Relevance of Emotion Regulation Difficulties in the Etiology and Treatment of Binge-Eating Disorder and Loss of Control Eating:

An Empirical Investigation in Adults and Youth

Kumulative Dissertation zur Erlangung der Doktorwürde an der Philosophischen Fakultät der Universität Freiburg (CH)

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Erklärung der Selbstständigkeit

Ich erkläre hiermit ehrenwörtlich, dass ich meine Dissertation selbstständig und ohne unzulässige fremde Hilfe verfasst und sie noch keiner anderen Fakultät vorgelegt habe.

Freiburg, 22.05.2021

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Die vorliegende kumulative Dissertation umfasst folgende Publikationen:

Publikation 1: Forrer, F., Wyssen, A., Messerli-Bürgy, N., Meyer, A. H., & Munsch, S. (submitted). The Mediating Role of Emotion Regulation Difficulties and Cognitive Distortions in the Association between Body Dissatisfaction and Eating Disorder Pathology: A Gender Comparison.

Publikation 2: Forrer, F., Rubo, M., Meyer, A. H., & Munsch, S. (ready to be submitted). BEAT Pilot Study: Binge-Eating Adolescent Treatment - Efficacy and Acceptance of a Blended Treatment Program for Youth with Loss of Control Eating.

Publikation 3: Forrer, F., Rubo, M., Wyssen, A., Meyer, A. H., & Munsch, S. (ready to be submitted). The Influence of Emotion Regulation Difficulties on Short- and Long-Term Treatment Outcome in an Online Guided Self-Help Program for Adults with Binge-Eating Disorder.

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Publikationen und Kongressbeiträge

Publikationen

Forrer, F. (2018). Was Kinder krank macht - Wie helfen wir Kindern mit Zurückweisungen umzugehen? *Fritz und Fränzi – das Schweizer Elternmagazin,* (9).

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Forrer, F., Rubo, M., Wyssen, A., Meyer, A. H., & Munsch, S. (ready to be submitted). The Influence of Emotion Regulation Difficulties on Short- and Long-term Treatment Outcome in an Online Guided Self-Help Program for Adults with Binge-Eating Disorder.

Forrer, F., Wyssen, A., Messerli-Bürgy, N., Meyer, A. H., & Munsch, S. (submitted). The Mediating Role of Emotion Regulation Difficulties and Cognitive Distortions in the Association between Body Dissatisfaction and Eating Disorder Pathology: A Gender Comparison.

Kongressbeiträge

Forrer, F., Schmid, M., & In-Albon, T. (24.03.2017). *Emotional Facial Mimicry in Female Adolescents with Nonsuicidal Self-Injury Disorder.* Referat anlässlich des Kongresses der deutschen Gesellschaft für Kinder- und Jugendpsychiatrie, Psychosomatik und Psychotherapie (DGKJ), Ulm.

Forrer, F., Schmid, M., & In-Albon, T. (15.09.2017). *Emotional Facial Mimicry in Female Adolescents with Nonsuicidal Self-Injury Disorder.* Posterbeitrag anlässlich der 15. Konferenz der Schweizerischen Gesellschaft für Psychologie (SPS), Lausanne.

Forrer, F., Wyssen A., Messerli-Bürgy, N., Meyer, A. H., & Munsch, S. (11.05.2018). *Körperbild und gestörtes Essverhalten: konvergente und divergente Determinanten bei jungen Frauen und Männern.* Referat anlässlich des 36. Symposiums der Fachgruppe Klinische Psychologie und Psychotherapie der Deutschen Gesellschaft für Psychologie (DGPS), Landau.

Forrer, F. & Munsch, S. (23.11.2018). *BEAT: Ein Behandlungsprogramm für Jugendliche mit Essanfällen.* Workshop im Rahmen der 8. internationalen Tagung des Experten-

Netzwerks Essstörungen Schweiz (ENES) – Neue Entwicklungen in der Behandlung von Essstörungen, Bern.

Forrer, F., Meyer, A. H., & Munsch, S. (10.09.2019). *BEAT: Binge-Eating Adolescent Treatment – Preliminary Findings in Youth with Loss of Control Eating (LOC).* Referat anlässlich der 16. Konferenz der Schweizerischen Gesellschaft für Psychologie (SPS), Bern.

Forrer, F., Meyer, A. H., & Munsch, S. (01.11.2019). *Interpersonal Stress as a Potential Maintaining Factor in Loss of Control Eating (LOC). Preliminary Findings from the Binge-Eating Adolescent Treatment (BEAT) in Youth*. Referat anlässlich des ersten Kongresses der "European Association of Clinical Psychology and Psychological Treatment (EACLIPT)", Dresden.

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- Fallseminar „Klinische Psychologie und Psychotherapie"
- Gastvortrag zu „nicht-suizidalem selbstverletzendem Verhalten und Borderline-Persönlichkeitsstörung" in der Vorlesung Klinische Kinder- und Jugendpsychologie I
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- Schweizerische Gesellschaft für Psychologie (SPS, SGP, SSP)
- European Association of Clinical Psychology and Psychological Treatment (EACLIPT)

Content

List of Abbreviations

ACT	Acceptance-Commitment Therapy
AN	Anorexia Nervosa
APA	American Psychiatric Association
ART	Affect Regulation Training (German: TEK = Training emotionaler Kompetenzen)
AWMF	Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften
BED	Binge-Eating Disorder
BMI	Body Mass Index
BMI-SDS	Age and Gender Adjusted BMI Standard Deviation Score
BN	Bulimia Nervosa
BWL	Behavioral Weight Loss
BWLgsh	Behavioral Weight Loss Guided Self-Help
CBT(-E)	Cognitive-Behavior Therapy (for EDs)
CBTgsh	CBT-based Guided Self-Help
DALYs	Disability-Adjusted Life-Years
DBT	Dialectic Behavioral Therapy
DERS	Difficulties in Emotion Regulation Scale
DSM (IV and 5)	Diagnostic and Statistical Manual of Mental Disorders (Fourth and Fifth Edition)
ED(s)	Eating Disorder(s)
EDE-Q	Eating Disorder Examination Questionnaire
EMA	Ecological Momentary Assessment
HRV	Heart Rate Variability
ICAT-BED	Integrative Cognitive-Affective Therapy for BED
ICD-11	International Classification of Diseases, 11th Edition
IPT	Interpersonal Psychotherapy
LOC	Loss of Control Eating
NICE	National Institute of Clinical Excellence
NNT	Number Needed to Treat
Mini-DIPS	Diagnostic Interview for Mental Disorders, Short Version
OSFED	Other Specified Feeding or Eating Disorders
RCT(s)	Randomized Controlled Trial(s)
RMSE	Root-Mean Square Error
SD	Standard Deviation Score
TSF	Thought-Shape Fusion
UN	United Nations
VR	Virtual Reality
WHO	World Health Organization

Abstract

Binge-Eating Disorder (BED) and Loss of Control Eating (LOC) represent the most prevalent eating disorders (EDs) in adults respectively youth with detrimental consequences for mental and physical health. Recent studies indicated that *emotion regulation difficulties* are an important factor in the development and maintenance of BED/ LOC, but little is known about the mechanisms and potential gender differences of how they relate to BED/ LOC. Interplays with etiological factors such as body dissatisfaction, body-related cognitive distortions and appearance-based rejection sensitivity (referred to as *interpersonal emotion regulation difficulties*) can be assumed. Findings of *publication 1* indicate that emotion regulation difficulties as opposed to body-related cognitive distortions might not mediate the relationship between body dissatisfaction and ED pathology in a community sample of women and men. Mechanisms of emotion regulation difficulties therefore need further clarification in clinical samples, whereas their relevance for the development and maintenance of BED/LOC remains undisputed. In line with this and given that more efficacious and accessible treatments are needed especially for youth with LOC, *publication 2* investigated for the first time the efficacy of a blended treatment program for youth with LOC, including interventions addressing interpersonal emotion regulation difficulties. Results indicate that blended treatments might be efficacious in reducing core LOC and depressive symptoms, whereas the treatment of interpersonal emotion regulation difficulties may need more profound and enduring interventions. *Publication 3* complemented that increased emotion regulation difficulties at treatment begin might be a relevant predictor of particularly immediate treatment outcome in online guided self-help for individuals with BED. While findings of *publication 2 and 3* support the relevance of (interpersonal) emotion regulation difficulties in the maintenance and treatment of BED/ LOC in adults and youth, results from *publication 1* also indicate that emotion regulation difficulties do not represent a sufficient condition to elicit BED/ LOC. Mechanisms of difficulties in emotion regulation in the etiology of BED/ LOC need to be investigated more differentiated in terms of specific aspects of emotion regulation difficulties in clinical samples suffering from increased emotional distress. It is proposed to enhance clinical and scientific efforts to include emotion regulation difficulties in the diagnostic assessment, prevention and treatment of BED and LOC.

1 Introduction: Objective and Structure of the Thesis

Binge-Eating Disorder (BED) is the most prevalent Eating Disorder (ED) across ages, gender and ethnicities (Swanson, Crow, Le Grange, Swendsen, & Merikangas, 2011; Udo & Grilo, 2018). The proportion of individuals with BED relative to Bulimia Nervosa (BN) and Anorexia Nervosa (AN) increases with age (Santomauro et al., 2021) as full-threshold BED most often develops during young adulthood (Kessler et al., 2013; Udo & Grilo, 2018). Therefore, BED has been called a typical adult ED. However, BED warrants a developmental perspective given that during adolescence into young adulthood a substantial group of adolescents and young adults report a sense of loss of control over eating different quantities of food and of different frequencies, often not fulfilling the criteria of full-threshold BED (Shomaker et al., 2010; Tanofsky-Kraff et al., 2011). This typical pre-adulthood variant of BED has been referred to as *Loss of Control Eating (LOC),* which is independent of the amount of food consumed as opposed to binge-eating in BED (Tanofsky-Kraff et al., 2011). BED and LOC are associated with marked impairment in psychosocial functioning, increased comorbid psychopathology especially in terms of depression and anxiety, and relate to overweight and obesity. BED together with subclinical ED variants such as LOC even accounted for the majority of disability-adjusted life-years (DALY) among EDs, underlining the burden related to BED and LOC (Santomauro et al., 2021).

Sociocultural changes brought significant challenges and stressors, increasing the risk for BED and LOC. For instance, our current obesogenic environment with high availability of palatable and high caloric foods, accompanied by reduced physical activity, lead to a worldwide increase of overweight and obesity (Ward et al., 2019). This is contrasted by omnipresent unrealistic body ideals of super trained thin women and muscular men that are promoted via an increased variety of media channels (e.g. social media), simultaneously increasing the pressure to meet these body ideals (Swami et al., 2010; Tylka, 2011). The exposure to such self/ideal discrepancies promotes body dissatisfaction, negative mood and dieting behavior, increasing the risk for binge-eating and LOC (Stice, Gau, Rohde, & Shaw, 2017). Therefore, the ability to respond to and deal with the emotional distress elicited by the daily exposure to these stressors is of major importance (i.e. emotion regulation). In this thesis, *emotion regulation difficulties* are defined as trait-like problems regarding the awareness, understanding, acceptance and modulation of emotional responses to daily stressors as well as difficulties in controlling impulsive behavior and maintaining goal-directed behavior especially when experiencing

negative emotions (Gratz & Roemer, 2004). Difficulties in emotion regulation are assumed to play a fundamental role in the development and maintenance of BED and LOC as well as comorbid mental disorders (Svaldi, Griepenstroh, Tuschen-Caffier, & Ehring, 2012). However, the mechanisms of how emotion regulation difficulties relate to BED symptoms and potential gender differences in these mechanisms, as well as the relevance of emotion regulation difficulties in the treatment of BED and LOC have not yet been sufficiently investigated.

The *objective of the present thesis* is to examine the importance of emotion regulation difficulties in the development and maintenance of symptoms of BED/ LOC, and to investigate its relevance in the treatment of BED and LOC. Furthermore, clinical implications of the findings of *publication 1-3* on the relevance of emotion regulation difficulties in the etiology and treatment of BED and LOC will be discussed with regard to future perspectives in the etiology, diagnostic, prevention and further development of current treatment approaches.

The present thesis is structured into *three parts:* Before starting with the investigation of the relevance of emotion regulation difficulties in the etiology and treatment of BED and LOC, an overview on the importance of BED and LOC is provided given that particularly LOC during adolescence and young adulthood needs further clarification. In the second part, mechanisms of how emotion regulation difficulties relate to symptoms of BED and LOC together with other etiological factors such as body dissatisfaction and body-related cognitive distortions are described and examined *(publication1).* This is followed by a short overview on the efficacy and availability of current treatment approaches and an outline of current challenges in the health care provision of BED and LOC. To address some of these challenges, an emphasis is made on the translation of emotion regulation difficulties related to interpersonal problems (i.e. appearance-based rejection sensitivity) into the treatment of LOC in adolescents and young adults *(publication 2),* where studies on efficacious and accessible treatments are scare (Crow, 2014). Furthermore, it is examined whether individuals with endorsed difficulties in emotion regulation show worse treatment outcome in an online guided self-help program for adults with BED *(publication 3).* In section three, the findings of the present thesis will be summarized and the relevance of emotion regulation difficulties discussed in terms of clinical implications for the etiology, prevention, diagnosis and treatment of BED and LOC. Suggestions for further research in the field of emotion regulation difficulties in relation to BED and LOC are made.

Publication 1 aims at investigating the relevance of emotion regulation difficulties relative to body-related cognitive distortions as an etiological mechanism in the close relationship between body dissatisfaction and ED pathology related to BED/ LOC. The vast majority of previous research has focused on female samples. Little is known about etiological mechanisms in men, respectively whether men differ from women in the way of how etiological factors such as emotion regulation difficulties relate to BED and LOC (e.g. Wyssen, Bryjova, Meyer, & Munsch, 2016). Therefore, the objective of *publication 1* is further to investigate potential gender differences in these mechanisms.

The intention of *publication 2* is to evaluate the efficacy and acceptance of the innovative blended treatment program "BEAT" for youth with LOC, combining three face-to-face workshops and six email-guided self-help sessions and including interventions on *interpersonal emotion regulation difficulties.* Beside treatment outcomes of core LOC and general psychopathology, *publication 2* aims at investigating treatment effects on interpersonal emotion regulation difficulties.

Publication 3 targets the influence of emotion regulation difficulties on the prognosis of short- and long-term treatment outcome in a short 8-weeks online guided self-help program for adults with BED. It is evaluated whether emotion regulation difficulties relative to negative mood predict treatment outcomes independently of other demographic and clinical characteristics (i.e. age, gender and BED severity).

2 Relevance of Binge-Eating Disorder and Loss of Control Eating

2.1 Presentation of Binge-Eating Disorder

According to the *Fifth Edition of the Diagnostic and Statistical Manual of Mental Disorders* of the American Psychiatric Association (DSM-5; APA, 2013), the core feature of BED are recurrent binge-eating episodes characterized by the consumption of an objectively large amount of food in a discrete period of time (exceeding what most people would eat under comparable conditions), associated with a feeling of loss of control over eating. During binge-eating episodes affected individuals often eat different kinds and tastes of mostly high caloric food, which they eat often faster than usual, in the absence of hunger and until feeling uncomfortably full. Binge-eating often occurs in the absence of others or as secretly as possible because individuals are ashamed about the amount of food consumed. Furthermore, binge-eating episodes result in marked distress, guilt feelings and depressiveness. In contrast to BN, binge-eating episodes in BED are not followed by

regular compensatory behaviors such as vomiting, excessive sports or laxative abuse to prevent weight gain (APA, 2013).

Beside the core symptom of recurrent binge-eating without regular compensation, the eating behavior between binge-eating episodes of individuals with BED is typically characterized by chaotic and irregular eating patterns with a general tendency toward overeating (Chao et al., 2019; Heaner & Walsh, 2013). This contributes to overweight and obesity that has been consistently related to BED, even after adjusting for sociodemographic factors such as gender or socioeconomic status (e.g. Hudson, Hiripi, Pope, & Kessler, 2007; Kessler et al., 2013; Mustelin, Bulik, Kaprio, & Keski-Rahkonen, 2017; Rodgers, Watts, Austin, Haines, & Neumark-Sztainer, 2017; Shomaker et al., 2010; Tanofsky-Kraff et al., 2007; Thornton et al., 2017; Udo & Grilo, 2018). For instance, in laboratory test meal studies, individuals with BED not only consumed more than weight-matched controls when instructed to binge-eat but also during non-binge-eating meals (Goldfein, Walsh, Lachaussee, Kissileff, & Devlin, 1993; Heaner & Walsh, 2013; Walsh & Boudreau, 2003; Yanovski et al., 1992). This has been underlined by ecological momentary assessment (EMA) data, indicating that obese individuals with BED report more overeating episodes and more consumed kcals per day than obese individuals without BED (Engel et al., 2009). In addition, individuals with BED report more grazing behavior, defined as the unstructured, repetitive eating of smaller amounts of food over a longer time period, outside of planned meals and snacks and not in response to hunger, than obese controls or individuals with other EDs (Heriseanu, Hay, Corbit, & Touyz, 2017; Masheb, Grilo, & White, 2011). This can make it more difficult in BED compared to BN to differentiate single binge-eating episodes from each other, wherefore individuals with BED often report binge-eating episodes that endure several hours (Heriseanu et al., 2017). Even though less pronounced than in BN, individuals with BED often report a history of dieting attempts (actual restriction of caloric intake) and restraint eating (the cognitive attempt to restrict overall energy intake, whether or not the individual has succeeded; Elran-Barak et al., 2015; Grilo & Masheb, 2000; Masheb et al., 2011). The restriction of the quantity and type of food contributes through physiological and psychological mechanisms to the dominating overeating pattern in this population (Burton & Abbott, 2017; Schulte, Grilo, & Gearhardt, 2016). Furthermore, individuals with BED report greater emotional eating respectively eating to deal with distress and emotional states than weight-matched controls (Leslie, Turton, Burgess, Nazar, & Treasure, 2018).

