndromes, the results may not be able to generalized to other sample populations, for example, clinical patients.

For the valence-arousal investigation, despite the theoretical precedence for categorizing affect into groups based on the dimensions of valence and arousal (Feldman, 1995; Klonsky, 2009; Reisenzein, 1994), the affect groups used in this study (i.e., HN, LN, HP, LP) were not empirically generated. The Cronbach's alpha (Table 2) showed that the internal consistency of both positive valenced groups was unsatisfactory. This may be due to having not enough items in each affect group. Moreover, LN only contained one affect (i.e., sadness), which may affect reliability. It would be better for future studies to directly utilize dimensional assessments (e.g., the affect grid; Russell, Weiss & Mendelsohn, 1989) to measure arousal changes. It might be necessary to separate NA and PA into two studies in order to gain a reasonable number of affect ratings for EMA study.

Regarding the predictor (i.e., *Hour*), the value of *Hour* was the interval between the time affect ratings were recorded and the time a binge occurred. More specifically, the pre-binge *Hour* should be the interval between its measure and the beginning of a binge episode, and the post-binge *Hour* should be the interval between its measure and the end of a binge episode. Since a binge lasted for a specific duration, the beginning and the end of a binge episode had an interval.

However, our study did not provide a protocol to accurately record the exact beginning and end of a binge. We presumed that the average duration of a binge was 20 minutes, applying this assumption to each participant. This rough estimation may render inaccurate coding for *Hour*. We have not seen previous studies mention how they solved this problem, but future studies could consider asking participants to indicate the exact starting and ending points of a binge episode. Alternatively, researchers could ask for the average duration of a binge for each participant and apply it to all episodes for the respective participant.

Lastly, regarding the analyses themselves, we consider that it would be optimal to nest data in *episode* (and then in *participant*) so that variations between each episode would be controlled, as some research has already done (e.g, Becker, 2016). However for this study, our binge-related affect ratings were not frequent enough (i.e., three or more observations per episode) to create such models. We used an alternative way in which we nested the data in *day* (and then in *participant*) to control the variation between each day.

Conclusions

The present study demonstrated that both higher NA and lower PA were antecedent to binge eating episodes. However, neither NA nor PA was being regulated after binge eating. Thus, while the first part of affect regulation theory was supported, the second part was rejected.

The investigation into dimensions of valence and arousal revealed that there was no trade-off between high- and low-arousal affects. The change in arousal levels did not account for affect regulation theory.

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Appendix A Binge-purge behavior screening questions

(These questions were embedded in a large questionnaire, with other questions being irrelevant to our study in hiding our purpose.)

1. Have you anytime experienced periods of binge eating, where you had a strong urge to eat large amounts of food?

Yes / No

2. Did you feel that you had lost the control under such “binge eating” periods?

Yes / No

3. Have you been throwing up to prevent weight gain?

Yes / No

4. Have you had at least one “binge eating” periods a week over a three months period?

Yes / No

Appendix B EMA questionnaire (English version)

Event-contingent questionnaire

Answer it when you encounter events

1. What is currently happening? (select all that apply)

a. I am about to binge/ I plan to binge.

b. I am bingeing now.

c. I binged a few minutes ago.

d. I binged 1 hour (or longer) ago.

e. I am about to purge/ I plan to purge.

f. I purged a few minutes ago.

g. I purged 1 hour (or longer) ago.

Please rate how you are feeling now.

Not at all - Somewhat - Moderately - Very – Extremely

1. I am feeling anxious now.

2. I am feeling angry at myself now.

3. I am feeling sad now.

4. I am feeling guilty now.

5. I am feeling in control now.

6. I am feeling a sense of relief now.

7. I am feeling happy now.

8. I am feeling excited now.

9. I am feeling accomplished now.

10. I am feeling calm now.

<u>Food Imagery Experience Question</u>

Which of the following is occurring now? (select all that apply)

a. I am visualizing certain food(s).

b. I am imagining the smell of certain food(s).

c. I am imagining the taste of certain food(s).

d. I am picturing myself eating food.

e. None of above.

