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BINGE EATING AND EMOTIONAL FLUCTUATIONS: AN ECOLOGICAL
MOMENTARY ASSESSMENT STUDY

Master's thesis

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ABSTRACT

The objective of current master's thesis was to investigate the associations between emotional fluctuations and emotion regulation difficulties in predicting binge eating episodes in a general population study using ecological momentary assessment (EMA). In addition, emotional experience was assessed in order to compare the differential impact of binge eating with and without loss of control. The sample consisted of 97 women and 61 men with a mean age of 22.35 (SD = 4.82). The gender differences in eating behavior were also of interest. The results pointed, that fluctuations in negative emotion did indeed predict binge eating with loss of control among both men and women. Among women, the emotion regulation difficulties, restrained eating, as well as the interaction of negative emotion fluctuations and emotion regulation difficulties were significant predictors. Among men, impulsivity predicted binge eating episodes with loss of control. Overall, binge eating with loss of control, compared to without loss of control, was significantly more associated with emotion regulation difficulties as well as increased negative emotions indicating the significance of loss of control in the assessment of eating pathology. It also appeared that women were considerably more sensitive to binge eating with loss of control as it resulted in greater levels of negative emotions, whereas among men this tendency was not found. In addition, binge eating without loss of control resulted in higher rates in several positive emotions both among men and women.

Keywords: binge eating, emotion regulation, emotion fluctuations, ecological momentary assessment

KOKKUVÕTE

Liigsöömishood ja emotsioonide kõikumine: kogemuse väljavõtte uuring

Käesoleva magistritöö eesmärk oli uurida emotsionaalse kõikumise ja emotsiooniregulatsiooni raskuste koosmõju kontrollikaoga liigsöömishoogude ennustamisel kasutades kogemuse väljavõtte meetodit. Uuringus osales kokku 158 osalejat keskmise vanusega 22.35 (SD = 4.82), neist 97 naist ja 61 meest. Lisaks uuriti erinevusi kontrollikaoga ja ilma kontrollikaota liigsöömishoogude vahelisi erinevusi enesekohastes küsimustikes ning emotsionaalses kogemuses. Soolised erinevused olid samuti tähelepanu all. Tulemused viitavad, et negatiivse emotsiooni kõikumine ennustab kontrollikaoga liigsöömishoogude esinemist nii meestel kui ka naistel. Naistel osutusid oluliseks emotsiooniregulatsiooni raskused, söömise piiramine, aga ka emotsiooniregulatsiooni raskuste ja negatiivse emotsiooni kõikuvuse koosmõju. Meestel oli oluliseks ennustajaks impulsiivsus. Üleüldiselt olid kontrollikaoga liigsöömishood võrreldes kontrollikaota liigsöömishoogudega oluliselt rohkem seotud emotsiooniregulatsiooni raskustega, aga ka kõrgema negatiivsete emotsioonide tasemega. Lisaks ilmnes, et naised on kontrollikaoga liigsöömishoogude suhtes tundlikumad, kuna sellele järgnevalt oli negatiivsete emotsioonide tase kõrgem võrreldes liigsöömishoo puudumise või kontrollikaota liigsöömishoo korral. Meestel sarnast tendentsi ei leitud. Seevastu kontrollikaota liigsöömishoogudele järgnevalt esines mitme positiivse emotsiooni puhul kõrgem tase.

Märksõnad: liigsöömishood, emotsiooniregulatsioon, emotsionaalne kõikuvus, kogemuse väljavõtte meetod

INTRODUCTION

Binge eating

In DSM-V binge eating is defined as a consummation of a large quantity of food in a brief period of time and experiencing loss of control over eating, often followed by discomfort (American Psychiatric Association, 2013). Binge eating is a core diagnostic criteria of binge eating disorder (BED) and *bulimia nervosa* (BN), as well as for a binge-purge type of *anorexia nervosa* (AN).

Studies indicate that binge eating is also common among non-clinical population (Greeno, Wing, & Shiffman, 2000; Lynch, Everingham, Dubitzky, Hartman, & Kasser, 2000; Whiteside, Chen, Neighbors, Hunter, & Larimer, 2007) and the trend is growing (Skinner, Haines, Austin, & Field, 2012). It has been found that up to 41% of female students experience binge eating every week and 15% of them binge eat on a daily basis (Vanderlinden, Grave, Vandereycken, & Noorduyn, 2001). Nguyen-Rodriguez, Unger and Spruijt-Metz (2009) found that among high school students 16.5% of boys and 20.4% of girls experience emotional eating. Although binge eating is more common among young women it is also frequent among men (Lavender & Anderson, 2010). Whiteside and colleagues (2007) found that in their population-based study 8% of binge eaters met the diagnostic criteria for binge eating disorder according to DSM-IV.

Binge eating consists of two key components: a behavioral abnormality (consumption of an objectively large amount of food) and a cognitive component (a sense of loss of control, LOC) (Pollert et al., 2013). Loss of control over eating is a crucial diagnostic feature of binge eating and it has been implied to be even more significant indicator of psychopathology than the large amount of food eaten during the binge episode (Jenkins, Conley, Rienecke, Hoste, Meyer, & Blissett, 2012; Telch, Pratt, & Niego, 1998). Studies suggest that subjective binge may even be more characteristic of loss of control eating than objective binge, which is characterized by both loss of control and the consumption of an objectively large amount of food (Berg et al., 2014; Brownstone et al., 2013). This implies that the amount of food eaten is not always the best indicator of eating pathology (Pollert et al., 2013). Although loss of control over eating is a crucial feature of binge eating in the clinical sense, it is rarely explicitly addressed in previous studies. Only a few studies have differentiated binge eating episodes with and without loss of control. Still, it has been found that binge eating *with* loss of control is associated with larger amounts of food, more distress and increased guilt in comparison with binge eating *without* loss of control (Stein, Kenardy, Wiseman, Douchis,

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Arnou, & Wilfley, 2007). Loss of control over eating has also been associated with higher levels of anxiety among youth (Goossens, Braet, Van Vlierberghe, & Mels, 2009). It has been posited that loss of control is a significant predictor of eating disorders and mental health issues in general (Latner, Hildebrandt, Rosewall, Chisholm, & Hayashi, 2007).

Binge eating is also associated with psychiatric illnesses (Hudson, Pope, Jonas, & Yurgelun-Todd, 1983) such as affective disorders (Hudson et al., 1983), borderline personality disorder. Binge eating also increases risk for other health problems such as overweight, addiction disorders and sleeping problems (Ferriter & Ray, 2011; Trace et al., 2012). This indicates the importance of determining the predisposing factors of binge eating.

Emotional eating

In addition to physiological needs, human eating behavior is influenced by many factors such as social and situational cues as well as emotions (Canetti, Bachar, & Berry, 2002; Macht, 2008; Grilo, Shiffmann, & Carter-Campbell, 1994). Eating in response to emotions has been referred to as emotional eating (Adriaanse, de Ridder, & Evers, 2011; Koball, Meers, Storfer-Isser, Domoff, & Musher-Eizenman, 2012; Macht & Simons, 2000). It has been speculated that emotional eaters do not distinguish between different physiological sensations that can also derive from emotions thus leading them to mistaking the sensation of emotional arousal as hunger (van Strien, & Ouwens, 2007). As binge eating is often accompanied by emotional eating, they are not always distinguishable from each other (Stice, Presnell, & Spangler, 2002).

Negative affect is one of the most frequently reported precipitants of binge eating (Polivy & Herman, 1993). According to research, the most common negative emotions leading to binge eating are sadness, disappointment and boredom (Abraham & Beaumont, 1982; Lingswiler, Crowther, & Stephens, 1989; Heatherton & Baumeister, 1991; Herman & Polivy, 1993; Kelly et al., 2012; Koball et al., 2012; Zeeck, Stelzer, Linster, Joos, & Hartmann, 2011). Overall, increased eating is associated with negative emotions (Macht & Simons, 2000). Stress and the concomitant anxiety are important factors influencing eating behavior (Heatherton & Baumeister, 1991; Greeno & Wing, 1994). General notion is that people tend to react to stress with reduction in eating behavior, whereas emotional eaters exhibit the opposite tendency (van Strien, Herman, Anschutz, Engels, & de Weerth, 2012). Tan and Chow (2014) proposed that the relation between stress and emotional eating is mediated by a construct called *eating dysregulation* which refers to individual's tendency of not being sensitive to one's internal cues of hunger and satiety, thus relying on external

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factors to initiate and stop eating. In fact, emotional eaters have been found to be lacking of interoceptive awareness, making them vulnerable to external factors (van Strien & Ouwens, 2003). Among restrained eaters stress interferes with cognitive control thus leading them to overeat (Polivy & Herman, 1993). In general, empirical studies indicate that binge eating is more likely to occur when negative affect is elevated (Crosby et al., 2009; Tuschien-Caffier, 2007).