In addition to disturbed eating behavior, BED is associated with elevated emotional-cognitive ED symptoms. Individuals with BED often express marked eating concerns such as preoccupation with food, eating and calories, avoidance and fear of social eating or worrying about losing control over eating (Hilbert, Tuschen-Caffier, & Ohms, 2004; Nakai et al., 2017; Wang, Jones, Dreier, Elliott, & Grilo, 2019). Furthermore, individuals with BED exhibit pronounced body image disturbances (Grilo et al., 2008; Lewer, Bauer, Hartmann, & Vocks, 2017), including body dissatisfaction and related marked concerns about weight and shape as well as overvaluation of shape and weight for self-evaluation (Ahrberg, Trojca, Nasrawi, & Vocks, 2011; Grilo, 2013; Lewer et al., 2017). These body image disturbances in BED are associated with marked distress and impairment as in other EDs (e.g. Grilo, 2013; Harrison, Mond, Rieger, & Rodgers, 2015). Moreover, they occur independently of body mass index (BMI) and of potential demographic confounds such as age or ethnicity, indicating that body image disturbances in BED do not simply reflect concerns related to overweight or obesity (Grilo, 2013; Grilo et al., 2008). Nevertheless, body image disturbances are not captured by current classification systems, neither in the DSM-5 nor in the upcoming *International Classification of Diseases and Related Health Problems, Eleventh Edition* of the World Health Organization (ICD-11; WHO, 2020b).

2.2 Loss of Control Eating in Youth

The age of first onset of full-threshold BED covers a larger period than in other EDs. First onset of BED usually occurs during the ages of 20-30 years with a mean age of onset of approximately 23-25 years (Kessler et al., 2013; Mohler-Kuo, Schnyder, Dermota, Wei, & Milos, 2016; Udo & Grilo, 2018). Another prevalence peak of BED has been found in middle adulthood between the ages 45 and 54 years (Gagne et al., 2012). Therefore, and in contrast to BN and AN, BED has been called a typical adult ED (Tanofsky-Kraff, Schvey, & Grilo, 2020). However, prospective studies in adolescent samples indicated an increased risk after puberty begin for the onset of BED with a particular salient phase in young adulthood between 18 and 20 years (Glazer et al., 2019; Stice, Marti, & Rohde, 2013). This developmental period of approximately 14 to 24 years has been referred to as *youth* according to the definition of the United Nations (UN) to increase consistency regarding health-related activities across regions (https://en.unesco.org/youth). Youth is characterized by fast and deep neurobiological and body modifications such as growth spurts, brain and secondary sexual characteristics development and shifts in the accumulation and location of body fat (Blakemore & Mills, 2014; Bray, Krongold, Cooper,

& Lebel, 2015; Susman et al., 2010). Psychological challenges that are increasingly influenced by peer relationships include the development of autonomy, identity based on a healthy body image and mature interpersonal competences (Blakemore & Mills, 2014). This leads to higher concerns about peer acceptance and evaluation, which is often related to increased concerns and attention for body size and shape (Gondoli, Corning, Salafia, Bucchianeri, & Fitzsimmons, 2011). Furthermore, higher developed cognitive and emotional competences (e.g. profound emotion regulation capacities) mature and consolidate during these age period (Blashill, 2014; King, McLaughlin, Silk, & Monahan, 2018). For these reasons, youth is a critical period for the onset of disturbed eating and ED pathology as well as other mental disorders (Culbert, Racine, & Klump, 2015; Fusar-Poli & Partnership, 2019; Stice et al., 2013).

Even though full-threshold BED also occurs during youth, a substantial proportion of youth report the feeling of loss of control over eating smaller respectively normative amounts of foods, which do not fulfill the criteria of an objective large food amount as required for binge-eating according to the DSM-5 (APA, 2013; Goldschmidt et al., 2008; Shomaker et al., 2010; Tanofsky-Kraff et al., 2007). For instance, already children as young as age 8 may suffer from the feeling of losing control over eating, while having limited access to high quantities of food compared to older youth and adults (Tanofsky-Kraff, Faden, Yanovski, Wilfley, & Yanovski, 2005; Tanofsky-Kraff et al., 2011). The definition of an objectively large amount of food further varies during youth due to different growth-dependent needs of energy intake (Tanofsky-Kraff et al., 2011). Moreover, youth often report loss of control eating episodes of lower frequency than required to meet DSM-5 criteria for BED (APA, 2013; Tanofsky-Kraff et al., 2011). Therefore, the term *Loss of Control Eating (LOC)* has been introduced in youth to describe the feeling of being unable to control food intake irrespective of the consumed food amount as opposed to binge-eating and not necessarily fulfilling the time and duration criteria for BED according to the DSM-5 (Tanofsky-Kraff et al., 2020). This definition of LOC has been legitimized by findings indicating that LOC over smaller amounts of food is of comparable psychopathological relevance as LOC over large amounts of food, therefore representing a more salient marker of ED pathology than the mere amount of food intake (Goldschmidt, 2017; Goldschmidt et al., 2008; Shomaker et al., 2010; Tanofsky-Kraff et al., 2007). For instance, LOC in female and male youth has been related (cross-sectionally and longitudinally) to higher emotional eating in response to emotional distress, to more frequent eating in the absence of hunger, to higher depressive and anxiety symptoms as well as to higher body weight compared to

healthy controls, independently of food amounts (Goldschmidt et al., 2008; Munsch et al., 2017; Shomaker et al., 2010; Tanofsky-Kraff et al., 2007; Tanofsky-Kraff et al., 2011). However, the finding of increased body weight in LOC irrespective of the amount of food intake might also indicate that the intake of large food amounts is frequently underreported due to feelings of shame and guilt (Marzilli, Cerniglia, & Cimino, 2018; Tanofsky-Kraff et al., 2011). The clinical relevance of LOC is further underlined by findings indicating that also youth with LOC of markedly lower frequency than required for recurrent binge-eating in BED show significant greater psychosocial and physical impairment than youth without LOC (e.g. Glasofer et al., 2007; Goossens, Braet, & Decaluwe, 2007; Schlüter, Schmidt, Kittel, Tetzlaff, & Hilbert, 2016; Tanofsky-Kraff et al., 2011). For instance, in a study on 195 young adolescents (mean age 10.4, *SD*=1.5) those who experienced at least one LOC episode in their life reported greater disordered eating and depressive symptoms as well as higher body weight compared to their peers who never experienced LOC (Tanofsky-Kraff et al., 2011).

Research indicates that the clinical presentation of LOC largely maps onto BED in adults but of lower intensity and frequency (Cassidy, Shank, Matherne, Ranzenhofer, & Tanofsky-Kraff, 2016; Kurz et al., 2017; Tanofsky-Kraff et al., 2007; Tanofsky-Kraff et al., 2020). For instance, youth with LOC might report increased depressive symptoms, whereas BED often comes along with comorbid full-threshold depression (Tanofsky-Kraff et al., 2020). The presented findings underline that LOC represents a youth-like variant of BED that needs further attention.

2.3 Prevalence

BED is the most prevalent ED in adults and youth (Keski-Rahkonen & Mustelin, 2016; Marzilli et al., 2018). In adults, large representative and interview-based studies (providing most accurate prevalence rates) indicate lifetime prevalence rates of BED to vary from 1.3 - 3.5% among women and 0.4 - 2% among men (Hudson et al., 2007; Keski-Rahkonen & Mustelin, 2016; Mohler-Kuo et al., 2016; Udo & Grilo, 2018). In Switzerland, a representative cross-sectional survey on 10’038 residents between the ages 15-60 years applying DSM-5 duration (recurrent binge-eating for at least 3 months) and DSM-IV frequency criteria (3 episodes per week) found BED lifetime prevalence rates of 2.4% among women and 0.7% among men (Mohler-Kuo et al., 2016). BED prevalence rates were assumed to be smaller in Europe than in the U.S. (Hudson et al., 2007; Keski-Rahkonen & Mustelin, 2016; Kessler et al., 2013; Mohler-Kuo et al., 2016). However, the

most recent U.S. community study on 36'306 adults (≥18 years) applying interview-based DSM-5 criteria found lower lifetime prevalence rates of BED of 1.3% in women and 0.4% in men (Udo & Grilo, 2018). In youth, large interview-based representative community studies found DSM-5 lifetime prevalence rates of BED of 1.1 - 2.3% in girls and 0.4 - 0.7% in boys (Lee-Winn, Reinblatt, Mojtabai, & Mendelson, 2016; Smink, van Hoeken, Oldehinkel, & Hoek, 2014; Swanson et al., 2011). Therefore, overall prevalence rates of BED particularly in younger youth (<18) are lower than in adults (Galmiche, Dechelotte, Lambert, & Tavolacci, 2019). During youth, most cross-sectional and longitudinal studies indicate a relative continuous increase of full-threshold BED prevalence in girls and boys from early adolescence into young adulthood (Dahlgren, Wisting, & Ro, 2017; Glazer et al., 2019; Marzilli et al., 2018; Micali et al., 2015; Santomauro et al., 2021; Sonneville et al., 2013; Stice et al., 2013; Swanson et al., 2011), with more inconsistent findings for boys (Allen, Byrne, Oddy, & Crosby, 2013).

The above-mentioned prevalence rates of BED only reflect the tip of the iceberg of the extend of the public health problem of BED. Indeed, prevalence rates of subclinical forms of BED such as BED of lower frequency and or duration as well as LOC in youth are moderately to markedly higher. For instance, in a representative Australian community sample on 6041 predominantly adults, 3-month prevalence of BED of low frequency and duration was 6.9% (Hay, Girosi, & Mond, 2015). In youth, an 8-year prospective community study on 496 girls reported lifetime prevalence rates of BED of lower frequency and duration of 3.6% by the age of 20 (Stice et al., 2013). Another prospective U.S. community study over 17 years on 9031 female youths (mean age 11.6 years at baseline, *SD*=1.6) indicated subclinical BED (study) lifetime prevalence rates as high as 13% (Glazer et al., 2019). Further, prevalence rate of LOC in youth is substantial, ranging from c. 4-30%, depending on frequency and duration criteria (Goldschmidt, 2017; Goldschmidt et al., 2008; Goossens et al., 2007; Morgan et al., 2002; Shomaker et al., 2010; Tanofsky-Kraff et al., 2005). For instance, in a cross-sectional German community study on 1643 youths (12-20 years) roughly 23% reported at least one LOC episode respectively 10% reported weekly LOC during the past month (Schlüter et al., 2016). Highest prevalence rates of BED and LOC are found among weight-treatment seeking adults and youth. In these populations, BED prevalence rates in adults vary between 17-55%, whereas in youth 7% report BED and nearly 50% past or current LOC (Glasofer et al., 2007).

The gender ratio in adults and youth with BED and LOC is more balanced than in other EDs with the female gender being 2 to 3 times more like to be affected (Smink et al.,

2014; Swanson et al., 2011; Udo & Grilo, 2018). Subclinical symptoms of BED such as binge-eating or BED without marked distress are almost as frequent if not more frequent in male than female adults and youth (Hay et al., 2015; Hudson et al., 2007; Swanson et al., 2011). Furthermore, it can be assumed that disturbed eating behaviors in men have so far been underestimated given the tendency of male participants to prematurely terminate participation in epidemiological studies, the female bias of current self-report questionnaires and the reduced treatment seeking behavior in men (Murray et al., 2017; Schaefer et al., 2018; Wyssen et al., 2016).

BED and LOC occur across all ethnicities, while research has focused on white women (Davis, Graham, & Wildes, 2020). The rate of BED seems to be comparable between ethnic groups across all ages (Goode et al., 2020; Kessler et al., 2013; Lee-Winn et al., 2016; Marques et al., 2011; Udo et al., 2013). On a subclinical level, non-Hispanic Blacks and Hispanics might show higher rates of binge-eating respectively LOC and overeating than non-Hispanic Whites (Croll, Neumark-Sztainer, Story, & Ireland, 2002; Goode et al., 2020; Lee-Winn et al., 2016; Marques et al., 2011), while non-Hispanic Blacks may experience less marked distressed from binge-eating behaviors than other ethnic groups (Lee-Winn et al., 2016).

2.4 Classification

Since the introduction of the DSM-5 in 2013, BED represents a distinct empirically validated ED within the *Feeding and Eating Disorders Section* (APA, 2013). Specific diagnostic criteria of BED in the DSM-5 can be retrieved from Table 1. Time and frequency criteria of BED according to the DSM-5 are fulfilled if at least one objective binge-eating episode per week has occurred during at least 3 months. The severity of the disorder in the DSM-5 is determined by the frequency of weekly binge-eating episodes according to four graduations: mild (1-3 episodes/ week), moderate (4-7 episodes/ week), severe (8-13 episodes/ week) and extreme (14 or more episodes/ week). If all criteria are fulfilled except that binge-eating episodes are of lower frequency (<1/ week) and limited duration (<3 months), an "Other Specified Feeding or ED (OSFED)" is diagnosed with the specification of a BED of limited duration or frequency (APA, 2013).

In order to capture LOC in youth, age adapted criteria are needed including LOC over smaller food amounts (subjectively large) and of lower frequency and duration than required for binge-eating in BED (e.g. Goossens et al., 2007; Shomaker et al., 2010; Tanofsky-Kraff et al., 2011). Currently there is no consensus regarding the latter as the

clinical significance of LOC frequency and duration has rarely systematically been examined (Schlüter et al., 2016). There is evidence that in female and male youth even low frequent LOC (e.g. LOC at least once in life) relates to impaired mental health, increased body weight and an increased risk of developing full-threshold BED compared to no LOC, even after accounting for general ED pathology and mood symptoms (Marzilli et al., 2018; Tanofsky-Kraff et al., 2011). While a majority of studies indicates that these impairments might be worse in youth with more frequent compared to low frequent LOC (Schlüter et al., 2016; Tanofsky-Kraff et al., 2011), there are also findings indicating similar negative consequences for youth with higher and lower LOC frequency compared to youth without LOC (Goossens et al., 2007). Therefore, frequency and duration criteria in previous studies widely ranged from at least one LOC episode ever to once a week during the last 3 months (Goldschmidt et al., 2008; Kurz et al., 2017; Schlüter et al., 2016; Tanofsky-Kraff, McDuffie, et al., 2009). In accordance with this research, broadened DSM-5 frequency and duration criteria for youth with LOC are applied in the present thesis, including youth who experienced *at least one LOC episode during the last 6 months*. The 6 months period seems further appropriate considering that LOC in youth, similar to BED, is fluctuating over time, characterized by alternating intervals without (or less) and with recurrent LOC episodes (Cassidy et al., 2016; Goldschmidt, Wall, Loth, Bucchianeri, & Neumark-Sztainer, 2014; Udo & Grilo, 2018).

In the ICD-11 due to be introduced in January 2022, it is proposed for BED and BN to broaden the diagnostic criteria of binge-eating (see Table 1). Binge-eating will be based on both, loss of control over eating objectively large amounts of food as well as over food amounts that are subjectively perceived as large while lying within the normal range (Berner, Sysko, Rebello, Roberto, & Pike, 2020; Claudino et al., 2019; WHO, 2020b). This refinement is based on findings, in line with LOC in youth, that loss of control over eating is a more salient marker of ED and general pathology in adults than the actual amount of food consumed (Goldschmidt, 2017; Palavras, Hay, Lujic, & Claudino, 2015; Vannucci et al., 2013). The application of the ICD-11 criteria for BED might therefore capture youth with recurrent LOC over subjectively large food amounts, who currently fail to meet BED criteria of the DSM-5. However, youth adapted frequency and duration criteria of LOC might still be needed. In adults, data on the clinical utility of broadened criteria of binge-eating seem more ambiguous than in youth (Goldschmidt, 2017). It has been cautioned that the clinical significance of the BED diagnosis might be decreased by excluding the size criteria of binge-eating episodes (Hilbert, 2019).