Signal-contingent questionnaire

Answer it when you receive notifications

Affects rating

Since the last beep, have any of the following events happened? (select all that apply)

a. I binged.

b. I purged.

c. I am bingeing now.

d. I am purging now.

e. I have been thinking about bingeing.

f. I have been thinking about purging.

g. None of above.

If a was chosen in question 1:

When did the last binge happen?

a. Less than 10 minutes ago.

b. 10 to 60 minutes ago.

c. more than 60 minutes ago.

d. Since the last beep, I have binged more than once.

<u>If b was chosen in question 1:</u>

When did the last purge happen?

a. 10 to 60 minutes ago

b. more than 60 minutes ago

c. Since the last beep, I have purged more than once

(Food Imagery Experience Question)

Time-contingent questionnaire

Answer it at 10pm

1. Did you record all the binge or purge episodes today?

a. Yes. I recorded all episodes, or I did not binge or purge today.

b. No. I did not record all the episodes.

2. How many times did you binge today?

a. 0 b. 1 c. 2 d. 3 e. more than 3

3. How many times did you purge today?

a. 0 b. 1 c. 2 d. 3 e. more than 3

Appendix C EMA questionnaire (German version)

Event-contingent questionnaire

Bitte beantworten, wenn ein Ereignis auftritt

1. Was passiert gerade? (Mehrfachantworten möglich)

a. Eine Ess-Attacke steht bevor/ ich plane eine Ess-Attacke

b. Ich bin gerade mitten in einer Ess-Attacke

c. Vor einigen Minuten hatte ich eine Ess-Attacke

d. Vor 1 Stunde (oder mehr) hatte ich eine Ess-Attacke

e. Ich bin dabei mich zu übergeben/ ich plane mich zu übergeben

f. Vor ein paar Minuten habe ich mich übergeben

g. Vor 1 Stunde (oder mehr) habe ich mich übergeben

Bitte geben Sie an, wie Sie sich jetzt gerade fühlen.

Überhaupt nicht - Ein bisschen- Mittel- Sehr- Extrem

1. Ich fühle mich ängstlich

2. Ich bin wütend auf mich

3. Ich fühle mich traurig

4. Ich fühle mich schuldig

5. Ich habe das Gefühl von Kontrolle

6. Ich fühle mich erleichtert

7. Ich fühle mich glücklich.

8. Ich bin aufgeregt

9. Ich finde, ich habe etwas erreicht

10. Ich fühle mich ruhig

Food Imagery Experience Question

Welche der folgenden Aussagen trifft im Moment zu?

(Mehrfachantworten möglich)

a. Ich sehe bestimmte Nahrungsmittel vor meinem inneren Auge.

b. Ich stelle mir den Geruch von bestimmten Nahrungsmitteln vor.

c. Ich stelle mir den Geschmack von bestimmten Nahrungsmitteln vor.

d. Ich stelle mir vor, wie ich selber esse.

e. Keine der Aussagen trifft zu.

Signal-contingent questionnaire

Bitte beantworten, wenn Sie eine Benachrichtigung erhalten.

Seit dem letzten Signal, sind die folgenden Ereignisse eingetreten? (Mehrfachantworten sind möglich)

a. Ich hatte eine Ess- Attacke

b. Ich habe mich übergeben

c. Ich befinde mich gerade in einer Ess-Attacke

d. Ich übergebe mich gerade

e. Ich habe über eine Ess-Attacke nachgedacht

f. Ich habe darüber nachgedacht, mich zu übergeben

g. Keine der Aussagen trifft zu

<u>If a was chosen in question 1:</u>

Wann war die letzte Ess- Attacke?

a. Vor weniger als 10 Minuten

b. Vor 10-60 Minuten

c. Vor mehr als einer Stunde

d. Seit dem letzten Signal habe ich mehr als eine Ess-Attacke gehabt

<u>If b was chosen in question 1:</u>

Wann haben sie sich zuletzt übergeben?

a. Vor weniger als 10 Minuten

b. Vor 10-60 Minuten

c. Vor mehr als einer Stunde

d. Seit dem letzten Signal habe ich mehr als einmal übergeben

<u>(Food Imagery Experience Question)</u>

Time-contingent questionnaire

Bitte um 10 Uhr beantworten

1. Haben Sie heute alle Ess-Attacken oder Brech-Episoden berichtet?

a. Ja. Ich habe alle Episoden berichtet, bzw. ich habe heute weder eine Ess-Attacke gehabt noch mich Übergeben.

b. Nein. Ich habe nicht alle Episoden berichtet.