Eating as a response to positive emotions is mostly linked to social situations and associative learning due to early experience (Adriaanse et al., 2002). It has been found that people tend to eat more as a response to positive as well as to negative emotions compared to neutral mood (Patel & Schlundt, 2001). According to the general view, strong emotions, independent from their valence, inhibit control over eating, therefore leading to more frequent eating (Canetti et al., 2002). In general, positive emotions have been found to have an inhibiting effect on eating behavior. On the other hand it has also been found that normal weight subjects experienced positive emotions associated with eating (Adriaanse et al., 2002). Among healthy males experimentally induced happiness increased appetite whereas sadness decreased it (Macht, Roth, & Ellgring, 2002). On the same note, Evers, Adriaanse, de Ridder and de Witt Huberts (2013) found that positive emotions evoked eating and resulted in more snacking.

Binge eating and emotion regulation

As binge eating is common in both clinical and normal population (Greeno et al., 2000; Lynch et al., 2000) and is associated with health issues in general (Hudson et al., 1983), there is a growing interest in the determinants of binge eating. One of the highly discussed hypothesis is the emotion regulation theory. The rationale behind the theory is that binge eating is maintained via negative reinforcement such as reduction of negative emotions and distress (Polivy & Herman, 1993). The emotion regulation theory has been explained with reduction in cognitive control (Dingemans, Martijn, Jansen, & van Furth, 2009; Herman & Polivy, 1993), distraction (Macht et al., 2004), escaping from self-awareness (*The escape theory*, Heatherton & Baumeister, 1991), hedonical aspects and nutritional value (Macht, 2008; Mitchell et al., 1999), as well as with specific brain chemistry (van Strien et al., 2012).

Studies show mixed findings regarding the affect regulation theory. There is some evidence supporting the emotion regulation theory through reductions of negative affect following a binge (Abraham & Beaumont, 1982; Kelly et al., 2012; Mitchell et al., 1999; Aldao et al., 2010; Herman & Polivy, 1993). On the other hand, it has been found that certain

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emotions such as tension decreases after a binge whereas guilt and shame increase (Alpers & Tuschén-Caffier, 2001). Empirical studies have shown that binge eating often occurs as an effort to cope with negative emotions. For instance, studies using the ecological momentary assessment (EMA; also known as experience sampling method, ESM) have found that negative affect increased before binge eating episodes supporting the notion that binge eating may be used as an attempt to regulate emotions (Engel et al., 2006; Engelberg, Steiger, Gauvin, & Wonderlich, 2007; Munsch et al., 2012; Smyth et al., 2007).

In a meta-analysis of 36 EMA studies with a total of 968 participants greater negative affect was found to precede a binge, whereas in contrast to the affect regulation theory, negative affect also increased following binge eating (Haedt-Matt & Keel, 2011). Munsch, Meyer, Quartier and Wilhelm (2012) used EMA for studying relations between binge eating and emotions in patients with binge eating disorder (BED). They found that negative affect and tension grew and positive affect decreased before a binge eating episode. Likewise, negative affect and tension decreased and positive affect increased over the hours following binge eating. Smyth and colleagues (2007) found in an EMA study among BN patients that negative affect, hostility and perceived stress increased and positive affect decreased before binge eating, whereas after binge eating negative affect and hostility decreased quickly and positive affect increased. The empirical evidence on emotion regulation suggest that there may be different trajectories in specific emotions preceding and following a binge eating episode (De Young et al., 2013; Stein et al., 2007; Berg et al., 2013). The ambivalent results regarding the emotion regulation aspect of eating indicates possible impact of individual differences in mediating factors.

Difficulties in emotion regulation

Research has indicated that difficulties in emotion regulation may be the culprit of binge eating (Evers et al., 2009; Macht, 2008). In addition to eating disorders (Harrison, Sullivan, Tchanturia, & Treasure, 2010; McEwen & Flouri, 2009), emotion dysregulation has been related to various other psychopathologies (Aldao et al., 2010; Gratz & Roemer, 2004) including borderline personality disorder. Whiteside et al (2007) found among healthy participants that binge eating is associated with difficulties in emotion regulation, particularly with lack of emotion regulation strategies and lack of emotional clarity. Among people with disturbed eating behavior difficulties in emotion recognition have been found (Harrison et al, 2010) and non-acceptance of emotions, lack of emotional clarity (Vine & Aldao, 2014) and dysfunctional emotion regulation strategies (Svaldi, Griepenstroh, Tuschén-Caffier, &

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Ehring, 2012).

The rationale behind the emotion regulating function of binge eating is that one experiences negative emotions which he or she doesn't know how to regulate adequately (Whiteside et al, 2007) leading him or her to utilize dysfunctional methods. Tice, Bratslavsky and Baumeister (2001) posited that when one experiences acute distress, the reduction of the distress becomes his or her primary goal competing with long-term goals. The need to regulate emotions becomes more important than impulse control, which requires more cognitive resources thus leading the individual to be more subject to easily accessible and immediately rewarding means. Although these have been shown to have a slight mood improving effect in a short term, they have even more deteriorating influence on mood in a long run (Tice et al., 2001). Emotion regulation and impulse control difficulties due to emotional distress have been associated with restrained eaters (Polivy & Herman, 1993; Evers et al., 2009). Restrained eaters ignore physiological hunger and apply cognitive control in order to restrain their eating making them more vulnerable to various cognitive distractors such as emotions. These distractors compete with the same cognitive resources necessary for the controlling behavior thus often setting off a binge eating episode (Polivy & Herman, 1993). This tendency refers to the lack of adequate emotion regulation strategies (Aldao et al, 2010; Evers et al, 2009). Negative urgency – a tendency to react rashly as a response to distress – is also regarded as a component of emotion dysregulation. Meaning, that in an attempt to improve mood, individuals with high levels of urgency are more likely to react impulsively to negative affect by engaging in behaviors such as binge eating (Anestis, Selby & Joiner, 2007). Negative urgency also refers to distress intolerance (Kelly, Cotter, & Mazzeo, 2014). Racine and colleagues (2013) found that negative urgency predicted binge eating and emotional eating and that there might be a considerable genetic component. The link is also supported by findings that difficulties in emotion regulation are associated with eating disorders (Svaldi et al, 2012) and positive coping strategies are associated with fewer binge eating episodes (Kelly et al, 2012). Gianini and colleagues (2014) found in a recent study that difficulties with emotion regulation were independently associated with emotional overeating and general eating pathology. Theoretical models consider difficulties in emotion regulation as central trans-diagnostic aspect among eating disorders (Brockmeyer et al., 2014; Fairburn, Cooper, & Shafran, 2003; Vine & Aldao, 2014).

Emotional fluctuations

Elaborating on the association between emotion dysregulation and eating behavior, the present study investigates the effects of emotional fluctuations on eating behavior. Emotional fluctuation refers to the tendency to experience emotions that quickly change. There has been some discussions about the correct terminology on this topic (frequently used terms are *instability*, *lability*, *variability*, *fluctuations*) but there seems to be no consensus on the most accurate term (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009). For the sake of clarity and unification, the term *emotional fluctuation* is used in the current paper since it reflects dynamics and temporal variation.

Different findings seem to indicate that individuals who consistently experience rapidly changing emotions exhibit impaired coping skills and are therefore more vulnerable to engaging maladaptive behaviors when upset (Anestis et al., 2009). Anestis and colleagues (2009) found among BN patients that high emotional fluctuation was associated with impulsive behavior measured by Impulsive Behavior Scale. Selby, Anestis, and Joiner (2008) found that individuals who engage in dysfunctional behaviors might have troubles using adaptive emotion regulation strategies to down-regulate negative affect. Few EMA studies have addressed the emotional fluctuations in association with eating behavior, so reliable implications are lacking. An analytical approach used in EMA studies investigating emotional fluctuations is using *Mean Squared Successive Difference* (MSSD). The MSSD measures an individual's average difference from one time point to the next on a particular variable. Using the combination of EMA and MSSD for affective fluctuation measure Anestis and colleagues (2010) found that individuals with higher emotional fluctuations exhibited a higher average number of binge eating episodes on any given day. Zander and Young (2014) found that the interaction of negative emotion fluctuations and neuroticism predicted binge eating episodes. Fluctuations in positive emotions have been shown to be associated with higher psychopathology (Gruber, Kogan, Quoidbach, & Mauss, 2013).

Purpose of the thesis

The current research on the subject of binge eating and emotions is trending towards investigating the associations with emotion regulation difficulties as an extension of the emotion regulation theory. On that note, the current paper aims to investigate the associations between binge eating and emotional fluctuations as well as their relation to emotion regulation difficulties. The differential effect of loss of control in the eating behavior is also of interest in the current study.

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The literature supports a link between binge eating and emotion regulation difficulties as binge eaters have been shown to be lacking of strategies to down-regulate intensive emotions making them more vulnerable to binge eating. As an elaboration of these findings, the current study proposes a research question whether emotional fluctuations and emotion regulation difficulties are associated with binge eating episodes with loss of control and whether there is an interaction between emotion fluctuations and emotion regulation difficulties.