Table 1

DSM-5 and proposed ICD-11 diagnostic criteria for Binge-Eating Disorder

DSM-5	Proposed ICD-11
A. Recurrent binge-eating episodes. A binge-eating episode is characterized by both of the following: 1. Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than most people would eat in a similar period of time under similar circumstances. 2. A sense of loss of control over eating during the episode.	Recurrent episodes of binge-eating (e.g. once a week or more over a period of 3 months). A binge-eating episode is defined as a distinct period of *loss of control over eating*, during which an individual eats notably more or differently than usual and feels unable to stop eating or to limit the type or amount of food eaten (binge-eating episodes may therefore be *objectively* or *subjectively large*).
B. Binge-eating episodes are associated with at least three of the following: 1. Eating much more rapidly than normal. 2. Eating until feeling uncomfortably full. 3. Eating large amounts of food when not feeling physically hungry. 4. Eating alone because of being embarrassed by how much one is eating. 5. Feeling disgusted with oneself, depressed, or guilty after overeating.	Other characteristics of binge-eating episodes may include eating alone because of embarrassment, eating foods that are not part of the individual's regular diet, or feelings of guilt and disgust.
C. Marked distress regarding binge-eating.	Binge-eating episodes are not regularly accompanied by inappropriate compensatory behaviors aimed at preventing weight gain.
D. Binge-eating occurs at least once a week for at least 3 months.	There is marked distress about binge-eating or significant impairment in personal, family, social, educational, occupational or other important areas of functioning.
E. Absence of regular inappropriate compensatory behavior and no concurrent AN or BN.	The symptoms and behaviors are not better explained by another mental or medical condition.

Note. diagnostic criteria are retrieved from: APA (2013), Claudino et al., (2019) and WHO (2020b).

2.5 Comorbidity, Psychosocial and Physical Impairment

The introduction of BED in the DSM-5 as an empirically validated ED was based on extant literature on physical and psychosocial impairments that are associated with BED, underlining its significance (Hilbert, 2019). In a current meta-analysis to approximate the Global Burden of Disease from EDs, BED together with subclinical ED variants such as LOC accounted for the majority of subject burden and impairment (Santomauro et al., 2021).

As indicated, 30-40% of individuals with BED suffer from comorbid obesity (BMI ≥ 30.0 kg/m2; Kessler et al., 2013). In large community studies, individuals with a lifetime diagnosis of BED were 4 to 6 times more likely to have comorbid severe obesity (BMI ≥40.0 kg/m^2) compared to participants without a history of EDs (Kessler et al., 2013; Udo & Grilo, 2018). Similarly, LOC in youth is associated with increased weight and/or body fat (Goldschmidt et al., 2008). In addition to increased ED pathology, BED and LOC are related to increased general psychopathology, especially depressive and anxiety symptoms, up to full-threshold comorbid mental disorders (Grilo et al., 2009; Keski-Rahkonen & Mustelin, 2016). Representative cross-sectional data indicated that nearly 80% of adults and youth with lifetime BED suffer from lifetime comorbid mental disorders with more than 40% reporting comorbid depressive and more than 50-60% comorbid anxiety disorders. Additionally, approximately 25% of individuals with a lifetime BED show comorbid substance use disorder and up to 40% impulse control disorders, while 37% endorse three or even more classes of comorbid mental disorders (Kessler et al., 2013; Swanson et al., 2011).

Several studies found increased suicide risks in individuals with BED and LOC, even after controlling for sociodemographic characteristics (i.e. age, gender, race and socioeconomic status; Mandelli, Arminio, Atti, & De Ronchi, 2019; Micali et al., 2015; Stice et al., 2013; Swanson et al., 2011; Udo, Bitley, & Grilo, 2019; Welch et al., 2016). These suicide risks seem to be higher for BED than LOC (Marzilli et al., 2018; Swanson et al., 2011). There is evidence from a large representative U.S. community study that individuals with BED and a history of suicide attempts report a younger age of BED onset compared to affected individuals without suicide attempts (Udo et al., 2019). Moreover, and in contrast to AN and BN, suicidal risks are most often reported after the onset of BED and LOC in youth and adults (Forrest, Zuromski, Dodd, & Smith, 2017; Stice et al., 2013; Udo et al., 2019).

BED and LOC are associated with significant impairment in health-related quality of life and social functioning, which is similar to other defined EDs (Agh et al., 2016; Allen et al., 2013; Elliott et al., 2010; Micali, Ploubidis, De Stavola, Simonoff, & Treasure, 2014; Ranzenhofer et al., 2012; Shomaker et al., 2010; Stice et al., 2013; Udo & Grilo, 2018). For instance, 53% of adults with a lifetime diagnosis of BED report interferences with normal daily activities and 21% serious problems in getting along with others (Udo & Grilo, 2018). In a study on an obese population of youth, those with repeated binge-eating and LOC reported more severe impairments in activities of daily living, mobility, self-esteem and

interpersonal functioning relative to their counterparts without binge-eating/ LOC, even after controlling for body composition (Ranzenhofer et al., 2012). These findings have been replicated in community samples of youth, where BED and LOC were associated with social impairment and family burden in both genders (Micali et al., 2014; Swanson et al., 2011). Importantly, a study on data from two large Australian household surveys in 1998 and 2008 indicated that BED related quality of life impairment significantly increased over time in men (Mitchison, Hay, Slewa-Younan, & Mond, 2014). Community-based studies suggest similar levels of distress as well as physical respectively psychosocial impairment in women and men resulting from BED (Bentley, Monda, & Rodgers, 2014; Udo et al., 2013; Ulfvebrand, Birgegard, Norring, Hogdahl, & von Hausswolff-Juhlin, 2015). Conversely, in a study on youths (aged 13-18 years) with BED and LOC boys reported less distress and concerns related to binge-eating/ LOC than girls (Lee-Winn et al., 2016). It remains open whether this is based on real lower distress or rather on the possibility that boys are less likely to report eating-related distress than girls due to shame and stigmatization

The presented findings indicate that psychosocial and physical impairment seem to increase with the severity of BED symptoms with highest impairment for full-threshold BED (Swanson et al., 2011; Tanofsky-Kraff et al., 2020). However, there is also evidence that subclinical forms of BED such as LOC are a public health problem (Micali et al., 2014; Mustelin et al., 2017; Schlüter et al., 2016; Stice et al., 2013; Swanson et al., 2011; Tanofsky-Kraff et al., 2020). Therefore, early interventions that target the etiological factors in the development and maintenance of BED and LOC are crucial.

3 Relevance of Emotion Regulation Difficulties in the Development and Maintenance of Binge-Eating Disorder and Loss of Control Eating

The development and maintenance of BED and LOC is based on a complex interplay between biological, psychological and sociocultural mechanisms that are still not fully understood (Cassidy et al., 2016; Culbert et al., 2015). A deeper understanding of these etiological mechanisms is central to further enhance and develop current treatment approaches. This is essential as only around 50-60% of individuals are abstinent from binge-eating after cognitive-behavior therapy (CBT), the treatment of choice in adults with BED (Hilbert et al., 2019; Linardon, Messer, & Fuller-Tyszkiewicz, 2018). The severe psychosocial impairment and high comorbidity in BED and LOC strongly suggests the

importance of transdiagnostic factors that are involved in the development and maintenance of BED and LOC such as low self-esteem, high perfectionism, stress, interpersonal problems and emotion regulation difficulties (Burton & Abbott, 2019; Puttevils, Vanderhasselt, & Vervaet, 2019). Emotion regulation difficulties might thereby be especially relevant, as it encompasses deficits in automatic and conscious processes involved in the way an individual responds to and deals with emotional distress such as resulting from other transdiagnostic factors (Berking & Wupperman, 2012; Thompson, 1994). In line with this, difficulties in emotion regulation constitute a central transdiagnostic factor in the development and maintenance of various mental disorders across gender, ethnic groups and ages (Aldao & Nolen-Hoeksema, 2010; Berking & Wupperman, 2012; Cassidy et al., 2016; Compas et al., 2017; Culbert et al., 2015; Svaldi et al., 2012). More generally, problems in emotion regulation are associated with lower general mental well-being and higher interpersonal problems both in clinical and nonclinical samples (English, John, Srivastava, & Gross, 2012; John & Gross, 2004; Kraiss, ten Klooster, Moskowitz, & Bohlmeijer, 2020). Theoretical accounts on the relevance of emotion regulation difficulties in the development and maintenance of BED and LOC stems for example from the transdiagnostic cognitive-behavioral model of EDs from Fairburn, Cooper, and Shafran (2003). In this model, the authors suggest that dispositional difficulties in responding to and dealing with emotional distress (which they referred to as mood intolerance) describe a central mechanism in the development and maintenance of binge-eating/ LOC and general ED pathology. However, empirical knowledge on the relevance of trait-like emotion regulation difficulties in the development and maintenance of BED and LOC is limited and influenced by heterogeneous conceptualizations and operationalizations of emotion regulation difficulties and emotion-related constructs (Gratz, Weiss, & Tull, 2015; Gross, 2015). Therefore, chapter 3.1 provides an overview of how emotion-related concepts and difficulties in emotion regulation are understood in the present thesis. Furthermore, a more detailed description of the two most influential conceptualizations of emotion regulation (difficulties) in clinical research is warranted to understand current findings on BED and LOC in this research field.

3.1 Conceptualizing Emotion Regulation Difficulties

Emotions describe complex reactions of the organisms to external and internal situations (Frijda, 1986), consisting of more or less coherent clusters of emotional valence (i.e. positive or negative), physiological arousal, behavioral and mimic reactions and thoughts

(Koole, 2009). This includes a rich repertoire of discrete and more complex emotions of which those related to interpersonal experiences and destructive self-perception such as anger, frustration, disappointment, sadness, being hurt, loneliness, disgust and shame might be especially salient in BED and LOC (Ansell, Grilo, & White, 2012; Elliott et al., 2010; Ranzenhofer et al., 2014; Zeeck, Stelzer, Linster, Joos, & Hartmann, 2011). Overlapping constructs to emotion and emotion regulation difficulties that have often been used interchangeably or with fuzzy borders in previous research are mood, affect and affect regulation difficulties (Gross, 2015; Koole, 2009). In the present thesis mood is understood as a longer enduring emotional state that can take, if negatively expressed, the form of for example depressive or anxiety symptoms (Parkinson, Totterdell, Briner, & Reynolds, 1996). Emotion regulation difficulties are understood as a trait-like disposition of an organism for dysfunctional and deficient processes related to emotional functioning (including longer lasting mood), which influences state-like emotional experiences, related behaviors, thoughts and physiological reactions in concrete situations. These state-like emotional experiences and problems in their regulation are referred to as affect and affect regulation difficulties in the present thesis (Haedt-Matt & Keel, 2011; Munsch, Meyer, Quartier, & Wilhelm, 2012).

There is evidence that basal components of emotion regulation that already develop during early childhood such as facial emotion recognition and automatic facial mimicry (the automatic tendency to imitate or mimic the facial expressions of others; Hess & Fischer, 2014; Thompson, 1994) might not be altered in individuals with ED compared to healthy controls (Wyssen et al., 2019). Therefore, the present thesis focuses on deficits in higher developed emotional regulation capacities within the self, which mature and consolidate during youth (In-Albon, Bürli, Ruf, & Schmid, 2013). Two prominent conceptualizations of such difficulties in higher developed emotion regulation are provided by the *process model of emotion regulation* of Gross (2002) and the *multidimensional model of emotion regulation* of Gratz and Roemer (2004) that will be described in the following sections.

Probably the most influential conceptual framework of difficulties in emotion regulation in clinical psychology was developed by Gross (2002), who defined emotion regulation as processes that influence which emotions emerge, when they emerge, how intense emotions are experienced and how they are expressed. This definition is reflected in Gross' process model of emotion regulation that takes a micro-perspective on emotion regulation strategies used to alter the trajectory of an emotion at different time points in the

emotion generative process, to progress toward a desired goal (Gross, 2015). Empirically, this framework lead to broad investigations of specific emotion regulation strategies and their relationship with psychopathology, categorizing them as either adaptive (e.g. cognitive reappraisal or problem solving) or maladaptive (e.g. rumination, avoidance of emotions, suppression of emotional expressions and experiences; Aldao & Nolen-Hoeksema, 2012a; Aldao, Nolen-Hoeksema, & Schweizer, 2010). While the dispositional use of adaptive emotion regulation strategies is assumed to prevent the occurrence of psychopathology such as disturbed eating, limited access to adaptive and an increased habitual use of maladaptive strategies are assumed to reduce the ability to respond to and deal with daily stressors (Gross & Jazaieri, 2014; Munsch et al., 2012; Svaldi, Werle, Naumann, Eichler, & Berking, 2019). However, this conclusion is incomplete as previous studies emphasized that rather than specific emotion regulation strategies being adaptive or maladaptive per se, their protecting or detrimental consequences depend on contextual factors such as situational demands and the goals an individual has in a situation (Aldao, Jazaieri, Goldin, & Gross, 2014; Aldao, Sheppes, & Gross, 2015; Bonanno & Burton, 2013; Kobylinska & Kusev, 2019; Troy, Shallcross, & Mauss, 2013). Indeed, effective emotion regulation is flexible, context sensitive and based on a broad repertoire of maladaptive and adaptive strategies (Aldao & Nolen-Hoeksema, 2012a, 2012b; Aldao et al., 2015; Kobylinska & Kusev, 2019). Furthermore, the focus on specific emotion regulation strategies does not take into account other emotion regulation abilities beside the mere modulation of emotions that are important predictors of an adaptive and successful overall emotional functioning (Gratz & Roemer, 2004; Prefit, Candea, & Szentagotai-Tatar, 2019; Thompson, 1994). Therefore, a broader understanding of emotion regulation difficulties, not only including the mere modulation of emotions, might be of higher clinical utility (Gratz & Roemer, 2004; Gratz et al., 2015; Thompson, 1994).

One of the most cited conceptualizations of a broad understanding of emotion regulation difficulties stems from Gratz and Roemer (2004), who integrated several important aspects of emotion regulation in one multidimensional model. They implicated that the *awareness* and *understanding* of emotional experiences are important first steps before emotions can adaptively be modulated (Berking & Lukas, 2015). Furthermore, they argued that for an adaptive emotion regulation, the *acceptance* and *validation* of negative emotional experiences is central, as attempts to suppress or change emotions further increases the risk of emotional dysregulation and impulsive behavior (Linehan, Bohus, & Lynch, 2007; McRae & Gross, 2020). Instead of focusing on specific emotion regulation

strategies, they highlighted the relevance of the *access to and flexible us of situationally appropriate emotion regulation strategies* to modulate the intensity and/or duration (not valence) of emotional responses in order to accomplish individual goals and situational demands, addressing the context dependent nature of adaptive emotion regulation. Additionally, adaptive emotion regulation requires the ability to *inhibit dysfunctional impulsive behaviors* and to *pursuit goal directed behavior* also in negative emotional states (Linehan et al., 2007). In sum, Gratz and Roemer (2004) defined emotion regulation difficulties as deficits in one or more of the following competences that have been operationalized in the *"Difficulties in Emotion Regulation Scale" (DERS):*

1) The awareness and understanding of emotions
2) The acceptance and validation of negative emotions
3) The ability to flexibly use situational appropriate emotion regulation strategies to modulate the trajectory of emotional experiences
4) The ability to engage in goal directed behavior and restrain from impulsive behavior in negative emotional states

This conceptualization of emotion regulation difficulties as *trait-like deficits in overall emotional functioning* is used in the present thesis.

3.2 Evidence for Emotion Regulation Difficulties in Binge-Eating Disorder and Loss of Control Eating

In BED and LOC, prominent *affect-related models* such as the *affect regulation* and the *escape model* posit that binge-eating episodes are triggered by negative affective states (e.g. being angry, bored, stressed, frustrated, disappointed, hurt/ sad or lonely). Further, affect-related models assume that binge-eating serves as an attempt to alleviate respectively escape from these negative affective states by food providing short-term comfort and distraction (binge-eating as a dysfunctional emotion regulation strategy; Haedt-Matt & Keel, 2011; Heatherton & Baumeister, 1991; Polivy & Herman, 1993). It has therefore been suggested that binge-eating is maintained through immediate negative reinforcement mechanisms (Heatherton & Baumeister, 1991; Leehr et al., 2015; Polivy & Herman, 1993). A majority of descriptive, laboratory and naturalistic EMA studies provided evidence that greater negative affect reliably precedes binge-eating episodes relative to average affect and affect before regular eating (Dingemans, Danner, & Parks, 2017; Haedt-Matt & Keel, 2011; Leehr et al., 2015; Svaldi, et al., 2019). However, in contrast to BN, binge-eating episodes in BED seem to occur after a sudden deterioration of mood (increase of negative

affect and decrease of positive affect) and increase of tension rather than being the consequence of an accumulation of negative affect (Munsch et al., 2012). The hypothesis that binge-eating is maintained by short-term relief of negative affect has been questioned, as EMA studies found that negative affect does not necessarily decrease after a binge-eating episode, but is often maintained or even intensified due to feelings of guilt and shame arising after binging (Haedt-Matt & Keel, 2011; Munsch et al., 2012; Svaldi et al., 2019). These findings lead to the assumption of a bidirectional relationship between negative affect and binge-eating. Further, rather than being a dysfunctional emotion regulation strategy itself, binge-eating seems to be the consequence of an immediate breakdown in an individuals' ability to effectively regulate negative affect and impulses (Dingemans et al., 2017; Haedt-Matt & Keel, 2011; Munsch et al., 2012; Svaldi et al., 2019). This implies that individuals with BED display profound trait-like difficulties in emotion regulation (Svaldi et al., 2012).