2. Wie viel Ess-Attacken hatten sie heute?

a. 0 b. 1 c. 2 d. 3 e. mehr als 3

3. Wie häufig haben sie sich heute übergeben?

a. 0 b. 1 c. 2 d. 3 e. Mehr als 3

Appendix D EMA questionnaire (Dutch version)

Event-contingent questionnaire

Beantwoord het wanneer een gebeurtenis zich voordoet

1. Wat gebeurt er nu? (selecteer alles wat van toepassing is)

a. Ik sta op het punt een eetbui te hebben / Ik ben van plan een eetbui te hebben.

b. Ik heb nu een eetbui.

c. Ik had een paar minuten geleden een eetbui.

d. Ik had 1 uur (of langer) geleden een eetbui.

e. Ik sta op het punt te gaan braken / Ik ben van plan te gaan braken.

f. Ik heb een paar minuten geleden gebraakt.

g. Ik heb 1 uur (of langer) geleden gebraakt.

Beoordeel alsjeblieft hoe je je nu voelt

Helemaal niet – Een beetje – Gemiddeld – Heel erg – Extreem erg

1. Ik voel me nu angstig.

2. Ik ben nu boos op mezelf.

3. Ik voel me nu verdrietig.

4. Ik voel me nu schuldig.

5. Ik heb nu het gevoel controle te hebben.

6. Ik voel me nu opgelucht.

7. Ik voel me nu blij.

8. Ik voel me nu opgewonden.

9. Ik heb nu het gevoel iets volbracht te hebben.

10. Ik voel me nu kalm.

Food Imagery Experience Question

Welke van de volgende komt op dit moment voor? (selecteer alles wat van toepassing is)

a. Ik zie bepaald voedsel voor me.

b. Ik stel me de geur van bepaald voedsel voor.

c. Ik stel me de smaak van bepaald voedsel voor.

d. Ik stel me voor dat ik voedsel eet.

e. Geen van bovenstaande.

Signal-contingent questionnaire

Beantwoord het wanneer je notificaties ontvangt

Sinds het laatste piepje, heeft één van de volgende gebeurtenissen zich voorgedaan?

(selecteer alles wat van toepassing is)

a. Ik heb een eetbui gehad.

b. Ik heb gebraakt.

c. Ik heb nu een eetbui.

d. Ik ben nu aan het braken.

e. Ik heb aan eetbuien gedacht.

f. Ik heb aan braken gedacht.

g. Geen van bovenstaande.

<u>If a was chosen in question 1:</u>

Wanneer was de laatste eetbui?

a. Minder dan 10 minuten geleden.

b. 10 tot 60 minuten geleden.

c. Meer dan 60 minuten geleden.

d. Sinds het laatste piepje, heb ik meer dan één eetbui gehad.

If b was chosen in question 1:

Wanneer heb je voor het laatst gebraakt?

a. Minder dan 10 minuten geleden.

b. 10 tot 60 minuten geleden.

c. Meer dan 60 minuten geleden.

d. Sinds het laatste piepje, heb ik vaker dan eens gebraakt.

(Food Imagery Experience Question)

Time-contingent questionnaire

Beantwoord het om 22.00 uur

1. Heb je alle keren dat je vandaag een eetbui had of gebraakt hebt geregistreerd?

a. Ja. Ik heb alle keren geregistreerd, of ik heb vandaag niet gebraakt of een eetbui gehad.

b. Nee. Ik heb niet alle keren geregistreerd.

2. Hoe vaak heb je vandaag een eetbui gehad?

a. 0 b. 1 c. 2 d. 3 e. meer dan 3 keer

3. Hoe vaak heb je vandaag gebraakt?

a. 0 b. 1 c. 2 d. 3 e. meer dan 3 keer