The following hypotheses were postulated: (1) binge eating with loss of control is associated with emotion regulation difficulties among both men and women; (2) there are significant differences in emotional experience between binge eating *with* and *without* loss of control, (3) participants with binge eating with loss of control differ significantly from participants without binge eating episodes on the self-report measures of emotion regulation difficulties and disturbed eating behavior. Additionally we aimed to gather more insight about eating behavior among men and investigate whether they show different trends in comparison to women in relation to eating behavior and emotions. Since the literature on the eating behavior and emotions among men is scarce, no gender-specific hypotheses were postulated.

METHODOLOGY

Sample characteristics

The sample of the current study consisted in total of 159 individuals, 97 were female and 61 male. The mean age of the sample was 22.35 (SD = 4.82). Female participants were on average 21.44 years (SD = 3.04) old and male participants 24.10 (SD = 6.70) years old.

The data was collected in two waves – first one in spring 2013 and the second in fall 2014 until early spring 2015. The first data collection wave yielded 37 female and 4 male participants and the second yielded 60 female and 57 male participants. Participants were recruited via university mailing lists, social media, advertisements in local campuses and libraries. Students of Psychology Institute in University of Tartu were rewarded with research credit points.

Self-report measures

Eating Disorders Assessment Scale (EDAS) (Akkermann, Herik, Aluoja, & Järv, 2010). Assesses eating disorder symptoms characteristic to anorexia nervosa and bulimia nervosa. It is a 29-item self-report scale derived from the original 86-item scale with

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subscales Restrained eating, Binge eating, Purging and Preoccupation of appearance and bodyweight. The scale was designed to screen people with ED from the population sample and also discriminate patients with AN, BN, and BED. Binge Eating and Purging subscales and the total score of EDAS have been found to discriminate AN, BN, and BED patients from each other. The α coefficient for the EDAS total scale was .92 for women and .81 for men. The subscale's internal consistency for both men and women was good (Cronbach's $\alpha = .81 - .92$)

Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). The Estonian version of DERS (Vachtel, 2011) is a brief 34-item, self-report questionnaire designed to assess multiple aspects of emotion dysregulation. The measure yields six subscales: Non-acceptance of emotional responses, Difficulties engaging in goal directed behavior, Impulse control difficulties, Lack of emotional awareness, Limited access to emotion regulation strategies, Lack of emotional clarity. The alpha for the DERS total scale in among women was 0.89 (subscales $\alpha=.82 - .92$), among men DERS total scale $\alpha=.89$ (subscales $\alpha=.73 - .91$).

Positive and Negative affect Scale (PANAS-X; Watson, Clark, & Tellegen, 1988; Estonian version PONESK-X, Allik & Realo, 2000). The PANAS-X assesses the specific, distinguishable emotional states that emerge from within the broader general dimensions of positive and negative emotional experience. The α coefficient among women was .91 for positive emotions subscale and .90 for negative emotions subscale; among men positive emotions subscale alpha was .76 and negative emotions subscale $\alpha = .51$.

Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995) was designed to assess different aspects of impulsiveness: motor impulsiveness, attentional impulsiveness and non-planning impulsiveness. The Estonian version of Barratt Impulsiveness Scale is a 31-item scale measuring various components of trait impulsivity. In the current study, the total score was used. The *alpha* for the BIS-11 total score among women was 0.74, among men .78.

Ecological momentary assessment

As both emotional experience and eating behavior are vulnerable to retrospective memory biases ecological momentary assessment (EMA) was used in the current study. Anestis and colleagues (2010) posited that affective instability, whether measured by a retrospective self-report questionnaire or through EMA data collection, is highly predictive of pathological eating patterns. Still, they found that retrospectively self-reported levels of

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affective instability are not robust predictors of how often an individual will binge eat during a discrete period of time. EMA measures of affective instability, on the other hand, provide significant utility in predicting how often an individual will binge eat in a particular time period.

The experience-sampling experiment was programmed and conducted with palmtop computers (*Handspring Visor Neo*) using the freeware software iESP developed by Dr. Lisa Feldman Barrett and Daniel Barrett (<http://www.experience-sampling.org/esp/>). The palmtop computers signaled randomly 7 times per day (from 8:30 am to 23:05 pm) for a 3-day period. In order to minimize day of the week effects (Smyth et al., 2009) the study period was exclusively limited to Tuesday-Thursday. If participants did not respond to a signal within 2 minutes, the trial was recorded as missing. Participants were told to answer the questions based on their subjective feeling at that very moment without thinking too long. Participants were also informed about the type of questions with special emphasis on the questions regarding binge eating episodes. The binge eating episode was defined as an eating episode where participant consumed a relatively large amount of food within a brief period of time and in addition they were asked whether they experienced loss of control (LOC) while the binge eating episode. Participants were also explicitly instructed to ignore the signal if the answering is inconvenient or dangerous (e. g. while driving, showering).

At each occasion of measurement, participants were asked to indicate on a 4-point Likert-type scale (1 = *not at all* to 4 = *to a large extent*) the extent to which each of 16 emotion-related adjectives (see Appendix 1) described their current emotional state as quickly and accurately as possible by selecting appropriate answers on the screen of the palmtop computer. The EMA questionnaire was in the same order at each trial. In addition, participants were asked whether they drank alcohol more than they planned after the last signal and about the urge to restrain eating, also about their situational context (e. g. their whereabouts and companions), which were not included in the present paper since it was not the primary objective of the current paper.

There were 2633 (out of 3318 possible) measurement trials recorded across all participants constituting a response rate of 79.36 %. The number of measurement trials per participant varied from 7 to 21 trials, with an average of 16.66 measurement trials per participant. The response rate among female and male participants was 80.36% and 78.20% respectively.

Procedure

The study was approved by the Research Ethics Committee of the University of Tartu in 2013. Participants first completed a series of self-report questionnaires via Internet on the Institute of Psychology's online survey center. Participants then signed up and attended a meeting where they were given further information regarding the study. Participants completed an informed consent and they were given palmtop computers for the 3-day study period. At the meeting, participants were trained on the use of the palmtop computers. They were reminded of the goals of the study, what to expect during the data collection period, and how to deal with any questions that might arise from the signaling of the palmtop computer. By giving the palmtop computers the day before the assessment period participants had a chance to practice responding and get used to the procedure in order to minimize reactive answering. The author of the present thesis took part in the development of the study, conducted the pilot study, gathered the sample and conducted the study in question.

Data Analytic Strategy

Ecological momentary assessment data posits some analytical challenges that require special considerations. In EMA data there are large number of observations per subject as it is often referred to as "intensive longitudinal method". Second, EMA procedure is rather burdening to subjects resulting in missed data. According to meta-analysis by Haedt-Matt and Keel (2011) the average compliance rate of signal contingent methods was 84.1 %. Third, the data has a nested structure meaning that individual observations are nested within participants and participants are nested within groups (e.g. gender) and so on. Many conventional statistical methods do not take into account the hierarchical structure of the data. Thus, linear mixed models (also known as multilevel, MLM, or hierarchical linear models) are increasingly used for EMA data analysis. Linear mixed models include random subject effects accounting for the influence of subjects on their repeated observations. MLM also allows to model data with different observations per participant. Individuals who have more observations contribute more in the estimation of the Level 2 parameters (e.g. group mean) than do individuals who have fewer observations (Jahng, Wood, & Trull, 2008). The present data had a hierarchically nested structure, with affect ratings nested within persons thus multilevel approach is warranted.

First, to quantify the affective fluctuations into a single index the *mean squared successive differences* (MSSD) of positive and negative affect were calculated for every participant. In the current study, the 16 emotions were divided into positive and negative affect, which was used to compute the MSSD in question. The division into two dimensions

was verified by factor analyses. The factor analyses indicated that *anger* loaded significantly to both factors and was thus removed from the computation of NA MSSD. Thus NA MSSD was computed based on the following emotions: *boredom, sadness, shame, loneliness, guilt, irritation, tedium, anxiousness, disappointment* and *fatigue*. PA factor included following five emotions: *excitement, joy, satisfaction, confidence, motivation*. The MSSD measures the average change of a variable from one momentary assessment to the next, resulting in a measure of affective reactivity and frequency of affective fluctuations. In addition to temporal dependency the MSSD also reflects *amplitude* and *frequency* (Ebner-Priemer et al., 2009; Jahng, Wood, & Trull, 2008). The MSSD has been used as an emotional instability measure in various studies investigating affective disorders, impulsive behavior and borderline personality disorder (Ebner-Priemer et al., 2007; Ebner-Priemer et al., 2015; Trull et al., 2008). Trull and colleagues (2000) acknowledged MSSD as a valid measure of emotional instability implemented in a sample of borderline personality disorder.