During the last two decades, a growing number of studies has provided evidence for trait-like emotion regulation difficulties in BED and LOC in clinical and community samples (Svaldi et al., 2012; Whiteside et al., 2007). For instance, self-report studies on the dispositional use of adaptive and maladaptive emotion regulation strategies indicated that individuals with BED report an increased use of maladaptive (e.g. emotional suppression, rumination) and a decreased use of adaptive emotion regulation strategies (e.g. reappraisal and problem solving) compared to healthy controls and obese individuals without BED (Danner, Sternheim, & Evers, 2014; Svaldi, Caffier, & Tuschen-Caffier, 2010; Svaldi et al., 2012; Svaldi, Tuschen-Caffier, Trentowska, Caffier, & Naumann, 2014). The negative consequences of the trait-like use of maladaptive emotion regulation strategies in individuals with BED have been shown in a laboratory study, where emotional suppression after a sad mood induction relative to the use of reappraisal was associated with an increased desire to binge in women with BED compared to weight-matched controls (Svaldi et al., 2010). Furthermore, in a subsequent study of Svaldi et al. (2014) obese women with and without BED consumed more calories in a bogus taste task when instructed to engage in suppression relative to reappraisal after a sad mood induction. Women with BED thereby displayed greater food intake than their weight-matched controls across both emotion regulation strategies (Svaldi et al., 2014). These findings are in line with self-report studies showing that obese individuals with BED report higher emotional eating in response to daily stressors than weight-matched controls (Reichenberger et al., 2021), which in turn increases the risk for binge-eating and LOC (Ricca et al., 2009;

Sultson, Kukk, & Akkermann, 2017). A recent meta-analysis indicated that the dispositional use of putative maladaptive emotion regulation strategies such as rumination, suppression and avoidance of negative emotions and related thoughts are moderately to highly correlated to increased ED pathology in BED (Prefit et al., 2019). Conversely, the protecting impact of putative adaptive emotion regulation strategies such as cognitive reappraisal on BED symptoms might be somewhat weaker (Aldao & Nolen-Hoeksema, 2010; Prefit et al., 2019). This could be explained by the findings that the beneficial effects of adaptive emotion regulation strategies might be more context-dependent than the detrimental effects of maladaptive strategies (Aldao & Nolen-Hoeksema, 2012a, 2012b; McRae, Ciesielski, & Gross, 2012; Troy et al., 2013).

Studies taking into account the context-dependency of effective emotion regulation strategies using the DERS (Gratz & Roemer, 2004) found that women and men with BED consistently report less access to emotion regulation strategies perceived as effective than normal-weight and obese controls (Aguera et al., 2019; Brockmeyer et al., 2014; Svaldi et al., 2012). With regard to other important aspects in the overall ability of emotion regulation, self-report data that applied the DERS in mainly women indicated that individuals with BED display markedly increased problems in the awareness, understanding and acceptance of negative emotions (Aguera et al., 2019; Brockmeyer et al., 2014; Kenny, Singleton, & Carter, 2017; Mallorqui-Bague et al., 2018; Svaldi et al., 2012). These findings are underlined by a recent meta-analysis on alexithymia, the inability to accurately recognize and describe one's own emotions (Taylor, Bagby, & Parker, 1992; Taylor et al., 1998), where individuals with BED reported higher alexithymia levels than healthy controls, independent of body weight, age and gender (Westwood, Kerr-Gaffney, Stahl, & Tchanturia, 2017). Furthermore, difficulties to engage in goal directed and restrain from impulsive behavior when experiencing negative emotions (assessed with the DERS) have consistently been found in female dominated samples of individuals with BED relative to normal-weight and overweight controls (Aguera et al., 2019; Brockmeyer et al., 2014; Kenny et al., 2017; Mallorqui-Bague et al., 2018; Svaldi et al., 2012). Recent research on various facets of impulsivity in clinical and community samples with male and female participants have underlined that negative urgency - the emotion-based disposition to act rashly when being emotionally distressed - might be especially salient for BED and LOC (Berg, Latzman, Bliwise, & Lilienfeld, 2015; Davis et al., 2020; Fischer, Smith, & Cyders, 2008; Kenny, Singleton, & Carter, 2019; Ralph-Nearman, Stewart, & Jones, 2020). There are no major differences in emotion regulation difficulties between individuals with BED

and AN respectively BN (Prefit et al., 2019; Ruscitti, Rufino, Goodwin, & Wagner, 2016), albeit emotion regulation difficulties might be slightly less pronounced in BED than in other EDs (Brockmeyer et al., 2014; Kittel, Brauhardt, & Hilbert, 2015; Svaldi et al., 2012).

A recent meta-analysis also dimensionally related increased problems in the awareness and understanding of emotions and greater difficulties in the acceptance of negative emotions to more severe BED/ LOC symptoms in clinical and to a lesser degree in nonclinical samples (Prefit et al., 2019). Similarly, increased deficits in the access to effective emotion regulation strategies, as well as problems to restrain from impulsive and to engage in goal directed behavior in negative emotional states have been related to higher binge-eating frequency and more severe ED pathology in clinical and community samples, above and beyond other well-established etiological factors such as negative mood, body dissatisfaction, dieting and dietary restraint, body-weight, age or gender (Gianini, White, & Masheb, 2013; Kenny et al., 2017; Sim & Zeman, 2006; Svaldi et al., 2012; Whiteside et al., 2007). These associations are slightly stronger for women than for men (Aguera et al., 2019; Prefit et al., 2019). There is further evidence from a study on 221 female students (average age of 19 years) that binge-eating might be associated with greater emotion regulation difficulties than LOC, indicating that BED severity increases together with emotion regulation difficulties (Racine & Horvath, 2018). In addition, recent studies in clinical samples indicated that deficits in overall emotion regulation capacity might be somewhat more strongly related to emotional and cognitive ED symptoms (e.g. shape, weight and eating concerns) than to behavioral symptoms such as binge-eating/ LOC (Kenny et al., 2017; Pisetsky, Haynos, Lavender, Crow, & Peterson, 2017; Smith, Mason, & Lavender, 2018). Importantly, a prospective study in a community sample of 1065 young youths found that increased deficits in emotion regulation predict ED pathology about seven months later after controlling for baseline ED symptoms. In contrast, ED pathology did not predict elevated emotion dysregulation (McLaughlin, Hatzenbuehler, Mennin, & Nolen-Hoeksema, 2011).

Although there is evidence for increased trait-like emotion regulation difficulties in female and male individuals with BED and LOC compared to healthy and weight-matched controls, as well as its relation to BED/ LOC severity, little is known about the *mechanisms of how deficits in overall emotion regulation relate to BED and LOC* together with other important etiological factors.

3.3 Mechanisms of how Emotion Regulation Difficulties Relate to Binge-Eating Disorder and Loss of Control Eating

First, it seems important to note that BED/ LOC and emotion regulation difficulties share important bio-psychological risk and maintaining pathways, which might contribute to their close relationship. For instance, altered brain serotonin transmission has been linked to the regulation of appetite, impulsiveness as well as cognitive and emotion regulatory processes, all factors that have shown to be impaired in BED and LOC (Wolf et al., 2018). However, findings for a genetic risk of altered serotonin functioning in BED samples are mixed (Davis, 2015). Moreover, retrospective studies indicated that adverse childhood experiences, including parenting problems, family conflicts, parental psychopathology and physical and sexual abuse are associated with an increased risk for the development of both, BED/ LOC and emotion regulation difficulties (Dvir, Ford, Hill, & Frazier, 2014; Hilbert et al., 2014; Micali et al., 2017). Increased overall emotion regulation difficulties might thereby at least partially contribute to the negative impact of such adverse childhood experiences on mental and physical health (Cloitre et al., 2019; Rudenstine, Espinosa, Cancelmo, & Puliyampet, 2019).

In accordance with affect-related models, mechanisms of how emotion regulation difficulties relate to BED and LOC have predominantly been investigated in relation to *negative mood*[1]. Two cross-sectional studies on predominantly female and male students indicated that negative mood and high fluctuations in negative mood predict more binge-eating/ LOC especially in those individuals who display marked overall emotion regulation difficulties (as assessed with the DERS total score; Kukk & Akkermann, 2017, 2020b). In other words, emotion regulation difficulties may alleviate or attenuate the negative consequences of increased negative mood on BED/LOC, depending on the severity of deficits in emotion regulation. This has been further emphasized in a prospective study by Bodell et al. (2019), who found that negative mood and overall emotion regulation difficulties co-vary over time in individuals with repeated binge-eating and that the effects of emotion regulation difficulties on ED pathology in BED and LOC might show off via changes in negative mood. Moreover, a cross-sectional study on 104 community men suggested that negative mood manifests through emotion regulation difficulties in binge-eating, meaning that high negative mood is linked to increased deficits in emotion

[1] Note that negative mood most often has been operationalized with depressive- and anxiety symptoms respectively longer lasting general negative emotional states.

regulation capacity, which in turn leads to binge-eating (Kukk & Akkermann, 2020a). This close link between negative mood and emotion regulation difficulties in relation to BED and LOC is also supported by a study on a mixed gender sample of 71 adults with BED. In this study, overall emotion regulation difficulties were only associated with higher binge-eating frequency in the presence of elevated negative mood (i.e. high levels of depressive symptoms; Kenny et al., 2017). This indicates that individuals with BED/ LOC and increased emotion regulation deficits are especially vulnerable when experiencing more intense negative emotions. This is contrasted by daily-life data of a recent EMA study on 79 predominantly women with BED showing that increases in negative affect and rumination predicted subsequent binge-eating episodes, whereas the successful application of adaptive emotion regulation strategies substantially decreased the risk for binge-eating. However, neither the state-like use of adaptive nor maladaptive emotion regulation strategies alleviated respectively increased the probability of subsequent binge-eating episodes in interrelation with negative affect. This indicates that emotion regulation difficulties also contribute independently of the presence or absence of negative affect to binge-eating in BED (Svaldi et al., 2019).

In contrast to the interplay of emotion regulation difficulties with negative mood, much less is known about the relevance of emotion regulation difficulties in the development and maintenance of BED and LOC in the context of other important influencing factors such as *appearance-based rejection sensitivity*, *body dissatisfaction* and *cognitive distortions*.

3.3.1 Interpersonal Emotion Regulation Difficulties

Negative affect preceding binge-eating and LOC episodes often arises from interpersonal stressors (Dingemans et al., 2017; Ranzenhofer et al., 2014). These derive from increased *interpersonal problems* in individuals with BED and LOC compared to normal-weight and obese controls (Ansell et al., 2012; Blomquist, Ansell, White, Masheb, & Grilo, 2012; Brugnera et al., 2018; Elliott et al., 2010; Ranzenhofer et al., 2014; Zeeck et al., 2011). Indeed, interpersonal problems were cross-sectionally related to increased binge-eating/ LOC and general ED pathology via negative mood in adults with BED (Ivanova et al., 2015) and youth with LOC (Elliott et al., 2010). Interpersonal problems have been attributed, among other explanations, to a *high sensitivity for appearance-based rejection* (referred to as *appearance-based rejection sensitivity*; De Paoli, Fuller-Tyszkiewicz, & Krug, 2017; Park, 2007; Schmidt & Martin, 2017). The concept of appearance-based

rejection sensitivity refers to an individual's tendency to anxiously expect, readily perceive and overreact to real or imagined rejection based on one's own appearance. Appearance-based rejection sensitivity is associated with past and current adverse interpersonal experiences (Downey & Feldman, 1996; Park, 2007) such as for example weight-related teasing due to increased body weight, both risk factors that are specific for the onset of BED (Hilbert et al., 2014). Questionnaire-based studies related appearance-based rejection sensitivity to disturbed eating in youth and adults, independent of gender (De Paoli et al., 2017; Park, 2007). Moreover, there is evidence that overall increased emotion regulation difficulties favor the sensitivity for putative appearance-based rejection stimuli and decrease the ability to appropriately respond to and deal with related distress (Berenson et al., 2009; Cardi, Di Matteo, Corfield, & Treasure, 2013). These interactional mechanisms between emotion regulation difficulties and interpersonal stressors such as real or readily perceived appearance-based rejection is referred to as *interpersonal emotion regulation difficulties*[2]. Interpersonal emotion regulation difficulties based on appearance-related rejection sensitivity not only trigger binge-eating and LOC but also inappropriate social reactions, which in turn increases the risk for actual rejection, related distress and BED symptoms (De Paoli et al., 2017; Jarcho et al., 2015; Rosenbach & Renneberg, 2011; Schmidt & Martin, 2017). During the developmental phase of youth, peer acceptance is substantially influenced by appearance-related characteristics (Blakemore & Mills, 2014). Therefore, the impact of interpersonal emotion regulation difficulties in relation to appearance-based rejection sensitivity on BED and LOC might especially be salient during youth (Park, 2007; Webb et al., 2017). However, studies on the relevance of interpersonal emotion regulation difficulties in terms of appearance-based rejection sensitivity in the development and maintenance of BED and LOC in youth are still scare.

3.3.2 Body Dissatisfaction, Body-Related Cognitive Distortions and Gender

Appearance-based rejection sensitivity often occurs against the background of increased *body dissatisfaction* (Calogero, Park, Rahemtulla, & Williams, 2010; Hawes, Zimmer-Gembeck, & Campbell, 2020; Lantz, Gaspar, DiTore, Piers, & Schaumberg, 2018; Webb & Zimmer-Gembeck, 2015). Body dissatisfaction represents one of the most established and frequent etiological factors in the development and maintenance of BED and LOC in

[2] Note that interpersonal emotion regulation as defined in the present thesis should not be confused with the definition that has often been applied in previous studies, where interpersonal emotion regulation referred to the regulation of emotions in others (Thompson, 1994).

both female and male youth and adults (Neumark-Sztainer, Paxton, Hannan, Haines, & Story, 2006; Stice & Desjardins, 2018; Stice et al., 2017; Stice, Marti, & Durant, 2011). Recent cross-sectional and longitudinal studies on *dual-pathway models* of the development of disordered eating confirmed that sociocultural influences such as the female thin respectively the male muscular-slim body ideal spread by (social) media lead to self/ideal discrepancies and therefore to increased body dissatisfaction (Allen, Byrne, & McLean, 2012; Stice, 2001). Severe body dissatisfaction in turn contributes to binge-eating/ LOC and ED pathology and is again influenced by a dieting and a negative mood pathway (Stice, 2001; Stice et al., 2011; Stice & Shaw, 2017). The restriction of the quantity and type of food in order to adhere to the body ideal has been related to the onset and maintenance of BED and LOC through psychological and physiological mechanisms that provoke binge-eating behaviors (Reas & Grilo, 2007; Stice et al., 2017). However, data on the dieting pathway relating body dissatisfaction to binge-eating and ED pathology is mixed in both genders (Sehm & Warschburger, 2017; Stice, 2001). This is probably due to a conflation of dieting (energy restriction) with dietary restraint (the cognitive attempt to restrict energy intake regardless of actual food intake; Dakanalis et al., 2014). The negative mood pathway including the aversive impact of negative mood and self-evaluation arising from increased body dissatisfaction on binge-eating/ LOC has been confirmed in cross-sectional and longitudinal studies on female samples (Allen et al., 2012; Dakanalis et al., 2014; Goldschmidt, Lavender, Hipwell, Stepp, & Keenan, 2018; Stice, 2001; Stice et al., 2011). Initial studies on male participants provided less support for this mechanism in male than in female individuals (Brechan & Kvalem, 2015; Cruz-Saez, Pascual, Wlodarczyk, & Echeburua, 2018; Heywood & McCabe, 2006). While especially the negative mood pathway, in accordance with affect-related models, implies the relevance of emotion regulation difficulties, there is a lack of studies that investigated emotion regulation difficulties as an underlying mechanism in the relationship between body dissatisfaction and ED pathology related to BED/ LOC (Wyssen et al., 2016).