The MSSD was calculated using the following formula, where x stands for the variable of interest, n the total number of observations and i the individual observation.

$$MSSD = \frac{\sum_{i=1}^{n-1} (x_{i+1} - x_i)^2}{n - 1}$$

We used multilevel modeling to examine what predicts binge eating. In the multilevel modeling each square successive difference (SSD) is the lower level (Level 1) random variable and an individual MSSD is the upper level (Level 2) random realization. MLM takes the different number of observations at Level 1 into account in estimation of the Level 2 parameters. We used the SSD – which uses the same formula as the MSSD without averaging out – in multilevel modeling in order to take into account the within-individual variability. The first observations about the occurrence of binge eating of each day were omitted in order to make it more compatible with the computed SSD's. Thus the second observation of the day regarding the occurrence of binge eating was paired with *squared successive difference* (SSD) computed from the first two emotional state assessments. The rationale of this strategy is to assess whether the occurrence of binge eating with loss of control is associated with the concurrent emotional fluctuations (SSD's). Since the dependant variable is binary outcome (0 – no binge eating, 1 – binge eating occurred), R procedure *glmer* from package *lme4* was used for generalized linear mixed modelling (GLMM). Independent variables were self-report measures and the affective fluctuations. GLMM was conducted using R; correlative analyses, group comparisons and linear regressions were conducted using SPSS 20.0.

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Separate analysis for men and women were done in order to investigate the potential sex differences.

RESULTS

During the three-day study period 84 participants (53.16%) experienced binge eating. A total of 162 binge eating episodes were reported during the study period ($M = 2.35$ binges per person; maximum 9 binge eating episodes). Among women 56 (57.14%) women reported altogether 134 binge eating episodes of which 38 (28.36%) *with* loss of control and 96 (71.64%) *without* loss of control. Among male participants 28 (38.9%) reported a total of 72 binge eating episodes of which 26 (34.21 %) were reported as with loss of control and 46 (65.79%) *without* loss of control.

Binge eating and self-report measures

In order to investigate the associations between self-report measures and the number of binge eating episodes reported via EMA, Pearson's correlative analysis was conducted. The results for correlative analysis for women and men are presented in Table 1 and Table 2 respectively. Binge eating with LOC correlated statistically significantly with EDAS total score and its subscales (except Purging) and DERS total score and subscales Difficulties engaging in goal directed behavior and Limited access to emotion regulation strategies, as well as with PANAS-X negative affect. In contrast binge eating episodes *without* LOC did not correlate with EDAS and DERS total scores, however statistically significant negative correlation with DERS subscale Lack of emotional awareness were presented.

As seen on Table 2, among men both number of binge eating episodes and number of binge eating episodes with LOC correlated significantly positively with all of the EDAS subscales. The number of binge eating episodes also correlated positively with DERS subscale Impulse control difficulties and BIS11. Binge eating with loss of control also correlated significantly with all of the EDAS subscales as well as with DERS total score and subscales Impulse control difficulties and Non-acceptance of emotional responses. Significant positive correlation was also present between binge eating with loss of control and BIS11. Number of binge eating episodes without loss of control correlated positively with EDAS total score, subscale Restrained eating and Preoccupation of appearance and bodyweight as well as DERS subscale Impulse control difficulties.

Table 1. Correlations between the number of binge eating episodes reported on EMA and self-report measures among women

	Binge eating episodes	Binge eating episodes with loss of control	Binge eating episodes without loss of control
EDAS subscales			
EDAS total score	.39**	.43**	-.03
Restrained eating	.21*	.30*	-.23
Binge eating	.36**	.29**	.35
Purging	.11	-.16	-.16
Preoccupation of appearance and bodyweight	.30**	.38**	-.14
DERS subscales			
DERS total score	.29**	.29**	-.01
Difficulties engaging in goal directed behavior	.33**	.25*	.26
Lack of emotional clarity	.21*	.15	-.06
Impulse control difficulties	.09	.14	-.15
Non-acceptance of emotional responses	.08	.06	.07
Lack of emotional awareness	-.10	-.16	-.37*
Limited access to emotion regulation strategies	.23*	.26*	-.20
BIS11			
PANAS-X positive emotions	.16	.12	-.02
PANAS-X negative emotions	-.13	-.07	-.08
PANAS-X negative emotions	.22*	.12	.17

* - $p < .05$; ** - $p < .01$. N = 97

The differences in aforementioned self-report measures between participants without binge eating episodes, participants with binge eating episodes *without* LOC and participants with binge eating episodes *with* LOC are presented in Appendix 2 Table 1. When comparing women who did not report binge eating episodes, women with binge eating *with* LOC and women with binge eating *without* LOC, significant differences appeared in EDAS total score [$F(2, 94) = 5.22, p = .0001$] and subscales Binge eating [$F(2, 94) = 5.56, p = .008$] and Preoccupation with appearance and bodyweight eating [$F(2, 94) = 4.07, p = .001$]. *Post hoc* test indicated that the significant differences appeared between women with binge eating *with* LOC and women who did not binge eat. Among women there were also significant differences in DERS total score [$F(2, 94) = 5.54, p = .001$] and its subscales Difficulties in goal directed behavior [$F(2, 94) = 2.79, p = .004$], Lack of emotional clarity [$F(2, 94) = 3.85, p = .007$] and Limited access to emotion regulation strategies [$F(2, 94) = 2.93, p = .007$]. *Post hoc* test revealed that in DERS total score and subscale Difficulties engaging in goal directed behavior statistical differences appeared across all three groups. Among men, similar associations appeared. Goup differences are presented in Appendix 2 Table 2. There was a significant difference in EDAS total score [$F(2, 52) = 12.19, p = .0001$] and its subscales Restrained eating [$F(2, 52) = 6.52, p = .003$], Binge eating [$F(2, 52) = 4.46, p = .017$], Purging [$F(2, 52) = 5.37, p = .008$] and Preoccupation of appearance and bodyweight [$F(2,$

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52) = 7.30, $p = .002$]. Similarly to women, differences appeared between men without binge eating and with binge eating *with* LOC. In contrast to women differences in emotion regulation differences appeared only in DERS subscale Impulse control difficulties [$F(2, 58) = .59, p = .001$] and the differences relied between women without binge eating and women with binge eating *with* LOC. Also, group differences appeared In the BIS11 [$F(2, 59) = 1.87, p = .001$)], where the difference appeared once again between women without binge eating and women with binge eating *with* LOC.

Table 2. Correlations between the number of binge eating episodes reported on EMA and self-report measures among men

	Binge eating episodes	Binge eating episodes with loss of control	Binge eating episodes without loss of control
EDAS subscales			
EDAS score	.55**	.53**	.37**
Restrained eating	.41**	.40**	.28*
Binge eating	.42**	.44**	.25
Purging	.28*	.49**	.03
Preoccupation of appearance and bodyweight	.43**	.34**	.36*
DERS subscales			
DERS score	.20	.31*	.04
Difficulties engaging in goal directed behavior	.19	.22	.02
Lack of emotional clarity	.11	.21	.00
Impulse control difficulties	.43**	.40**	.27*
Non-acceptance of emotional responses	.26	.37**	.07
Lack of emotional awareness	-.14	-.07	-.12
Limited access to emotion regulation strategies	.08	.25	-.06
BIS11	.27*	.41**	-.02
PANAS-X positive emotions	-.12	-.18	-.06
PANAS-X negative emotions	.08	.10	.02

N=61; * - $p < .05$; ** - $p < .01$; N=61

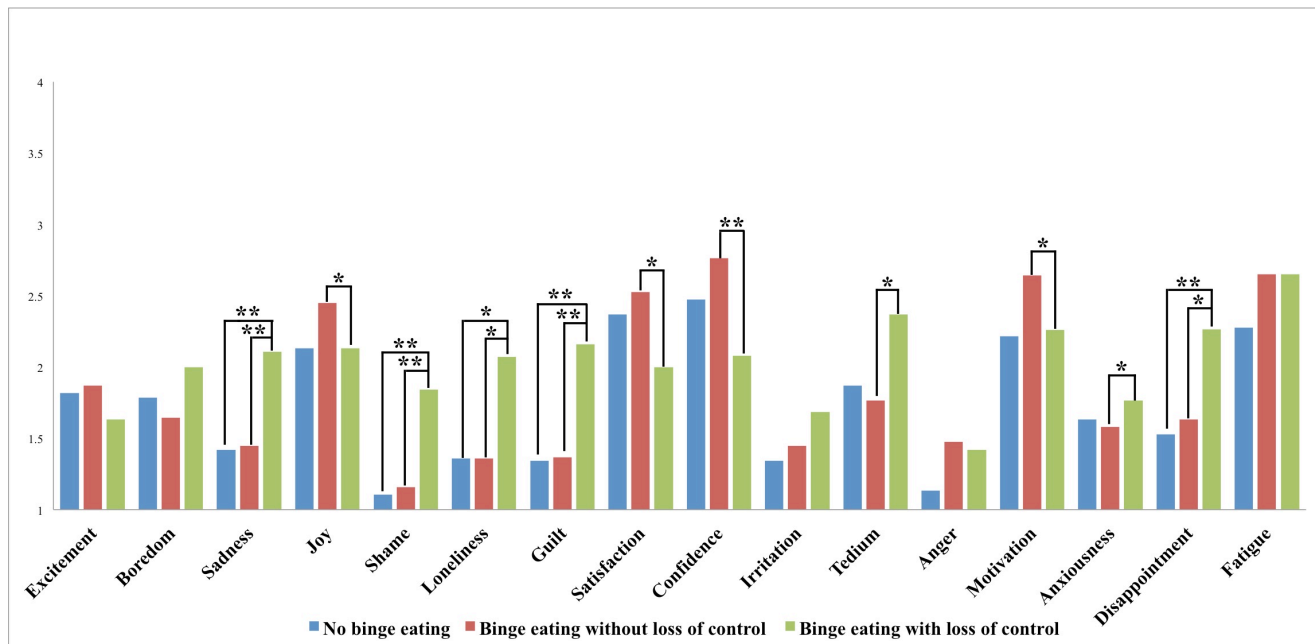
Emotional experience via EMA

The rates of self-reported emotional experience within different occasions were compared in order to assess the overall tendencies in emotional experience. The EMA observations were grouped based on the occurrence of binge eating: no-binge eating; binge eating with loss of control and binge eating without loss of control. Since there were disproportionally less binge eating episodes with loss of control compared to observations without binge eating, the groups were equated with each other. This means that a random selection of observations was made from the larger groups to match the number of binge eating episodes with loss of control. A non-parametric Mann-Whitney U test was used for the

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pair-wise between-group comparisons. The graphs for the mean levels of emotions for women and men are presented in Graph 1 and Graph 2 respectively.