Closely related to emotional disturbances such as overall emotion regulation difficulties are deficits in *cognitive functioning* such as increased *cognitive distortions*. Cognitive distortions are defined as consistent, false, irrational, and skewed patterns of thinking and are often related to psychopathology (Kittel et al., 2015). In the context of ED pathology, cognitive distortions have particularly been investigated in terms of the concept Thought-Shape Fusion (TSF; Shafran, Teachman, Kerry, & Rachman, 1999), almost exclusively in women. TSF includes the irrational belief about the closeness of the

relationship between thoughts about food or body ideals[3] and the physical world (Coelho, Baeyens, Purdon, Pitet, & Bouvard, 2012; Coelho, Carter, McFarlane, & Polivy, 2008; Coelho, Roefs, & Jansen, 2010). Adapted from the concept of "Thought Action Fusion" in individuals with obsessive compulsive disorders (Shafran, Thordarson, & Rachman, 1996), TSF holds that the mere thinking about eating fattening/ forbidden food (or thinking about the body ideal) or discontinuing a diet (or giving up the body ideal) increases the sensation that subsequent weight gain is more likely and morally equally wrong than actually eating fattening/ forbidden food (or giving up the body ideal for real; Shafran et al., 1999; Wyssen et al. 2016). Laboratory studies showed that TSF can be experimentally induced in women by instructions to vividly imagine eating large amounts of high caloric/ fattening food or body ideals (Coelho et al., 2008; Wyssen et al. 2016; Munsch et al. in press). Subsequently, feelings of fatness, perceived weight gain, feelings of guilt, of moral wrong-doing and the urge to neutralize the effects of such induced thoughts increased slightly in healthy individuals, but substantially more in women with EDs (Coelho et al., 2012; Coelho, Ouellet-Courtois, Purdon, & Steiger, 2015; Coelho et al., 2010). Accordingly, self-reported TSF trait values are significantly higher in women with EDs compared to healthy women (Coelho et al., 2013; Coelho et al., 2015; Wyssen et al., 2017; Wyssen et al., 2018). Moreover, the only study known to the author that investigated the expression of such body-related cognitive distortions in men compared to women found that women experience higher levels of body-related cognitive distortions in relation to a broader spectrum of ED pathology than men (Dubois, Altieri, & Schembri, 2016). Importantly, there is evidence that the impact of activated body-related cognitive distortions on subsequent negative affect is more pronounced in women with EDs compared to healthy and clinical controls (Munsch et al. in press), and especially in those individuals who report increased emotion regulation difficulties (Humbel et al., 2018). This indicates the ED specific salience of body-related cognitive distortions and their interaction with emotion regulation difficulties in the development and maintenance of BED and LOC.

As outlined, the vast majority of research on the etiology of BED and LOC is based on female samples. However, subclinical BED symptoms and etiological factors such as

[3] TSF in relation to body ideals has been referred to as TSF body (TSF-B; Wyssen, Coelho, Wilhelm, Zimmermann, & Munsch 2016). Note that *publication 1* of this thesis focuses on the original TSF concept related to the imagination of fattening/ forbidden food. Therefore, the term TSF includes TSF-B in the theoretical part of the present thesis for simplification.

body dissatisfaction are frequent in male adults and youth, causing similar impairments than in women (Udo et al., 2013). For instance, body dissatisfaction is reported by 11-72% of women and 8-61% of men of the general U.S. population (Fiske, Fallon, Blissmer, & Redding, 2014). Similarly, in the German part of Switzerland almost 60% of girls report feeling too fat and 60% have already tried to lose weight, while in boys almost 80% wish to have more muscles and 54% have actively engaged in gaining more muscles (Schär & Weber, 2015). Although such numbers are alarming, only around 1% of previous clinical studies on disturbed eating focused on men/ boys (Murray et al., 2017; Rubo, Forrer, & Munsch, 2020). Of these studies, only a handful investigated the mechanism of emotion regulation difficulties in relation to BED symptoms with mixed results (Dubois et al., 2016; Kukk & Akkermann, 2020a; Wyssen et al., 2016). For instance, some studies point to the influence of emotion regulation difficulties on the relationship between body dissatisfaction and disturbed eating in men and boys (Hughes & Gullone, 2011; Lavender & Anderson, 2010). In contrast, a cross-sectional study on 123 adult men of the general population found that body dissatisfaction partially manifests through body-related cognitive distortions but not emotion regulation difficulties in disturbed eating such as binge-eating and LOC (Wyssen et al., 2016). Given the small amount of studies on how etiological factors such as increased emotion regulation difficulties relate to disturbed eating and ED pathology in boys and men, even less is known about potential *gender differences* in these mechanisms. Knowledge on shared and differential etiological mechanisms is crucial to further improve and adapt current treatments to gender specific needs and to potentially reduce treatment barriers, which are especially high in men (Murray et al., 2017).

In sum, current state of research indicates the relevance of emotion regulation difficulties in the development and maintenance of BED and LOC (Aguera et al., 2019; McLaughlin et al., 2011; Svaldi et al., 2012). Complex interplays of emotion regulation difficulties with other important etiological factors eliciting emotional distress such as appearance-based rejection sensitivity, body dissatisfaction and body-related cognitive distortions are assumed but need clarification (Dakanalis et al., 2015; Kenny et al., 2017; Park, 2007). Moreover, there is a significant gap in the literature regarding potential gender differences in these etiological mechanisms. These shortcomings are addresses in *publication 1*.

3.3.3 Publication 1: Gender Differences in the Mechanism of Emotion Regulation Difficulties relative to Body-Related Cognitive Distortions in the Relationship between Body Dissatisfaction and Binge-Eating Disorder Pathology

The objective of *publication 1* was *first* to examine the relevance of emotion regulation difficulties relative to body-related cognitive distortions as an underlying mechanism in the relationship between body dissatisfaction and ED pathology associated with BED, based on the dual pathway approach (Stice, 2001). Specifically, a *path model of mediation* of the relationship between body dissatisfaction and ED pathology was evaluated, including body-related cognitive distortions and emotion regulation difficulties as mediators. *Second*, *publication 1* aimed at shedding light on potential gender differences in the mechanisms of the path model of mediation, thereby being the first study that directly compared women and men in the same statistical model. Based on findings that emotion regulation difficulties might be more strongly associated with BED and LOC in women than in men (Prefit et al., 2019; Wyssen et al. 2016) and that women may report higher body-related cognitive distortions associated with a broader range of ED pathology (Dubois et al., 2016), the mediating mechanisms of emotion regulation difficulties and body-related cognitive distortions were expected to be more important in women than in men.

Methods and Main Results

Publication 1 included cross-sectional self-report (questionnaires) data from a community sample 418 women (mean age of 23.2, *SD*=4.8) and 141 men (mean age of 23.5, *SD*=3.4) not differing in age ($t(551)=-.80$, $p=.426$). Participating individuals were part of different substudies related to a multicenter study conducted at the Department of Clinical Psychology and Psychotherapy of the University of Fribourg and the Department of Clinical Child and Adolescent Psychology of the Ruhr-University of Bochum (Munsch, 2014)[4]. Data used in *publication 1* were exclusively assessed at the University of Fribourg. Almost three quarters (72.3%) of participants were students.

The path model of mediation included body dissatisfaction as predictor, ED pathology associated with BED/ LOC as outcome variable and overall emotion regulation difficulties and body-related cognitive distortions as mediators. BMI, perceived social pressure from media to meet the transmitted body ideal and the internalization of this body ideal were included as covariates. After giving informed consent, participants filled in online questionnaires about sociodemographic information and the respective variables in

[4] The type of substudy had no effect on the path coefficients in the present path model of mediation.

the model. All questionnaires that were applied are well established and possess good psychometric properties. For more information about which specific questionnaires were used see *publication 1* in appendix A[5]. Note that overall emotion regulation difficulties were assessed with the DERS total score (Gratz & Roemer, 2004). The path model of mediation was first applied separately in women and men. In a second step, a multiple-group path model of mediation with gender as a grouping factor was conducted to test whether path coefficients differ between women and men. In the present thesis statistical coefficients are not presented in detail but can be retrieved from full-length publications (appendix A for *publication 1*).

Women reported higher levels of body dissatisfaction, ED pathology and body-related cognitive distortions but lower levels emotion regulation difficulties compared to men (with small to medium effects: Cohen's *d* ranging from 0.24 to 0.68). Moreover, and consistent with what can be expected from community samples, a substantial part of women and men displayed relevant body dissatisfaction (44.1%), emotion regulation difficulties (18.3%), body-related cognitive distortions (25.9%) and ED pathology (24.7%).

Results of the path-model of mediation revealed that, controlling for covariates, increased body dissatisfaction strongly predicted elevated ED pathology in both women and men. Body-related cognitive distortions partially mediated this relationship in both genders. In contrast, emotion regulation difficulties did not emerge as mediator in the relationship between body dissatisfaction and ED pathology in either gender because deficits in emotion regulation were not related to ED pathology neither in women nor in men. Body dissatisfaction was still significantly associated with ED pathology when controlled for the covariates and the two mediators, underlining its partially independent association with ED pathology. Overall, the path model of mediation explained substantial 51.9% of the total variance of ED pathology in women and 58.3% in men. Importantly, direct comparisons of path coefficients in the multiple-group path model revealed no gender differences in any path.

[5] Note that the outcome variable ED pathology included binge-eating/ LOC frequency, eating concerns and compensatory behavior. Compensatory behavior was included as especially normal-weight individuals with BED and LOC can show low-threshold dysfunctional attempts to prevent weight gain (Goldschmidt et al., 2011), not fulfilling the criteria of full-threshold or subclinical BN according to the DSM-5. Further note, that ED pathology did not include weight- and shape concerns to prevent overlap with the predictor variable body dissatisfaction.

The findings of *publication 1* highlight the importance of body dissatisfaction and body-related cognitive distortions in etiological models of BED and LOC in both genders. Moreover, *publication 1* indicates that there might be more similarities than differences between women and men in the etiological mechanisms leading to ED pathology associated with BED and LOC. The missing mediation effect of emotion regulation difficulties in both genders warrants further considerations for the present thesis, against the background of an integrative etiological model of BED and LOC. This is discussed in chapter 3.3.4 and more extensively in chapter 5.1.

Publication 1 is available in appendix A.
Citation: Forrer, F., Wyssen, A., Messerli-Bürgy, N., Meyer, A. H., & Munsch, S. (submitted). The Mediating Role of Emotion Regulation Difficulties and Cognitive Distortions in the Association between Body Dissatisfaction and Eating Disorder Pathology: A Gender Comparison.

3.3.4 Implications for an Integrative Etiological Model

The finding that emotion regulation difficulties failed to mediate the relationship between body dissatisfaction and ED pathology in the community sample of young women and men of *publication 1* does not necessarily contradict current state of research indicating emotion regulation difficulties as an important underlying mechanism in BED and LOC (Aguera et al., 2019; Svaldi et al., 2012; Svaldi, et al., 2019). For instance, Prefit et al. (2019) confirmed in their meta-analysis that the association of emotion regulation difficulties with ED pathology is weaker in nonclinical than in clinical populations. Moreover, a recent study indicated that if distress resulting from stressors like body dissatisfaction is on average low such as in the present sample, emotion regulation difficulties are consequently less relevant for BED symptoms (Kenny et al., 2017). Furthermore, emotion regulation difficulties might not directly translate into ED pathology as implicated in *publication 1* but rather increase or weaken the influence of body dissatisfaction and other important etiological factors in an integrative model of the development and maintenance of BED and LOC (moderator, see Figure 1; Dakanalis et al., 2015; Hughes & Gullone, 2011; Humbel et al., 2018; Lavender & Anderson, 2010). This is especially relevant against the background that individuals with BED experience greater negative emotional intensity in response to stressors than weight-matched controls (Svaldi et al., 2012). Importantly, the relationship of emotion regulation difficulties with other etiological factors and BED/ LOC

can be assumed to be bidirectional (Aguera et al., 2020). Therefore, deficits in emotion regulation difficulties might also worsen due to increased psychopathology and emotional distress, generating a vicious and maintaining circle of distress arising from etiological factors and daily stressors, emotion regulation difficulties, binge-eating/ LOC and weight-gain.

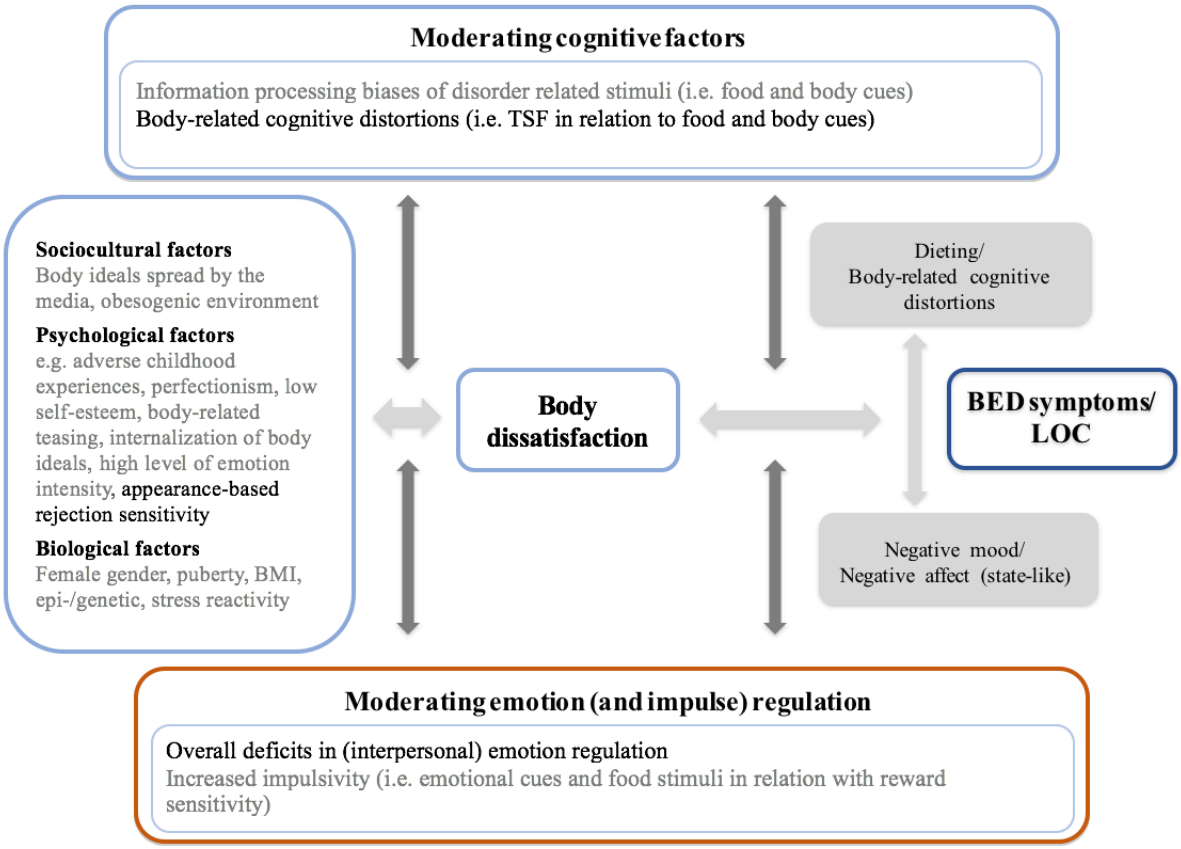

Figure 1. Integrative model of the development and maintenance of BED and LOC based on Culbert et al. (2015), Munsch (2014) and Stice & Van Ryzin (2019). Note that this model is not conclusive as for instance molecular genetic studies are not included. Body-related cognitive distortions in terms of TSF have been included as mediator based on *publication 1* but also as moderating factor as such a mechanism might also be assumed for body-related cognitive distortions.

4 Relevance of (Interpersonal) Emotion Regulation Difficulties in the Treatment of Binge-Eating Disorder and Loss of Control Eating

4.1 Natural Course and Consequences of Binge-Eating Disorder and Loss of Control Eating

Limited longitudinal evidence suggests that the natural course of BED and LOC without treatment is more variable than in AN or BN (Davis et al., 2020; Tanofsky-Kraff et al., 2020). Findings indicated that once fully emerged, BED follows a rather chronic course with a mean illness duration of 15.9 years in community samples. This course is characterized by fluctuating episodes of remission (i.e. abstinence from binge-eating for a certain time period, mostly 4 weeks) and relapse (Udo & Grilo, 2018). Especially in the beginning of BED manifestation spontaneous remission rates are high. About two third of affected individuals experiences only one episode of BED followed by a subsequent remission rate of up to 93% within the first year. One third experiences two or more BED episodes with persisting symptoms (Stice et al., 2013). Studies on LOC in youth indicated remission rates of up to 50% in the natural course of LOC over approximately 5 years (Goldschmidt, Wall, Zhang, Loth, & Neumark-Sztainer, 2016; Tanofsky-Kraff et al., 2011). Another 50% of youth with LOC develops full or partial BED in adulthood (Hilbert, Hartmann, Czaja, & Schoebi, 2013; Tanofsky-Kraff et al., 2011). Importantly, especially youth with more severe disordered eating including LOC have a high risk (up to 75%) to experience persistent disordered eating 10 years later (Pearson et al., 2017). Moreover, a recent meta-analysis suggested that a younger age with LOC and binge-eating is associated with a more persistent course over 10-15 years (Romano et al., 2020). While during adulthood BED shows fewer instances of diagnostic crossovers to other EDs compared to AN and BN (Davis et al., 2020; Schaumberg et al., 2019), 20-50% of adolescents with BED do develop compensatory behaviors respectively BN during youth (Allen et al., 2013; Davis et al., 2020; Stice et al., 2013). This indicates that diagnostic crossovers might be more likely prior to adulthood.