Among women, no significant differences between no-binge occasion and binge occasions *without* LOC was reported. Whereas comparing binge occasions *without* LOC with binge occasions *with* LOC, significant differences appeared in following emotions: (U = 1573, Z = -2.42, p = 0.016), sadness (U = 1621, Z = -2.38, p = .017), joy (U = 1467, Z = -2.92, p = .004), shame (U = 1547, Z = -3.03, p = .001), guilt (U = 1442, Z = -3.65, p = .0001), satisfaction (U = 1392, Z = -3.29, p = .001), confidence (U = 1386, Z = -3.33, p = .001), anxiousness (U = 1688, Z = -1.97, p = .049), disappointment (U = 1567, Z = -2.72, p = .007), loneliness (U = 58.50, Z = -2.00, p = .045), tedium (U = 538, Z = -2.025, p = .043) and motivation (U = 55.50, Z = -2.15, p = .031). Comparing no-binge occasions with binge occasions *with* LOC was reported, statistically significant differences appeared in following emotions: sadness (U = .478, Z = -2.82, p = .005), shame (U = 462, Z = -3.56, p = .0001), guilt (U = 447.50, Z = -3.28, p = .001), loneliness (U = 91, Z = -2.50, p = .012) and disappointment (U = 465, Z = -2.90, p = .004). The directions of the differences are depicted in the Graph 1.



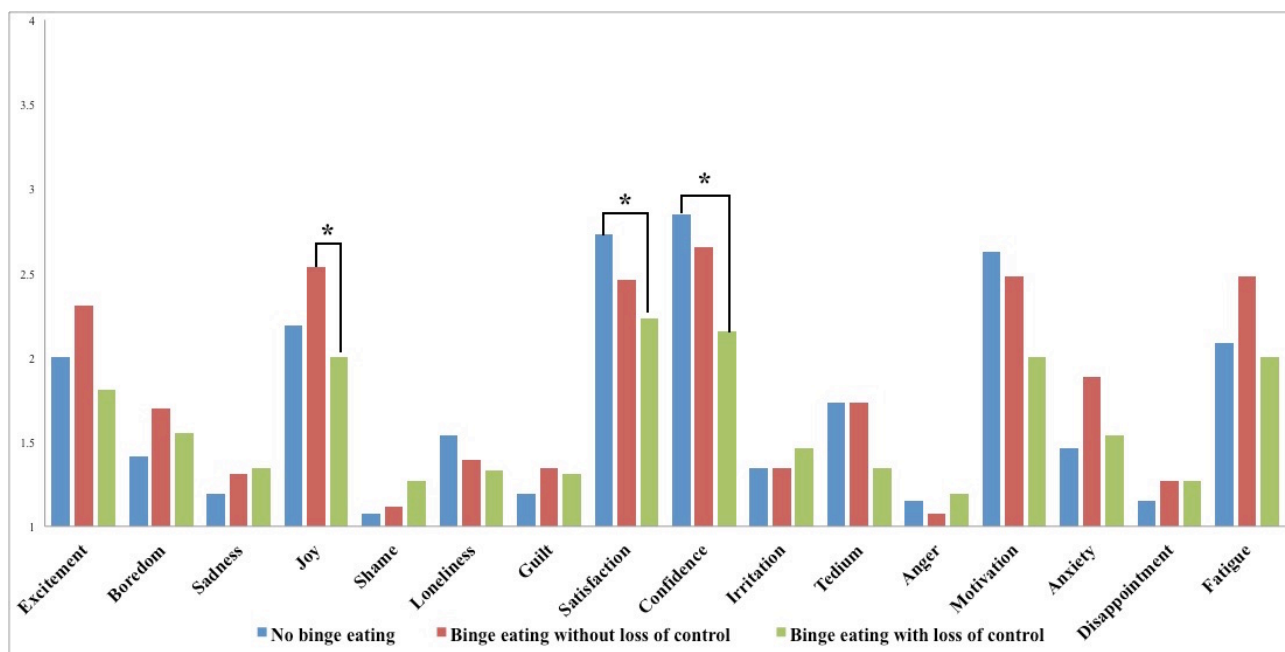
Graph 1. Mean emotion levels among women measured via EMA

* - p < .05 ; ** - p < .01

Among men there were no statistically significant differences in emotion levels between no-binge occasions and occasions when binge eating without LOC was reported. Comparing occasions without and with LOC, significant differences appeared in joy (U =

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225, $Z = 2.21$, $p = .027$). Occasions when binge eating with LOC was reported and no-binge occasions differed significantly in satisfaction ($U = 237$, $Z = -2.00$, $p = .045$) and confidence ($U = 204$, $Z = 2.57$, $p = .010$). The overall tendencies are shown in Graph 2.



Graph 2. Mean emotion levels among men measured via EMA

* - $p < .05$; ** - $p < .01$.

Multilevel modelling

Multilevel modelling was conducted to investigate whether emotional fluctuations (SSD's) predicted the occurrence of binge eating *with* LOC and *without* LOC, thus the separate models for predicting binge eating with LOC and binge eating without LOC were tested out. We also added self-report measures (EDAS; DERS; BIS11; PANAS-X) and their subscales as covariates and tested for possible interactions.

The dependant variable was the occurrence of binge eating *with* LOC (binary variable, coded 1 – binge eating *with* LOC present; 0 – no binge eating *with* LOC) and independent variable NA_SSD. Several models were constructed in order to find the best-fitting model and to assess the impact of different covariates (self-report measures) and their interactions on the outcome measure. The AIC information criteria was taken into account in the selection of the best-fitting model. R function *anova* was also used to compare different models.

Table 3. GLMM interaction of Negative Affect fluctuation and DERS total score on the occurrence of binge eating episode with loss of control among women.

Parameter	Estimate	SE	Wald Z	<i>p</i>
(Intercept)	-8.30	.002	-4903	.0001 ***
NA_SSD	-1.82	.002	-1078	.0001 ***
DERS total score	.02	.002	15	.0001 ***
EDAS Restrained eating	.09	.002	56	.0001 ***
NA_SSD x DERS total score	.03	.001	20	.0001 ***

Note. $N = 97$; * $p < .05$; ** $p < .01$; *** $p < .000$. Dependant variable: binge eating with LOC. NA_SSD – negative affect fluctuations

First, the null-model was conducted to assess whether there was significant variability between women regarding the outcome measure (occurrence of binge eating with loss of control). The null-model suggested that the intercepts vary significantly across participants (Wald $Z = -7.17$, $p = .000$) thus the development of a multilevel is warranted. Second, NA_SSD was added to the model as a fixed effect, which resulted as a non-significant model, meaning that NA_SSD alone does not predict the occurrence of binge eating episode *with* LOC. Third, covariates were added as fixed effects in order to assess their impact on the outcome measure as well as their interaction with NA_SSD. The procedures resulted in a model, where occurrence of binge eating *with* LOC was significantly predicted by NA_SSD, DERS total score, EDAS subscale Restrained eating and the interaction of NA_SSD and DERS total score, meaning that the higher fluctuations in negative affect and DERS total score, the higher the likelihood of the occurrence of binge eating *with* LOC. The model parameters are presented in Table 3. Note, that when paired with DERS total score, the NA_SSD effect became a significant predictor of the outcome measure.

The null-model for men also suggested that intercepts vary significantly across participants (Wald $Z = -4.38$, $p = .000$). The model summary is presented in Table 4. As with women NA_SSD alone did not predict the occurrence of binge eating episodes but became significant as covariates and interactions were added. Covariates were added as described above. The final model indicates that among men, binge eating *with* LOC is predicted by NA_SSD, BIS11, EDAS subscale Binge eating and the interaction between NA_SSD and EDAS Binge eating. Interaction effect of NA_SSD and DERS was not a significant predictor of binge eating *with* LOC. Although the interaction of EDAS subscale

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Binge eating and NA_SSD itself was not significant, the incorporation of the interaction resulted in an increased significance of other variables and improved the overall model fit.

Table 3. GLMM interaction of Negative Affect fluctuation and EDAS Binge Eating on the occurrence of binge eating episode with loss of control among men.

Parameter	Estimate	SE	Wald Z	<i>p</i>
(Intercept)	-10.07	2.18	-4.62	.0001 ^{***}
NA_SSD	5.35	2.31	2.32	.021 [*]
BIS11	.05	.02	2.17	.030 [*]
EDAS Binge eating	.12	.05	2.67	.008 ^{**}
NA_SSD x EDAS Binge eating	-.39	.22	-1.80	.072

Note. *N* = 61; ^{*}*p* < .05; ^{**}*p* < .01; ^{***}*p* < .000. Dependant variable: binge eating with LOC. NA_SSD – negative affect fluctuations

Note that in the current model, contrary to women, NA_SSD is positively associated with binge eating *with* LOC. Among both women and men, fluctuations in PA did not significantly predict binge eating episodes *with* LOC. The occurrence of binge eating *without* LOC were also modeled in the same manner but did not result in a model that significantly predicted the outcome variable in question.

Table 4. Facets of everyday emotional experiences among women

Variable	Group			ANOVA	
	No BE (n=21)	BE without LoC (n=36)	BE with LoC (n=40)	F (df)	<i>p</i>
Mean Affect	M (SD)	M (SD)	M (SD)	F (df)	<i>p</i>
NA	1.46 (.26) ^a	1.55 (.33)	1.78 (.47) ^c	6.06 (95)	.003
PA	2.40 (.35) ^a	2.32 (.36)	2.16 (.46) ^c	3.13 (95)	.048
Emotional fluctuations (MSSD)					
NA	.15 (.24) ^a	.18 (.17) ^a	.36 (.45) ^{b c}	4.98 (95)	.009
PA	.32 (.21)	.40 (.26)	.47 (.29)	2.98 (95)	.056

Note. No BE = participants with no binge eating; BE without LOC = participants with binge eating without loss of control; BE with LOC = participants with binge eating with loss of control; NA = negative affect; PA = positive affect; MSSD = mean square successive difference. ^a differs statistically significantly (*p*<.05) from participants with binge eating with loss of control; ^b differs statistically significantly (*p*<.05) from participants with binge eating without loss of control; ^c differs statistically significantly (*p*<.05) from participants without binge eating.

In order to examine whether participants with different eating behavior vary in their emotional experience, groups were formed based on the occurrence of binge eating episode, also differentiating participants based on binge episodes with and without loss of control. The

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differences in NA and PA fluctuations were examined by analysis of variance (ANOVA) with group as the between-subjects variable and valence (positive, negative) as the within-subject variable. ANOVA was conducted on NA values transformed using the log transformation to base 10 to correct for skewness and kurtosis. The group means and ANOVA results among women are presented in Table 4. Among women groups significantly differed on mean levels of NA, $F(2, 95) = 6.06, p = .003$, and PA, $F(2, 95) = 3.13, p = .048$, as well as NA fluctuations, $F(2, 95) = 4.98, p = .009$. *Post hoc* tests indicated significant differences between women without binge eating and women with binge eating *with* LOC on mean affect levels. On measure NA MSSD, women with binge eating *with* LOC differed significantly with other two groups. To rule out the possibility that the group difference in fluctuations of NA was driven by higher mean levels of NA, and as recommended by Russell, Moskowitz, Zuroff, Sookman, and Paris (2007), ANOVA was conducted on fluctuations of NA, including mean level of NA as a covariate. Both the main effect of group, $F(1, 95) = 4.98, p = .003$ and the covariate mean level of NA, $F(1, 95) = 6.22, p = .014$, were significant, indicating that group differences in NA fluctuations remained even after controlling for mean levels of NA.

Table 5. Facets of everyday emotional experiences among men

Variable	Group			ANOVA	
	No BE (n=21)	BE without LoC (n=36)	BE with LoC (n=40)	F (df)	<i>p</i>
Mean Affect	M (SD)	M (SD)	M (SD)		
NA	1.40 (.25) ^b	1.58 (.28) ^c	1.39 (.19)	3.19 (60)	.049
PA	2.19 (.43) ^b	2.60 (.37) ^c	2.36 (.39)	5.10 (60)	.009
Emotional fluctuations (MSSD)					
NA	.11 (.13)	.13 (.08)	.12 (.10)	.28 (60)	.758
PA	.40 (.26)	.45 (.35)	.45 (.29)	.19 (60)	.825

Note. No BE = participants with no binge eating; BE without LOC = participants with binge eating without loss of control; BE with LOC = participants with binge eating with loss of control; NA = negative affect; PA = positive affect; MSSD = mean square successive difference. ^b differs statistically significantly ($p < .05$) from participants with binge eating without loss of control; ^c differs statistically significantly ($p < .05$) from participants without binge eating.

Among men, ANOVA indicated significant differences between groups in mean levels of negative affect, $F(2, 60) = 3.19, p = .049$, and positive affect, $F(2, 60) = 5.10, p = .009$. *Post hoc* tests revealed that on both measures men without binge eating differed from participants with binge eating *without* LOC. No group differences occurred in positive emotion fluctuations.

DISCUSSION

Binge eating has been found to be common in both clinical and non-clinical population (Greeno, Wing, & Shiffman, 2000; Lynch et al., 2000). Binge eating is associated with emotion regulation difficulties (Evers et al., 2009) and it is speculated that it might serve as a means to regulate emotions (Abraham & Beaumont, 1982; Kelly et al., 2012; Mitchell et al., 1999; Aldao et al., 2010; Haedt-Matt & Keel, 2011; Herman & Polivy, 1993). The purpose of the current thesis was to examine the relationship between binge eating and emotion regulation difficulties combined with emotional fluctuations measured via EMA. The aspect of loss of control was also of interest, as well as the differences between men and women.

First, it was hypothesized that binge eating is associated with emotion regulation difficulties. The results of correlational analyses and group comparisons supported the hypothesis. Among women, the number of binge eating episodes was significantly associated with DERS total score, as well as subscales Difficulties engaging in goal directed behavior, Lack of emotional clarity and Limited access to emotion regulation strategies. Group comparisons also revealed that those women who experienced binge eating episodes with loss of control had significantly higher emotion regulation difficulties. These results are in concordance with previous studies about the associations of binge eating and emotion regulation difficulties (Evers et al., 2009; Harrison et al., 2010; Macht, 2008; Svaldi et al., 2012; Whiteside et al., 2007). Svaldi and colleagues (2012) found that eating disorders are associated with non-acceptance of emotional responses, lack of emotional clarity and limited access to emotion regulation strategies. Vine and Aldao (2014) discussed that the lack of emotional clarity may be associated with binge eating because not identifying one's feelings clearly might restrict the access to useful information about possible actions for coping. Moreover, Lack of emotional clarity may thus be a cornerstone of emotion dysregulation, because acknowledging one's emotions seems to be the prerequisite of emotion regulation. The association of binge eating and DERS subscale of Limited access to emotion regulation strategies is also an expected result as it is intuitively linked to the emotion regulation theory. This suggests that binge eaters are lacking of adaptive emotion regulation strategies and maladaptive behavior (i.e. binge eating) might be used as an attempt to regulate emotions. Difficulties in goal directed behavior may manifest in the lack of self-control among binge eaters due to the shift from long-term goals onto immediate ones.

Another aim of this study was to investigate the interaction effect of emotional fluctuations and emotion regulation in predicting binge eating with loss of control. Among

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women, multilevel modelling indicated that binge eating with loss of control was predicted by fluctuations in negative emotions, emotion regulation difficulties, restrained eating and the interaction between negative emotion fluctuations and emotion regulation difficulties. This finding is in concordance with previous findings noting the association of binge eating and emotion regulation difficulties discussed previously. The effects of the interaction between emotion regulation difficulties and emotional fluctuations on binge eating have not yet been directly addressed in previous studies. Still, the connection is intuitively anticipated since, by definition, emotion regulation difficulties indicate disturbances in coping with emotions. As emotional fluctuations represent rapid changes in emotions, people who have difficulties in emotion regulation in a dispositional level, are more likely vulnerable to emotional reactions therefore leading them to implement maladaptive strategies such as eating. These results corroborate with previous studies. For instance, Anestis and colleagues (2009) found among bulimic patients that negative emotion fluctuations predicted binge eating. Yu and Selby (2013) found in an EMA study that the interaction of emotional fluctuations and interpersonal problems predicted binge eating episodes. The influence of restrained eating has also been suggested in the previous literature. Herman's and Polivy's (1993) restraint theory proposed that restrained eaters apply cognitive control in order to limit their food intake. Constant controlling requires cognitive resources making them more vulnerable to external distractors interfering with the control. In concordance, among restrained eaters emotion regulation and impulse control difficulties due to emotional distress have been found (Polivy & Herman, 1993; Evers et al., 2009). This suggests that emotional fluctuations disrupt cognitive control that is required for restraining and the difficulties in emotion regulation make them even more vulnerable to external factors. Thus, the experience of emotional fluctuations may set off a binge eating episode due to the lack of cognitive resources and adequate emotion regulation strategies.