The negative consequences of untreated BED and LOC are further underlined by longitudinal community studies indicating that BED and LOC during childhood and early adolescence predict later depressive- and anxiety symptoms as well as substance use and self-harm behaviors in youth and young adulthood (Field et al., 2012; Micali et al., 2015; Skinner, Haines, Austin, & Field, 2012; Sonneville et al., 2013; Stice et al., 2013; Tanofsky-Kraff et al., 2011). Prospective studies further indicated that BED and LOC in

childhood and early adolescence predict overweight and obesity during youth into young adulthood (Field et al., 2012; Micali et al., 2015; Sonneville et al., 2013; Tanofsky-Kraff, Yanovski, et al., 2009), as did BED in young women (Fairburn, Cooper, Doll, Norman, & O'Connor, 2000). Accordingly, BED and LOC increase the risk for obesity-related sequelae in youth and adults such as metabolic syndrome, cardiovascular diseases and premature mortality (Global et al., 2016; Juonala et al., 2011; Kessler et al., 2013; Mitchell, 2016; Olguin et al., 2017).

In sum, current findings on the course of untreated BED and LOC in adults and youth underline the long-term adverse impacts on psychosocial and physical functioning. Furthermore, the findings indicate that youth posits an especially vulnerable phase for the manifestation of chronicity, the detrimental consequences of binge-eating behaviors as well as the development of full-threshold BED. This underlines that not only efficacious treatment options for adults respectively BED are needed but also prevention and early treatment approaches for youth with LOC.

4.2 Efficacy of State of the Art Treatments

Current evidence on the efficacy of treatment approaches of BED is almost exclusively based on adults, predominantly women. *Psychotherapy,* more specifically the most frequently studied approach of *manualized CBT*, is clearly considered as the treatment of choice in BED according to the current German (AWMF, 2019) and the English (NICE, 2017) treatment guidelines. For instance, CBT has shown to be superior to behavioral weight loss treatments (BWL) in reducing binge-eating in the short- and long-term, independent of the treatment format (face-to-face or structured self-help; Iacovino, Gredysa, Altman, & Wilfley, 2012; Munsch et al., 2007; Wilson, Wilfley, Agras, & Bryson, 2010). Similarly, while pharmacological treatments (mostly antidepressants) are superior to pill placebos in reducing binge-eating with inconsistent results for depressive and general ED pathology, CBT-based face-to-face therapy and *structured self-help* provide significantly better treatment outcomes (Brownley et al., 2016; Ghaderi et al., 2018; Vocks et al., 2010). None of the mentioned treatment options substantially reduce body weight of individuals with BED (Ghaderi et al., 2018; Hilbert et al. 2019; Vocks et al., 2010).

In a recent meta-analysis including 43 randomized controlled trials (RCTs) on particularly CBT-based face-to-face psychotherapy and structured self-help (guided and unguided respectively online and offline formats) for BED, face-to-face psychotherapy provided large and structured self-help medium to large reductions of binge-eating episodes

compared to inactive control groups at the end of treatment. Furthermore, face-to-face as well as structured self-help treatments moderately improved general ED pathology relative to inactive control conditions (Hilbert et al., 2019). Following face-to-face CBT in RCT results in highest abstinence rates (i.e. no binge-eating episodes during the last month) of 42-61%, whereas abstinence rates of 32-59% are reported for structured self-help (Hilbert et al., 2019; Linardon et al., 2018). Evidence on the effect of CBT-based face-to-face therapy and structured self-help for BED on depressive symptoms is inconsistent but indicates that face-to-face CBT has a small effect on comorbid depressive symptoms, whereas structured self-help often provides no meaningful improvement (Ghaderi et al., 2018; Hilbert et al., 2019; Schlup, Munsch, Meyer, Margraf, & Wilhelm, 2009; Vocks et al., 2010). Preliminary meta-analytic findings suggested that, although CBT is the most well-established therapy for BED, other psychotherapies with specific interventions for BED may be similarly efficacious, with growing evidence especially for interpersonal psychotherapy (IPT; Hilbert et al., 2019; Spielmans et al., 2013). In contrast to BN, guided structured self-help may not provide substantially better treatment outcomes than unguided structured self-help (Hilbert et al., 2019). This indicates that in structured self-help for BED guidance might not be indispensable for treatment success, albeit this needs further clarification. Face-to-face therapy results in lower dropout rates than structured self-help, where attrition is smaller in guided than in unguided formats (Beintner, Jacobi, & Schmidt, 2014; Hilbert et al., 2019).

Long-term maintenance of achieved improvements in RCTs was found up to 6 years after treatment end for face-to-face CBT and IPT (Fischer, Meyer, Dremmel, Schlup, & Munsch, 2014; Hilbert et al., 2020; Wilson et al., 2010) and up to 2 years for structured self-help (de Zwaan et al., 2017; Wilson et al., 2010). For instance, in a study by Munsch et al. (2007) only 6% of individuals still fulfilled the diagnostic criteria of BED at 12-month follow-up of a 16-weeks CBT and these effects were largely maintained 6 years after treatment end (Munsch, Meyer, & Biedert, 2012). However, a recent meta-analysis also indicated that the abstinence rate of binge-eating up to 12-months after treatment end is similar to the abstinence rate at posttreatment with 46-52% for face-to-face therapy and 45-53% for structured self-help (Hilbert et al., 2020).

Despite the detrimental consequences of BED and LOC in youth for mental and physical health trajectories, studies on psychological treatments in youth are scarce (Crow, 2014). Accordingly, current treatment guidelines are based on research in adults and therefore particularly address adults with BED, whereas only little considerations for

children and youth are made (AWMF, 2019; NICE, 2017). Preliminary treatment studies on LOC and BED in youth adapted evidence-based interventions for adults to the needs of youth. Findings of face-to-face psychotherapy point to the efficacy of CBT (DeBar et al., 2013), dialectical behavioral therapy (DBT; Kamody, Thurston, Pluhar, Han, & Burton, 2019; Safer, Lock, & Couturier, 2007), IPT (Tanofsky-Kraff et al., 2014) and family-based IPT (Shomaker et al., 2017) in reducing LOC frequency. For instance, DeBar et al. (2013) evaluated in their pilot study on 26 girls between 12 and 18 years with LOC an age adapted standard face-to-face CBT with eight initial and four supplement sessions, including interventions on emotion regulation and interpersonal relationships. They found that LOC episodes substantially decreased in CBT compared to a delayed treatment as usual (DeBar et al. 2013). Another study on 105 overweight male and female students at a mean age of 15 years provided first evidence for the efficacy of self-help programs in youth with LOC. In this study, a 16-weeks online *CBT-based guided self-help (CBTgsh)* program lead to greater reductions of LOC at posttreatment and of weight until 9-month follow-up compared to an inactive waitlist condition (Jones et al., 2008).

4.3 Current Challenges and Possible Solutions in the Health Care Provision of Binge-Eating Disorder and Loss of Control Eating

4.3.1 Major Challenges

Current health care provision of BED and LOC is faced with some significant challenges that need to be addressed. As outlined, the efficacy of evidence-based treatments for BED in adults indicates that even though these treatments substantially improve core symptoms of BED, still approximately 50-60% of affected individuals do not fully benefit in terms of being abstinent from binge-eating (Hilbert et al., 2019; Linardon et al., 2018). Moreover, efficacy of age adapted treatments in youth needs further clarification (Crow, 2014). This shows that there is still need for improvement in current treatments. For this reason, research on important mechanisms in the development and maintenance of BED and LOC such as (interpersonal) emotion regulation difficulties warrants enhanced translation into treatment (Hilbert et al., 2019).

Another major challenge in current health care provision of BED and LOC includes that both are still not sufficiently recognized, diagnosed and treated (Kornstein, 2017). Missed opportunities for recognition of BED in daily health care lead to length delays in the diagnosis and treatment of BED, which is associated with increased health care cost expenditure and a significant hidden health burden (Huizinga, Cooper, Bleich, Clark, &

Beach, 2009; Mond, Myers, Crosby, Hay, & Mitchell, 2010; Santomauro et al., 2021; Supina, Herman, Frye, & Shillington, 2016; Watson et al., 2018). For instance, international data indicates that 50-60% of adults with BED never seek or have no access to specialized treatment offers, even in high income countries with good health care provision such as Switzerland (Hart, Granillo, Jorm, & Paxton, 2011; Kessler et al., 2013; Mohler-Kuo et al., 2016). In youth, the health care situation with regard to BED is even more precarious with a representative U.S. community study indicating that only around 11.6% of youth with BED seek or have access to adequate treatment. This is the lowest rate among EDs in youth (Forrest, Smith, & Swanson, 2017). Information on treatment utilization of youth with LOC is missing but it may be even lower than in full-threshold BED given that youth tend to show lacks in self-identification of having a problem (Ali et al., 2020). Treatment barriers include, among others, public and self-stigmatization associated with increased shame about having eating and weight related problems, as well as limited access to adequate treatments due to a lack of specialized institutions and large distances to treatment facilities in remote areas (Ali et al., 2020; Ihde-Scholl & Rössler, 2019; Schnyder, Panczak, Groth, & Schultze-Lutter, 2017).

In the following chapters, possible solutions to improve the current health care provision of BED and LOC are discussed and examined in *publication 2* and *3*.

4.3.2 Methodological Solutions: Online Self-Help Interventions and Blended Treatments

Even though current research indicates that face-to-face CBT might outperform CBT-based structured self-help in terms of treatment efficacy and attrition, the latter provides substantial and satisfying improvements in key symptoms of BED (Hilbert et al., 2019). Within structured self-help, guidance (i.e., by a therapist providing support via short face-to-face contacts or e-mail) is highly appreciated by individuals with BED, even if contacts to the therapist are rarely offered and highly standardized (Aardoom, Dingemans, Spinhoven, & Van Furth, 2013; Beintner et al., 2014). This may have an impact on lower dropout rates in guided compared to unguided self-help (Beintner et al., 2014; Hilbert et al., 2019). A major advantage of guided self-help compared to face-to-face treatments is the independency of time and location, increasing the accessibility and availability of

adequate treatments (Beintner et al., 2014). In this regard, online applications of CBTgsh[6] (e.g. via internet platforms or e-mail) might be especially useful compared to the original CBTgsh programs (Aardoom et al., 2013; Dolemeyer, Tietjen, Kersting, & Wagner, 2013), which applied the treatment offline via self-help books with short face-to-face contacts (e.g., Carter & Fairburn, 1998; Grilo & Masheb, 2005; Striegel-Moore et al., 2010). In addition, online CBTgsh provides lower dropout rates than original offline CBTgsh, while there is preliminary evidence that online CBTgsh may also result in better treatment outcomes than the latter (Beintner et al., 2014). Online CBTgsh might be especially beneficial for individuals with less severe comorbid psychopathology, binge-eating compared to restrictive ED pathology, and individuals with BED compared to BN (Aardoom et al., 2013). The first online CBTgsh program in German "INTERBED", including weekly e-mail contacts with a therapist, found substantial improvements of BED core symptoms after 4-months of treatment, albeit a 4-month face-to-face CBT provided faster and greater reductions in binge-eating frequency and ED pathology (at posttreatment: abstinence rate of 61% in face-to-face CBT vs. 36% in CBTgsh; at 6-month follow-up: 58% in face-to-face CBT vs. 38% in CBTgsh; de Zwaan et al., 2012; de Zwaan et al. 2017). However, at 1.5-years follow-up, both treatment conditions provided similar beneficial treatment outcomes (de Zwaan et al., 2017), indicating that in the long-term online CBTgsh may result in similar positive outcomes than conventional face-to-face CBT. However, this needs further consideration. Wyssen et al. (resubmitted) evaluated a short 8-session online CBTgsh program "BED-Online", including weekly written contacts with a therapist via the online platform, in 63 adults with BED (87% women, mean age 37.2 years, *SD*=10.4). The online CBTgsh program lead to a significant reduction of weekly binge-eating episodes compared to a waiting condition, which was maintained during 6-month follow-up. Abstinence rates increased from 0 to 18% after only eight active treatment sessions and further to 38% at 6-month follow-up (Wyssen et al. resubmitted). In youth with LOC, there is so far one study providing evidence that online CBTgsh, enriched with interventions on behavioral weight loss, leads to favorable treatment outcomes compared to a waiting condition in terms of LOC frequency at posttreatment and 9-month follow-up, and general ED pathology and body weight at 9-month follow-up (Jones et al., 2008). Altogether, online CBTgsh is an efficacious lower-threshold treatment approach with the important advantage

[6] Note that the advantages and limitations of online guided self-help are also valid for other treatment approaches than CBT. However, as most research so far is based on CBT, the term CBTgsh is used hereafter instead of guided self-help in general for simplification.

to improve access to care also in underserved populations (Aardoom, Dingemans, & Van Furth, 2016). Therefore, CBTgsh is recommended as a first line treatment of BED and LOC in *stepped care*[7] approaches (NICE, 2017), especially if provided online.

Beside pure online CBTgsh, so called *blended treatments* gained growing interest in recent clinical research. Blended treatments combine the advantages of face-to-face therapy and technology-based interventions such online CBTgsh within one treatment protocol (Andersson, Titov, Dear, Rozental, & Carlbring, 2019; Erbe, Eichert, Riper, & Ebert, 2017). There are various ways how face-to-face sessions can be combined with online CBTgsh. For instance, online CBTgsh sessions can be applied as an adjunctive treatment tool to face-to-face therapy, increasing treatment frequency and intensity, or to decrease the number of face-to-face sessions and replacing them by online CBTgsh sessions (Berger, Krieger, Sude, Meyer, & Maercker, 2018). In BED and generally EDs so far, no clinical trials have been conducted on blended treatments combining face-to-face therapy with online CBTgsh (Ahmadiankalati, Steins-Loeber, & Paslakis, 2020). However, there is evidence from blended treatment studies on depressive disorders that adding online CBTgsh might improve treatment outcomes of face-to-face therapy (Berger et al., 2018) and that a combined approach (partially replacing face-to-face sessions by online CBTgsh) seems to be as effective as face-to-face therapy in adults and youth (Kooistra et al., 2019; Sethi, Campbell, & Ellis, 2010; Thase et al., 2018). With regard to current problematic treatment utilization of individuals with BED and LOC, the latter has the advantage of improving treatment accessibility. In youth, blended treatments might be especially promising as they are likely to be more appealing than conventional face-to-face therapy given its technological component. Further, they address the desire for autonomy in this age group by providing more flexibility in treatment conduction (Sadeh-Sharvit, 2019). On the other hand, close monitoring of severe crisis is still guaranteed during face-to-face sessions, which is a caveat in online CBTgsh and especially relevant in youth (Berger, Bur, & Krieger, 2019).

[7] Stepped care approaches begin with less resource intensive interventions such as online CBTgsh followed by more resource intensive interventions like face-to-face therapy when low-threshold approaches were not efficacious.

4.3.3 Content-Related Solutions: (Interpersonal) Emotion Regulation Difficulties as a Supplement to Current Evidence-Based Treatments

Another way to improve current health care provision in adults and youth with BED and LOC is to further refine current treatments in order to increase remission rates (i.e. being abstinent from binge-eating/ LOC; Linardon et al., 2018). Emotion regulation difficulties have been highlighted as a central mechanism in the integrative model of the development and maintenance of BED and LOC (Figure 1), demanding treatments that improve the ability to respond to and deal with emotion distress. It's important to note that current standard CBT for EDs (CBT-E) focuses more intensively on dysfunctional behaviors (i.e. disturbed eating) and thoughts than on overall emotion regulation difficulties (Munsch, Wyssen, & Biedert, 2018). Therefore, knowledge on how deficits in emotion regulation can be improved by the current treatment of choice in BED is needed to potentially enhance it with more profound interventions on emotion regulation difficulties. In BED, clinical trials generally just began to investigate this question (Mallorqui-Bague et al., 2018) with an especial lack of research in youth with LOC. For instance, a study on 69 women with EDs showed that among individuals with BED overall emotion regulation difficulties assessed with the DERS total score improved, albeit less than in BN, following 16-weeks group CBT-E. Improvements in emotion regulation difficulties were greater in individuals with a better treatment outcome in terms of core BED symptoms. Individuals with a poor treatment outcome especially displayed less progression in accepting negative emotional responses and limited access to emotion regulation strategies (Mallorqui-Bague et al., 2018). Further, a recent study on 97 adults with recurrent binge-eating of an outpatient center offering CBT-based approaches found that improvements of emotion regulation capacity were reciprocally related over time to greater improvements in general ED pathology but not binge-eating (Bodell et al., 2019). In a RCT, Peterson et al. (2020) investigated in 112 individuals with BED the efficacy of face-to-face CBTgsh compared to integrative cognitive-affective therapy (ICAT-BED), which puts an emphasis on labeling and modifying emotional experiences beside standard CBT-E interventions. Interestingly, in both treatments, overall emotion regulation difficulties and core BED symptoms improved similarly. This might probably be based on still substantial overlaps between CBT-E and ICAT-BED given that for example also CBT-E interventions address emotion-related contents in the context of coping with binge-eating (Fairburn et al., 2003).

Altogether, the presented findings indicate that the capacity of emotion regulation can be improved following standard CBT-E, which is related to improvements in key BED

symptoms. However, the findings also indicate that current treatments might further benefit from more specific interventions targeting at emotion regulation difficulties. Moreover, the findings of Peterson et al. (2020) may imply that interventions on emotion regulation difficulties might particularly provide enhanced treatment efficacy if they are embedded in disorder and age salient contents such as interpersonal emotion regulation difficulties in terms of appearance-based rejection sensitivity in youth with BED/ LOC.

Importantly, the need of such profound interventions on emotion regulation difficulties might depend on the severity of emotion regulation difficulties an individual shows at treatment begin (Anderson et al., 2020; Gratz & Roemer, 2004). However, no study has examined the relevance of emotion regulation difficulties as a *predictor of treatment outcome* in online CBTgsh and blended treatments for BED/ LOC. More knowledge on factors such as emotion regulation difficulties that influence treatment outcome is important for accurate treatment planning but also to gain information why these new treatments may work better or less for some individuals. This will help to further develop them accordingly (Linardon, Garcia, & Brennan, 2017). Recent research on predictors of treatment outcomes of various psychological treatments for BED so far provided no robust predictor (Grilo, 2017; Linardon et al., 2017). For instance, inconsistent findings emerged for sociodemographic predictors (i.e. age and gender), severity of BED and negative mood as well as for emotion regulation difficulties, whereas emotion regulation difficulties have rarely been investigated (Accurso et al., 2016; Anderson et al., 2020; Beintner et al., 2014; Hilbert et al., 2019; Linardon et al., 2017; Thompson-Brenner et al., 2013; Vall & Wade, 2015).

To summarize chapter 4.3, online CBTgsh and blended treatments are a solution to increase the accessibility of efficacious treatment options in adults and youth with BED respectively LOC. While the efficacy and positive impact on treatment accessibility of online CBTgsh has been demonstrated in an increasing number of studies in adults (Aardoom et al., 2016), research on blended treatments is in its infancy and might be promising for youth with BED and LOC, for which studies on efficacious and accessible treatment offers are highly lacking (Crow, 2014). Profound interventions on (interpersonal) emotion regulation difficulties are a solution to further improve current treatments of BED/ LOC. However, especially in youth with LOC and BED adapted interventions on (interpersonal) emotion regulation difficulties to disorder and age salient contents are scarce. Moreover, there is a significant lack of studies on the relevance of emotion

regulation difficulties in predicting treatment outcomes in new innovative treatments. In *publication 2 and 3*, these shortcomings are addressed.

4.3.4 Publication 2: Efficacy of a Blended Treatment Program, Addressing Interpersonal Emotion Regulation Difficulties, for Youth with Loss of Control Eating

The objective of *publication 2* was to evaluate for the first time the efficacy and acceptance of a 9-weeks blended treatment program "BEAT" (Binge-Eating Adolescent Treatment – a Training Program for Adolescents and Young Adults with LOC), consisting of three face-to-face workshops and six email-guided self-help sessions, for youth between the ages 14-24 years with LOC. Furthermore, BEAT is the first treatment study in youth with LOC that includes age and disorder salient interventions on interpersonal emotion regulation difficulties in terms of appearance-based rejection sensitivity. Therefore, *publication 2* further aimed at evaluating the efficacy of BEAT in terms of appearance-related rejection sensitivity.

Methods and Main Results

In total, 24 youths with LOC were enrolled in BEAT (mean age: 19.1 years, *SD*=3.5; one male and 23 female participants), of which 16 (all female) completed the posttreatment assessment and 3-month follow-up. Youth were eligible to participate if they experienced LOC at least once during the last 6 months up to the frequency and duration of full-threshold BED. Youth who suffered from AN, BN or a psychological respectively medical condition that needed prior treatment (e.g. acute substance abuse, psychosis, suicidality) were excluded. Parallel participation in a psychological treatment was allowed if this treatment was not ED specific or consisted of a diet-or weight loss program.

BEAT represents a repeated-measures (within-subjects) waitlist control design, which means that all eligible participants completed a two-weeks waiting time after the completion of pretreatment assessment and before starting with the active treatment of BEAT. The active treatment of BEAT consisted of three face-to-face workshops (lasting 90-180 minutes) and six email-guided self-help session (lasting 30-60 minutes) that were applied between face-to-face workshops to support participants in implementing interventions in daily life. Workshops were conducted in either groups of max. three people or in a single setting to avoid long waiting times. The active treatment was followed by 1-

month and 3-month follow-up sessions[8]. BEAT is based on a well-established CBT treatment manual for adults with BED (Fischer et al., 2014; Munsch et al., 2018; Wyssen, Forrer, Meyer, & Munsch, 2019). The manual has been adapted to youth and enriched with standardized interventions on interpersonal emotion regulation difficulties in terms of appearance-based rejection sensitivity in the second half of BEAT. This encompassed psychoeducation of how interpersonal emotion regulation difficulties relate to LOC, self-observation regarding real rejection and appearance-based rejection sensitivity, and skills to respond to and deal with rejection respectively appearance-based rejection sensitivity (e.g. reappraisal and affect-tolerance to avoid inappropriate emotionally impulsive behaviors). Participants were guided by one out of four psychologists in CBT training, who wrote feedback via email on notes, questions and worksheets of processed email sessions, according to standardized topics and text templates (Munsch et al., 2019; Wyssen et al., 2019).

LOC and mental disorders according to the DSM-5 (APA, 2013) were assessed with the short version of the Diagnostic Interview for Mental Disorders (Mini-DIPS; Margraf & Cwik, 2017). Treatment efficacy was investigated in terms of weekly LOC episodes and abstinence from LOC (no LOC episodes during the last four weeks; primary outcomes), general ED pathology (restraint eating, eating concerns as well as shape- and weight concerns), depressive symptoms, appearance-based rejection sensitivity and body weight (secondary outcomes). Outcomes were based on self-report questionnaires that are frequently applied in clinical research (for detailed information on questionnaires see *publication 2* in appendix B). Weekly binge-eating episodes and depressive symptoms were assessed repeatedly during the waiting time and before each BEAT session (including follow-ups). Other outcomes were assessed twice at pre and posttreatment. Youths reported their satisfaction with BEAT at posttreatment to evaluate its acceptance.

The number of weekly LOC episodes strongly decreased during both the waiting-time and the active treatment (detailed statistical coefficients of the main results are presented in *publication 2* in appendix B)[9]. The number needed to treat (NNT; based on the total reduction of weekly LOC episodes during the active treatment relative to the waiting-

[8] The BEAT treatment protocol additionally included a 6 and 12-month follow-up, which were not part of the present thesis as youths were still participating in these follow-up sessions at that time.

[9] Analysis were based on (discontinues) multilevel models and in terms of abstinence rate on a generalized linear model based on a binominal distribution.

time) was 3.6, underlining a moderate to high treatment effect for weekly LOC episodes during the active treatment (Cohen, 1988; Wampold & Imel, 2015). There was a slight increase of youths who were abstinent from LOC at posttreatment (from 4% at pretreatment to 12.5% at posttreatment). During follow-up, achieved reductions of weekly LOC episodes were maintained. General ED pathology and depressive symptoms improved substantially from pretreatment to posttreatment. In contrast, body weight remained relatively stable and appearance-based rejection sensitivity showed a nonsignificant trend of improvement until the end of the active treatment. An additional analysis for the present thesis indicated a positive trend of improvement in the overall ability of emotion regulation as assessed with the DERS total score (Gratz & Roemer, 2004; b=–1.08, SE=0.60, $t(15)$=–1.80, p=.092, d=0.52). With regard to treatment acceptance, participants reported to be highly satisfied with BEAT (on average 8.9 out of 10 possible points, SD=1.2). Until 3-month follow-up, 33% of participants dropped out, which is in line with what can be expected from online interventions (Aardoom et al., 2013).

The findings of *publication 2* indicate for the first time that short blended treatments might be efficacious for core LOC and depressive symptoms, and a well-accepted treatment option for youth with LOC. Even though interpersonal emotion regulation difficulties in terms of appearance-based rejection sensitivity as well as overall emotion regulation capacity did not substantially change during BEAT, it seems reasonable to consider the positive trends for improvement as promising. Given that interpersonal emotion regulation difficulties were specifically target only in the second half of the already short BEAT program while representing an enduring trait-like disposition in the etiology of LOC, these positive trends should be evaluated in prolonged interventions on (interpersonal) emotion regulation difficulties.

Publication 2 is available in appendix B.
Citation: Forrer, F., Rubo, M., Meyer, A. H., & Munsch, S. (ready to be submitted). BEAT Pilot Study: Binge-Eating Adolescent Treatment - Efficacy and Acceptance of a Blended Treatment Program for Youth with Loss of Control Eating.

4.3.5 Publication 3: Emotion Regulation Difficulties as Predictor of Treatment Outcome in an Online CBT-Based Guided Self-Help Program

In order to improve the understanding of treatment outcome predictors in online CBTgsh, the objective of *publication 3* was to evaluate the relevance of sociodemographic and clinical characteristics in terms of age, gender, BED severity, negative mood and overall emotion regulation difficulties in predicting short and longer-term treatment outcome in an online CBTgsh program. This CBTgsh program has shown to be efficacious in reducing core BED symptoms (see summarized results of the CBTgsh program BED-Online on page 39 of the present thesis, Munsch et al., 2019; Wyssen et al. submitted). More specifically, *publication 3* aimed at investigating the relevance of emotion regulation difficulties relative to negative mood in predicting an individual's progress during treatment above and beyond age, gender and the severity of BED.

Methods and Main Results

Altogether, 63 adults with a primary diagnosis of BED between the ages 18 and 70 (mean age: 37.2 years, *SD*=10.4; 87.3% women) participated in the CBTgsh program "BED-Online". Individuals were excluded from participation if they suffered from another psychological or medical condition that needed prior treatment. Most participants were Swiss (88.9%) and 65% hold a University degree respectively a higher education entrance qualification.

Eight weekly active treatment sessions (i.e. 8 weeks of active treatment) as well as 1-, 3- and 6-months follow-up sessions, based on the CBT manual of Munsch et al. (2018), were implemented in the online platform BED-Online. Participants were guided by one of seven psychotherapists or psychologists in CBT training. After each online session, participants received written feedback on notes, worksheets and questions via an integrated communication system. Feedbacks were based on standardized topics and text templates, individualized to the needs of each participant. For detailed information on the study procedure see (Munsch et al., 2019).

To verify BED diagnosis and to assess further mental disorders according to the DSM-5, the Mini-DIPS was applied (Margraf & Cwik, 2017). Treatment outcomes encompassed the number of weekly binge-eating episodes and the severity of general ED pathology (restraint eating, eating- weight- and shape concern) at posttreatment and 6-month follow-up. Predictors included age, gender, the baseline value of an outcome variable (i.e. either weekly binge-eating episodes or general ED pathology), negative mood

in terms of depressive symptoms and emotion regulation difficulties. All data were based on established self-report questionnaires (see *publication 3* in appendix C for more details). It shall be noted here that overall difficulties in emotion regulation were assessed with the DERS total score (DERS; Gratz & Roemer, 2004).

A hierarchal regression model approach was applied for each outcome variable per measurement point to assess the influence of three sets of predictors on short- and longer-term treatment outcomes. In the first set, age and gender were entered and the best fitting model was determined (i.e. that with the lowest cross-validated root-mean square error, RMSE), which could contain both predictors, one of the predictors or none. Then, the baseline value of either weekly binge-eating episodes or ED pathology was included (second set) to evaluate whether the prediction model further improved. Finally, the third set of predictors including negative mood and emotion regulation difficulties were entered to examine whether emotion regulation difficulties relative to negative mood further improve the prediction of treatment outcomes.

Results indicated that gender, baseline weekly binge-eating episodes and emotion regulation difficulties provided the best prediction of weekly binge-eating episodes at posttreatment. Specifically, women, individuals with more baseline weekly binges and more severe emotion regulation difficulties reported a higher frequency of weekly binge-eating episodes at posttreatment (the final model explained 43% of the variance of weekly binge-eating episodes). At 6-month follow-up none of the predictors turned out to be relevant for the prognosis of the treatment outcome of weekly binges. Equally to weekly binge-eating episodes, women and individuals with more severe baseline ED pathology and emotion regulation difficulties showed a worse treatment outcome of general ED pathology at posttreatment (the best prediction model including gender, baseline ED pathology and emotion regulation difficulties explained 35% of the variance of ED pathology). Furthermore, baseline ED pathology and negative mood but not emotion regulation difficulties provided the best prediction of ED pathology at 6-month follow-up (the final model including these two predictors explained moderate 15% of the variance of ED pathology).

Findings of *publication 3* indicate that emotion regulation difficulties might represent an important predictor of immediate treatment outcome in online CBTgsh for BED even when accounting for other meaningful predictors (i.e. gender and baseline BED severity). Furthermore, emotion regulation difficulties contributed more meaningfully to the

prognosis of immediate treatment outcome than mere negative mood, underlining its relevance in the maintenance of BED (Gianini et al., 2013; Svaldi et al., 2019). However, emotion regulation difficulties might have lower impact on longer-term treatment outcome.

Publication 3 is available in appendix C.
Citation: Forrer, F., Rubo, M., Wyssen, A., Meyer, A. H., & Munsch, S. (ready to be submitted). The Influence of Emotion Regulation Difficulties on Short- and Long-Term Treatment Outcome in an Online Guided Self-Help Program for Adults with Binge-Eating Disorder.

5 Discussion

Based on the outlined clinical relevance of BED and its youth-like variant LOC, the aim of the present thesis was *first* to examine and describe mechanisms of how overall trait-like emotion regulation difficulties relate to symptoms of BED and LOC. *Publication 1* examined in a sample of predominantly students gender differences in the importance of emotion regulation difficulties, relative to body-related cognitive distortions, in relating body dissatisfaction to symptoms of BED/ LOC. *Second*, the intention of the present thesis was to translate conclusions drawn from *publication 1* and current state of research on the relevance of emotion regulation difficulties in the development and maintenance of BED and LOC into treatment. The thesis thereby aimed to address the need of more efficacious and accessible treatments, which are especially scarce in youth with LOC (Crow, 2014). *Publication 2* evaluated the preliminary efficacy and accessibility of an innovative 9-weeks blended treatment program (BEAT) for youth with LOC. Furthermore, *publication 2* addressed interpersonal emotion regulation difficulties in terms of age-salient appearance-based rejection sensitivity in the treatment of LOC. *Publication 3* completed the present thesis by examining the importance of emotion regulation difficulties relative to negative mood in predicting short- and longer-term treatment outcome in an online CBTgsh program (BED-Online) for adults with BED, after considering the influence of age, gender and BED severity.

In the present chapter the principal conclusions derived from the three publications are summarized and discussed in terms of etiology, prevention, diagnostic and treatment of BED and LOC.

5.1 Relevance of Emotion Regulation Difficulties in the Development and Maintenance of Binge-Eating Disorder and Loss of Control Eating

The findings of *publication 1* confirmed that body dissatisfaction strongly predicts ED pathology related to BED/ LOC in both genders (Lavender & Anderson, 2010; Stice, 2001; Stice et al., 2017; Stice et al., 2011). Women and men who are dissatisfied with their body seem thereby to be more susceptible to body-related cognitive distortions, which in turn promotes ED pathology in both genders (partial mediation effect of body-related cognitive distortions). Body dissatisfaction seems further to activate emotion regulation difficulties, but these might not directly translate into ED pathology (no mediation effect of emotion regulation difficulties in women and men). The missing mediation effect of emotion regulation difficulties as opposed to body-related cognitive distortions might be explained by findings of questionnaire-based and experimental studies indicating that body-related cognitive distortions represent a specific etiological factor for EDs (Coelho et al., 2008; Coelho et al., 2015; Shafran et al., 1999; Wyssen et al., 2018). In contrast, emotion regulation difficulties represent a transdiagnostic factor in the etiology of BED and LOC that is associated with various mental disorders (Berking & Wupperman, 2012; Svaldi et al., 2012). Instead of directly relating other etiological factors to BED and LOC, emotion regulation difficulties might therefore rather alleviate (promoting resilience) or attenuate (increasing vulnerability) the negative impact of emotional distress, such as resulting from the daily exposure to fattening foods and body ideals, on symptoms of BED/ LOC (i.e. operating as a moderating mechanism; Hughes & Gullone, 2011; Humbel et al., 2018; Lavender, De Young, & Anderson, 2010). However, this conclusion is contrasted by a study of Kukk and Akkermann (2020a), who found trait-like emotion regulation difficulties to fully mediate the relationship between negative mood and binge-eating in men. There is evidence that emotion regulation difficulties are particularly relevant in the context of increased negative mood or in other words, when there is something distressing to be aware of, to understand and to regulate (Kenny et al., 2017). In nonclinical samples such as in *publication 1*, severe negative mood in response to body dissatisfaction as well as substantial deficits in emotion regulation are rather the exception (Fiske et al., 2014; Hilbert, de Zwaan, & Braehler, 2012). Therefore, the mechanism of emotion regulation difficulties in the development and maintenance of BED/ LOC might especially become relevant in clinical samples but also in younger youth, where emotion regulation capacities still mature (King et al., 2018).