A similar trend in the associations in emotion regulation difficulties and binge eating with loss of control appeared among men, although among men other aspects of emotion regulation difficulties dominated, such as impulse control difficulties and non-acceptance of emotional responses. Similarly to women, binge eating without loss of control was in general not associated with emotion regulation difficulties, except for its subscale Impulse control difficulties. The positive correlation with Barratt's Impulsiveness Scale also indicated a link between impulsivity and binge eating among men. Men who experienced binge eating with loss of control had significantly greater scores on the aforementioned aspects of impulsivity in comparison to men without binge eating episodes. Also, in multilevel modeling, binge

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eating was predicted by negative emotion fluctuations, impulsivity, EDAS subscale Binge eating as well as the interaction between NA fluctuations and EDAS Binge eating subscale. Men with high EDAS Binge eating score are more likely to experience binge eating *with* loss of control when negative emotion fluctuation is low. In contrast, men with higher negative emotion fluctuations experience binge eating with loss of control with rather low EDAS Binge eating scores. It appears as among men, binge eating is not so much associated with emotion dysregulation *per se*, but with impulsivity or a tendency to act rashly. The DERS subscale Impulse control difficulties assesses individual's tendency to react impulsively to distress referring to negative urgency (Anestis, Selby & Joiner, 2007). This still fits into the emotion regulation theory, particularly the escape theory by Heatherton and Baumeister (1991), which indicates that the reduction of self-awareness is thought to remove inhibitions and disable individuals' ability to consider the long-term implications of their behavior and thus facilitating impulsive behavior such as binge eating. These results corroborate with previous findings that negative urgency predicts binge eating (Racine et al., 2013) and is also associated with poor distress tolerance and may thus contribute to binge eating (Kelly, Cotter, & Mazzeo, 2014). Since impulsivity is a broad term, different aspects – such as negative urgency – need to be dissected in order to make valid implications about the motives underlying eating behavior. Barratt's Impulsiveness Scale provides a general impulsivity level, although it includes items on different dimensions. Thus, it may well be that binge eating among men is also driven by sensation seeking, lack of planning or lack of perseverance. A meta-analysis found that among impulsive traits, negative urgency had the largest effect size in its relationship to bulimic symptoms, although the other aspects were also related to bulimic behavior (Fischer, Smith, & Cyders, 2008). Also, the DERS subscale Impulse control difficulties implies an association with emotion dysregulation.

We were also particularly interested in the differences between binge eating *with* and *without* loss of control in association to emotion regulation difficulties, disturbed eating, impulsivity and emotional experience. As expected, binge eating *with* loss of control was significantly associated with EDAS total score as it is an indicator of disturbed eating. Furthermore, there appeared no such associations with binge eating *without* loss of control among women, nor did the latter associate with emotion regulation difficulties. Moreover, binge eating episodes *without* loss of control were negatively associated with lack of emotional awareness, meaning that the more binge eating episodes without loss of control the higher the emotional awareness. This supports the previous notion that the occurrence of loss of control during eating is a determinative psychopathological marker (Jenkins et al., 2012).

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One might argue whether we can make inferences based on study participants' subjective assessment especially since it is found that people are not accurate in assessing portion sizes (Almiron-Roig, Solis-Trapala, Dodd, & Jebb, 2013). Still, it has been found that the aspect of loss of control during a binge is even more significant psychopathological indices (Latner et al., 2007) as it describes the subjective distress level, which is an important determinant of mental disorders. Moreover, Brownstone and colleagues (2013) have found that subjective and objective binges do not differ significantly in the pathologic sense (i.e. eating disturbance measures). The common thread in both subjective and objective binges is therefore the occurrence of loss of control implying that it is a reliable diagnostic feature.

Another important difference between binge eating with and without loss of control is the subsequently assessed emotional ratings. One of the aims of the current study was to investigate the (potential) differential impact of binge eating *with* and *without* loss of control on emotional experiences. Among women, between occasions when no binge eating was reported and occasions where binge eating episode *without* loss of control was reported no significant differences were reported on their mean levels of emotions levels. Conversely, significant differences appeared on occasions where binge eating *with* loss of control was reported. Moreover, it appeared that negative emotions such as sadness, shame, loneliness, guilt, tedium, anxiousness and disappointment were significantly higher when a preceding binge eating episode with loss of control was reported. These results are in concordance with previous studies, where negative emotions were reported after binge eating (Hilbert & Tuschen-Caffier, 2007; Stein et al., 2007). On the other hand, these results indicate that binge eating does not serve the (perhaps desired) purpose of emotion regulation. An interesting trend is that several positive emotions are higher in the occasion where binge eating *without* loss of control was reported in comparison to no-binge and binge eating episodes *with* loss of control. For instance, joy, satisfaction, confidence and motivation are the highest in the binge eating *without* loss of control, even higher than in the absence of prior binge eating. The same trend is seen among men, although to a smaller degree. This indicates that differences between binge eating without loss of control and binge eating with loss of control are not only different in the way that loss of control is more distressing, but also that binge eating *without* loss of control may be associated with subsequent positive emotions. This suggests that – along with the current finding that binge eating *without* loss of control is not associated with emotion regulation difficulties – binge eating *without* loss of control might be associated with hedonic motives. These results again confirm the role of loss of control as an important pathological indicator and the importance of distinguishing binge eating with and without

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loss of control in research when making implications as well as for intervention. It may be, that when one is able to abstain from losing control over eating, he or she is able to enjoy the eating process resulting in positive emotions. Whether a person is prone to losing control over eating might be determined by individual factors such as emotion regulation difficulties. For instance, the association of binge eating episodes *without* loss of control with emotional awareness indicates that understanding one's emotions may be the key factor in determining the emotional reactions to eating. In order to find the determinants and interactions underlying binge eating, in-depth studies are needed.

The finding that a similar pattern of mean emotion levels was not found among men indicates gender differences in emotional experiences in relation to eating behavior. Moreover the levels of negative emotions were in general lower than among women. There were significant differences in joy, satisfaction and confidence. On the occasions when binge eating was not reported satisfaction and confidence were significantly higher than on occasions with binge eating *with* loss of control. The mean level of joy was significantly higher on the occasions when binge eating *without* loss of control was reported compared to binge eating *with* loss of control. This again implies that binge eating *without* loss of control may even serve as a mood enhancer. The different patterns of emotions between men and women, may suggest that men and women react differently to eating, particularly overeating. It seems as women are in general more sensitive to the effects of binge eating. This may be because, in general, women are more preoccupied with bodyweight (Polivy & Herman, 1985) due to higher societal pressure for thinness. Higher preoccupation with bodyweight and appearance among female binge eaters are also supported in the present study. The expectation to look in a particular way puts women under daily pressure and causes distress in general. Binge eating may therefore represent a potential threat to their appearance thus leading to negative emotions. Also, the greater pressure on women often leads to restrictive eating, which in turn may predispose them to binge eating due to diminished cognitive resources that are necessary for self-control (Muraven, & Baumeister, 2000). When restricting, even a small deviation from diet is seen as a failure resulting in feelings of guilt, shame and disappointment. Whereas men are less likely to restrain their eating and do not see such threat in food.

Limitations and future directions

The current paper has its limitations. First, our study period was only three days long, so the amount of data collected from one individual is definitely not extensive enough for

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making comprehensive inferences on individual's eating behavior and its interaction with emotions. Also, for all participants, the study period was exclusively Tuesday to Thursday, as it has been found that people are more likely to binge/purge at the end of the week (Smyth et al., 2009). This study period was chosen since the purpose was to investigate eating behavior in a more neutral day-to-day life. Ideally the study period would consist of at least 7 days to obtain more data in order to assess individual affective trajectories and their relation to eating behavior. Nevertheless, the 168 participants reported a total of 162 binge eating episodes during the three-day study period making it still possible to assess the trends in general in the sample. Future studies should assess a longer time period in order to assess within-person tendencies more profoundly.

Second, regarding the eating behavior, we do not know exactly when the binge eating episode occurred. We asked whether participant experienced a binge eating episode after the last signal, so we can only presume that the emotional ratings at that point are “after” a binge eating episode. As the time intervals between signals varied between minutes and hours due to randomization, we do not actually know whether we assessed emotions minutes or hours after a binge. Literature suggests that emotion trajectories preceding and following a binge are not linear and— in fact — are different for various emotions. Therefore it is not possible to make implications on the “after” emotions. Still, it was possible to assess the overall tendencies in emotional experiences associated with binge eating.

Third, although the sample of the current study is conducted in general population, it is still considerably biased towards younger age. Also, the lion's share of the participants were students. Although it is a common issue among research, there might be significant differences between different age groups that we might not be entirely aware of. In order to be able to make valid conclusions about human binge eating behavior in general on such samples it is necessary to first investigate the potential differences between different age and social groups in a representative sample.

Fourth, although ecological momentary assessment (EMA) was used, there is room for improvement in that area. We used a palmtop computer, which was rather large at this technological era making it possibly uncomfortable to carry around. In the future, advantage should be taken of progressive technological opportunities in order to make the assessment more “ecologic”. One perspective direction is to use smartphone applications, which are widely used nowadays making it more convenient for participants to take part in studies since it interferes less with their daily life. Still, smartphones are more commonly used among younger individuals thus making the age problem salient once again. Another issue regarding

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the ecological momentary assessment is the possibility of reactivity as participants may – unconsciously or consciously – adjust their eating behavior due to the frequent assessments. Unfortunately, this cannot entirely be avoided, as with any other self-report measures. Nevertheless, there has not been found significant reactivity in studies implementing EMA (Stein & Corte, 2003) indicating the reliability of the method.

Fifth, the division of emotions into two factors when assessing emotional fluctuations may be too simplistic. The group comparisons in emotional experience pointed out potential differences in various emotions in association to binge eating. It is also supported by previous findings that there are varied emotion trajectories in different emotions indicating that the emotional experience is more complex. Therefore, the emotional fluctuations should be assessed separately for each emotion in order to determine the key emotions in binge eating.

Summary and conclusions

The current thesis investigated the relations between emotion fluctuations and emotion regulation difficulties in predicting binge eating episodes. The differentiation of binge eating with and without loss of control was also of interest. In addition, since the literature on eating behavior among men is scarce, the current thesis investigated the tendencies in the eating behavior among men, and thus provided some insight on the question. The results indicate that binge eating with and without loss of control indeed have differential impact on psychopathological indicators as well as on emotional experience. This points out the need to explicitly address the occurrence of loss of control when assessing eating pathology. Results also show that negative emotion fluctuations and emotion regulation difficulties are also associated with binge eating supporting the notion that emotional experience is an important factor in eating behavior. There are also some differences among men and women in the predictors of binge eating with and without loss of control implying that there may be different factors influencing binge eating among men and women. An important contribution of the current study is that it assessed eating behavior among both men and women. Further in-depth studies with representative sample are needed in order to make solid conclusions on the differences among the eating behavior among both gender.

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Appendix 1

EMA questionnaire

Please indicate how you feel right now, at this very moment.

1. Where are you at the moment? At home / at school / at work / at the street / visiting / other
2. Whom are you with? Alone / with a friend / with family / with schoolmates / with colleagues
3. *Do you feel excited?* Not at all / a little / moderately / to a large extent
4. *Do you feel bored?* Not at all / a little / moderately / to a large extent
5. Do you feel sad? Not at all / a little / moderately / to a large extent
6. Do you feel joyful? Not at all / a little / moderately / to a large extent
7. Do you feel shame? Not at all / a little / moderately / to a large extent
8. Do you feel lonely? Not at all / a little / moderately / to a large extent
9. Do you feel guilty? Not at all / a little / moderately / to a large extent
10. Do you feel satisfied? Not at all / a little / moderately / to a large extent
11. Do you feel confident? Not at all / a little / moderately / to a large extent
12. Do you feel irritated? Not at all / a little / moderately / to a large extent
13. Do you feel fed up (tedium)? Not at all / a little / moderately / to a large extent
14. Do you feel angry? Not at all / a little / moderately / to a large extent
15. Do you feel motivated? Not at all / a little / moderately / to a large extent
16. Do you feel anxious/tense? Not at all / a little / moderately / to a large extent
17. Do you feel disappointed? Not at all / a little / moderately / to a large extent
18. Do you feel tired? Not at all / a little / moderately / to a large extent
19. Have you had a binge eating episode after the last signal? Yes / No
If Yes – During that episode did you experience a loss of control over eating?
20. Have you consumed alcohol more than you planned after the last signal? Yes / No
21. How strong is your urge to eat at the moment? No urge / a little / to a large extent
22. How strong is your urge to restrain your eating at the moment? No urge / a little / to a large extent
23. How strong is your urge to consume alcohol at the moment? No urge / a little / to a large extent

Appendix 2

Table 1. Differences in EDAS, DERS, BIS11 and PANAS-X scores between women with binge eating with loss of control, binge eating without loss of control and women without binge eating.

	Women with binge eating with loss of control (n=21)		Women with binge eating without loss of control (n=36)		Women without binge eating (n=40)		ANOVA	
	M	SD	M	SD	M	SD	F	p
EDAS subscales								
EDAS score	57.62 ^c	14.06	44.67	18.59	37.95 ^a	15.00	5.22 (2, 94)	.000
Restrained eating	17.05 ^c	6.05	14.44	7.25	12.80 ^a	5.67	2.36 (2, 94)	.052
Binge eating	20.24 ^c	7.11	15.69	7.01	14.20 ^a	7.06	2.56 (2,94)	.008
Purging	1.24	1.48	.78	1.88	.43	1.43	1.26 (2, 94)	.179
Preoccupation of appearance and bodyweight	18.95 ^c	9.12	13.83	7.68	11.00 ^a	6.89	4.07 (2, 94)	.001
DERS subscales								
DERS score	86.52 ^{cb}	14.45	77.92 ^{ac}	19.61	67.63 ^{ab}	18.01	5.54 (2, 58)	.001
Difficulties engaging in goal directed behavior	21.24 ^{cb}	5.14	19.69 ^{ac}	5.94	16.49 ^{ab}	5.24	2.79 (2, 58)	.004
Lack of emotional clarity	17.10	5.28	15.57	4.52	13.67 ^a	3.12	3.85 (2, 58)	.007
Impulse control difficulties	8.52	4.69	7.57	3.53	6.74	3.05	.59 (2, 58)	.194
Non-acceptance of emotional responses	8.90	3.73	8.69	4.16	7.44	2.95	1.87 (2, 58)	.209
Lack of emotional awareness	9.95	3.22	10.29	4.11	10.18	4.25	.12 (2, 58)	.955
Limited access to emotion regulation strategies	16.57 ^c	4.73	15.49 ^a	5.53	12.46 ^a	5.14	2.93 (2, 58)	.007
BIS-11	61.57	7.28	60.40	9.37	58.30	9.09	1.87 (2, 59)	.345
PANAS-X positive emotions	31.05	6.74	32.89	6.68	33.65	7.09	1.10 (2, 60)	.373
PANAS-X negative emotions	26.62	8.52	26.06	7.50	21.53	6.93	3.68 (2, 60)	.011

^a differs statistically significantly ($p < .05$) from participants with binge eating with loss of control; ^b differs statistically significantly ($p < .05$) from participants with binge eating without loss of control; ^c differs statistically significantly ($p < .05$) from participants without binge eating.

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Table 2. Differences in EDAS, DERS, BIS11 and PANAS-X scores between women with binge eating with loss of control, binge eating without loss of control and women without binge eating.

	Men with binge eating with loss of control (n=10)		Men with binge eating without loss of control (n=13)		Men without binge eating (n=30)		ANOVA	
	M	SD	M	SD	M	SD	F	p
EDAS subscales								
EDAS score	48.10 ^{cb}	20.38	32.46 ^a	13.38	23.53 ^a	11.07	5.22 (2, 94)	.000
Restrained eating	14.70 ^c	7.32	11.08	5.44	7.03 ^a	5.94	2.36 (2, 94)	.003
Binge eating	17.90 ^c	7.59	11.46	8.12	10.53 ^a	5.92	2.56 (2,94)	.017
Purging	1.50 ^c	2.46	.62	1.12	.07 ^a	.37	1.26 (2, 94)	.007
Preoccupation of appearance and bodyweight	14.00 ^c	9.70	9.30	6.70	5.90 ^a	3.55	4.07 (2, 94)	.001
DERS subscales								
DERS score	75.67	27.09	68.44	9.78	68.83	14.03	5.54 (2, 58)	.438
Difficulties engaging in goal directed behavior	19.64	7.12	17.25	3.96	16.83	6.68	2.79 (2, 58)	.430
Lack of emotional clarity	15.45	5.47	14.19	4.10	14.60	3.72	3.85 (2, 58)	.741
Impulse control difficulties	8.73 ^c	4.50	7.25	2.24	5.43 ^a	1.49	.59 (2, 58)	.001
Non-acceptance of emotional responses	9.50	5.30	7.38	3.58	6.63	2.93	1.87 (2, 58)	.084
Lack of emotional awareness	11.00	6.10	11.25	3.67	12.80	3.86	.12 (2, 58)	.358
Limited access to emotion regulation strategies	14.91	8.15	11.13	3.24	12.53	4.22	2.93 (2, 58)	.162
BIS-11	72.45 ^a	16.67	56.27	10.01	60.16 ^c	12.65	1.87 (2, 59)	.007
PANAS-X positive emotions	29.20	9.86	35.08	7.66	32.77	7.74	1.10 (2, 60)	.249
PANAS-X negative emotions	23.70	10.01	22.92	8.46	22.93	8.32	3.68 (2, 60)	.969

^a differs statistically significantly ($p < .05$) from participants with binge eating with loss of control; ^b differs statistically significantly ($p < .05$) from participants with binge eating without loss of control; ^c

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Binge eating and emotional fluctuations

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