Publication 1 confirmed that women display generally higher body dissatisfaction, general ED pathology and body-related cognitive distortions than men (Bentley et al., 2014; Dubois et al., 2016; Quittkat, Hartmann, Dusing, Buhlmann, & Vocks, 2019), putting women under an increased risk for EDs such as BED/ LOC. In contrast, men reported higher difficulties in emotion regulation than women, although still at a nonclinical level. Findings on gender differences in specific aspects of self-reported difficulties in emotion regulation are inconsistent (e.g. Anderson, Reilly, Gorrell, Schaumberg, & Anderson, 2016; Gratz & Roemer, 2004; Weinberg & Klonsky, 2009) and need further examination. Overall, gender differences reported so far have probably been overestimated, also in *publication 1*, as most often female-oriented questionnaires have been applied to assess for example body dissatisfaction and ED pathology in men (Murray et al., 2017; Schaefer et al., 2018). Therefore, applying diagnostic tools assessing more male specific disturbed eating behaviors and body dissatisfaction (e.g. misuse of steroids, drive for muscularity, dissatisfaction with muscular composition of the body) might decrease the differences often found (Rubo et al., 2020). Independent of possible differences in the severity of ED related symptoms and etiological factors, *publication 1* indicates that mechanisms leading to core symptoms of BED and LOC might be comparable in both genders.

In sum, conclusions drawn from *publication 1* suggest that specific mechanisms of how emotion regulation difficulties relate to BED and LOC need further clarification. However, based on the outlined research, the relevance of emotion regulation difficulties in the development and maintenance of BED and LOC remains undisputed and has been integrated in an integrative model of the development and maintenance of BED and LOC in the present thesis (Figure 1). This is also supported by *publications 2* and *3*, which indicate that trait-like (interpersonal) emotion regulation difficulties need profound treatment and that individuals with BED and more severe emotion regulation difficulties show worse immediate treatment outcome in online CBTgsh. Furthermore, *publication 1* suggests that there might be more similarities than differences between women and men than previously assumed in the etiological mechanisms relating to BED and LOC, including emotion regulation difficulties. In line with these conclusions, it seems crucial to target emotion regulation difficulties in treatment, which is part of *publication 2* and *3.*

5.2 Relevance of Emotion Regulation Difficulties in the Treatment of Binge-Eating Disorder and Loss of Control Eating

Findings of *publication 2* provide evidence that the first blended treatment, BEAT, for youth with LOC might be efficacious in decreasing core LOC and depressive symptoms with no apparent rebound effect during 3-month follow-up. In contrast, difficulties in (interpersonal) emotion regulation respectively appearance-based rejection sensitivity did not substantially decrease during the active treatment, albeit showing a trend for improvement. Given that interventions addressing interpersonal emotion regulation difficulties have only been implemented in the second half of the treatment and that changes in trait-like dispositions such as (interpersonal) emotion regulation difficulties might rather take time (Gratz et al., 2015), these positive trends for improvement are promising and should be investigated in prolonged treatments. Preliminary findings in BED support that overall trait-like emotion regulation difficulties may improve in prolonged guided self-help and face-to-face treatments and that these improvements are associated with reductions in core BED pathology, even if treatments do not specifically address emotion regulation difficulties (e.g. in standard CBT-E; Bodell et al., 2019; Mallorqui-Bague et al., 2018; Sloan et al., 2017). However, treatments that include specific interventions targeting at (interpersonal) emotion regulation difficulties such as BEAT, practicing them more intensively, may further improve current treatments and be of greater transdiagnostic utility (this is discussed more detailed in chapter 5.4; Gratz et al., 2015; Hogue & Dauber, 2013; Sloan et al., 2017). *Publication 2* thereby left open if and to what extend the positive trends of improvement in (interpersonal) emotion regulation difficulties are related to improvements in core LOC pathology, and if these improvements predict reductions in LOC pathology and/or vice versa. Most likely seems a reciprocal relationship (Aguera et al., 2019; Bodell et al., 2019). However, the substantial improvement of core LOC pathology and depressive symptoms indicates that these symptoms also decrease independently of improvements in (interpersonal) emotion regulation difficulties.

Findings of *publication 3* provided preliminary evidence that gender, BED severity and emotion regulation difficulties contribute meaningfully to the prediction of immediate treatment outcome. More specifically, women, individuals with higher BED severity and more severe emotion regulation difficulties showed higher weekly binge-eating frequency and general ED pathology severity at the end of treatment. The finding that women might display worse immediate treatment outcome in online CBTgsh than men fits the evidence that female gender represents a risk factor in the development and maintenance of EDs

(Culbert et al., 2015). Increased emotion regulation difficulties predicted higher binge-eating frequency and ED pathology severity at the end of treatment, even after accounting for gender and baseline weekly binges respectively ED pathology. Furthermore, emotion regulation difficulties might have more negative impact on immediate treatment outcome than the mere severity of negative mood. This confirms studies on the development and maintenance of BED/ LOC that have underlined the relevance of emotion regulation difficulties in addition to mere negative mood respectively emotional distress in predicting the severity of core BED/ LOC symptoms (Gianini et al., 2013; Sim & Zeman, 2006). Even though gender and BED severity already provide important prognostic information about posttreatment outcome, emotion regulation difficulties should be assessed routinely in diagnostic procedures as it adds to a more reliable prognosis of immediate treatment outcome. At 6-month follow-up, no predictors of weekly binge-eating frequency emerged, whereas negative mood contributed slightly more meaningfully to the prognosis of the treatment outcome of general ED pathology. While the ability to adequately respond to and deal with emotional distress might be especially relevant for immediate treatment outcome when negative mood is generally elevated, the relevance of emotion regulation difficulties might decrease for longer-term treatment outcomes given that negative mood and emotional distress usually decreases during treatment (Hilbert et al., 2019; Kenny et al., 2017). *Publication 3* may implicate that online CBTgsh might especially be helpful for individuals with lower problems in emotion regulation, which seems intuitive as structured self-help programs demand higher self-regulation capacities than face-to-face treatments (Beintner & Jacobi, 2017). Consequently, individuals who show more pronounced difficulties to regulate their emotions may need more intense support and structure by conventional face-to-face therapy. However, the first study that compared a CBTgsh program (guidance via short face-to-face contacts) with face-to-face ICAT-BED found that individuals with BED and increased emotion dysregulation displayed comparable reductions in core BED symptoms and emotion dysregulation in both treatments, even though ICAT-BED provides a more profound focus on emotion regulation than CBTgsh (Anderson et al., 2020). This opens questions for further research (chapter 5.5).

Overall, *publication 2* and *3* implicate that prolonged interventions on (interpersonal) emotion regulation difficulties might be promising with regard to the further improvement of current evidence-based treatments for adults with BED and new innovative approaches such as blended treatments for youth with LOC. Furthermore, the assessment of emotion regulation difficulties by default within clinical routines might be in support of accurate

treatment planning. However, there are remaining open questions regarding the development and implementation of such interventions that will be discussed in further detail in chapter 5.4 and 5.5.

5.3 Strengths and Limitations of the Present Thesis

The present thesis made important contributions to the current state of research on the etiology and treatment of BED and LOC, with a specific focus on emotion regulation difficulties. The importance of a dimensional and developmental perspective on BED was underlined by providing an overview on the clinical relevance of full-threshold BED and the youth-typical BED variant LOC. This emphasis of both BED and LOC is important as research on LOC in youth is still largely lacking and its recognition as a serious mental health problem on its own insufficient, which is underlined by missing age-adapted diagnostic criteria for LOC (APA, 2013; Tanofsky-Kraff et al., 2020). *Publication 1* investigated for the first time the relevance of emotion regulation difficulties relative to body-related cognitive distortions as an underlying mechanism in the relationship between body dissatisfaction, one of the most potent and frequent etiological factors, and ED pathology associated with BED/ LOC. Although the findings show that specific mechanisms of how emotion regulation difficulties relate to BED and LOC need further clarification, especially in clinical samples, the present thesis nevertheless outlined the need of complementing current etiological models of BED and LOC with emotion regulation difficulties (see the integrative model of the development and maintenance of BED/ LOC in Figure 1). Importantly, *publication 1* was among the first studies that examined gender differences in such etiological mechanisms directly in the same statistical model, indicating that comparable mechanisms relate to BED and LOC in both genders. *Publications 2* and *3* addressed several shortcomings in current research on the treatment of BED and LOC. *Publication 2* investigated the efficacy and acceptance of the first blended treatment, BEAT, for youth with LOC. Against the background that the availability and accessibility of adequate treatment offers is a major concern especially in youth with LOC and BED (Crow, 2014; Forrest et al., 2017), *publication 2* made an important contribution to current research in this research field. Moreover, BEAT is the first pilot treatment program for youth with LOC that translated interpersonal emotion regulation difficulties into treatment, implicating the necessity to further investigate it in larger clinical trials. Finally, *publication 3* was the first study that investigated the relevance of emotion regulation difficulties as a predictor of treatment outcome in an online CBTgsh program for adults with BED.

Importantly, findings provided preliminary evidence for the incremental value of emotion regulation difficulties to other demographic and clinical characteristics in the prediction of treatment outcome.

Beside the mentioned strengths, the findings of the publications in the present thesis must be interpreted considering some limitations[10]. The male sample in *publication 1* and the samples of *publication 2* and *3* were rather small, liming the power to detect small effects while the risk of overestimating other effects cannot be excluded. ED related questionnaires that have been used across *publication 1-3* might not fully cover male ED pathology. For instance, the Eating Disorder Examination Questionnaire (EDE-Q; Hilbert & Tuschen-Caffier, 2016, see full-lenght publications) has been validated in male samples, providing a substantial lower clinical cut-off than the one for women (Schaefer et al., 2018). This might support that this questionnaire does not assess disturbed eating behaviors that seem to be especially salient in men such as muscularity-based shape and weight concerns and related disturbed eating- and weight control behaviors (Murray et al., 2017). In this context, the findings of *publication 1* on gender differences and *publication 3* on gender in the prediction of treatment outcome might be female biased to some degree. Furthermore, the present thesis relies on self-report data. This is legitimate given that for example trait-like dispositions in emotion regulation difficulties that are relevant across a wide range of situations might be best operationalized by directly asking people about their difficulties. However, with regard to difficulties in emotion regulation there lies a problem in itself as for example it may be rather difficult to ask people about their awareness of emotions when they are largely not aware of it. This might explain why especially the awareness subscale of the DERS showed rather poor internal consistency in previous studies, while the DERS generally demonstrated satisfying psychometric properties in female and male adults and youth (Gratz & Roemer, 2004; Weinberg & Klonsky, 2009). Furthermore, self-report data in general underlie the problem that they might be biased to some degree for example due to recall problems or a tendency to underreport ED symptoms and mental health burden especially in males and youth (Ali et al., 2020; Murray et al., 2017). Across all publications, the generalizability of findings is limited. For instance, in all publications a majority of participants was well-educated, limiting the generalizability to exactly those samples who most urgently need improvements with regard to mental-health provision such as for BED and LOC (Forrest et al., 2017). However, this limitation does not concern this thesis

[10] Note that in this chapter the limitations will be summarized across publications, whereas more specific limitations for each publication can be derived from full-length articles in appendices A to C.

exclusively, but represents a general problem of treatment research. Furthermore, given that the sample consisted predominantly of students, the findings of *publication 1* cannot fully be transmitted to clinical samples, to younger adolescents and to middle aged cohorts (age periods, in which BED and LOC are prevalent). In *publication 2* and *3,* especially the generalizations to male samples is limited. A major limitation of *publication 1* is that due to the cross-sectional design no conclusions about causality can be drawn regarding the mechanisms investigated, which has been addressed in *publication 2 and 3* that applied prospective designs. Furthermore, this thesis does not provide evidence on the differential importance of specific emotion regulation processes such as the awareness or understanding of emotions, as analyses were limited to the DERS total score. Given the rather small sample sizes and the evidence that individuals with BED reveal problems in all aspects of emotion regulation (Brockmeyer et al., 2014; Svaldi et al., 2012), the focus on the DERS total score seems nevertheless appropriate.

5.4 Clinical Implications

5.4.1 Diagnostic and Prevention of Binge-Eating Disorder and Loss of Control Eating

The present thesis underlines the importance of early detection and diagnosis of BED and LOC to decreases related psychosocial impairment and public health burden, and to prevent chronicity and associated detrimental consequences for mental and physical health trajectories (Udo & Grilo, 2018). Children and youth with LOC might be at particular risk to be left undiagnosed and untreated as indicated by the lack of research in this field (Crow, 2014; Tanofsky-Kraff et al., 2020). Therefore, an important step would be the development of evidence-based age adapted *diagnostic criteria for LOC* in youth. This should not only encompass broadened criteria with regard to the inclusion of LOC over smaller food amounts, which will be addressed by the implementation of the ICD-11 (WHO, 2020b). Indeed, lower frequency and duration criteria than for BED might be needed for youth with LOC given the negative consequences of also low frequent LOC (Tanofsky-Kraff et al., 2011). However, accurate frequency and duration criteria for LOC in youth need further investigations (Schlüter et al., 2016). Moreover, it may be examined whether body image disturbances (e.g. overvaluation of shape and weight) should be added to the diagnostic criteria of LOC, for example as a diagnostic specifier, indicating greater illness severity and as it has been recommended for BED (Grilo, 2013; Wang et al., 2019).

Beside accurate diagnostic criteria for LOC, early diagnostic identification of individuals at risk of or with BED and LOC requires suitable *screening instruments* of BED symptoms and related etiological factors (Aguera et al., 2019; Stice & Van Ryzin, 2019). While binge-eating and body dissatisfaction are already captured by well-established assessment instruments (e.g. Hilbert & Tuschen-Caffier, 2016), the present thesis outlines that self-report questionnaires assessing LOC, emotion regulation difficulties and body-related cognitive distortions should be included by default in screening tools. However, current instruments that assess LOC in youth are not sensitive enough and need to be improved (Altman et al., 2020; Kass et al., 2017). Furthermore, broad screening strategies are needed in terms of *awareness campaigns* that could be implemented for instance at primary, middle and vocational schools as well as other institutions where youth and young adults at risk of and with BED symptoms are reached. Based on such awareness campaigns promoted via schools, public institutions or social media, the implementation of *prevention programs* is needed. Thereby, selective and indicative preventive interventions (selective prevention: interventions for individuals at increased risk for BED symptoms, i.e. because of increase emotion regulation difficulties, body-related cognitive distortions or body dissatisfaction; indicative prevention: interventions for high risk individuals who show first signs of LOC/ BED) have generally shown to be more clinically and cost effective than universal prevention strategies (preventive interventions for the general public, not necessarily at risk; Dray et al., 2017; Stockings et al., 2016; Werner-Seidler, Perry, Calear, Newby, & Christensen, 2017). For instance, a meta-analytic review found that 51% of ED prevention programs reduce ED risk factors, with larger effects for selective relative to universal intervention programs (Stice, Shaw, & Marti, 2007). Nevertheless, there is evidence that universal preventive interventions might be especially beneficial with regard to transdiagnostic factors such as (interpersonal) emotion regulation difficulties (Smyth & Arigo, 2009). Therefore, the WHO strongly recommends the delivery of universal preventive programs for mental health promotion, including interventions on emotion regulation difficulties and interpersonal skills (among others), in their guidelines on prevention strategies for mental health in youth (WHO, 2020a). Some risk/ etiological factors such as body dissatisfaction or weight control behaviors are extremely prevalent already in younger youth of the general population (Schär & Weber, 2015; Schuck, Munsch, & Schneider, 2018). Moreover, rates of overweight and obesity are expected to further increase in the next years, in turn increasing the risk for BED and LOC (Ward et al., 2019). Therefore, it seems reasonable to promote curriculums in schools teaching about

mental health, including emotion regulation, healthy body image, physical activity or healthy nutrition (Rohde, Stice, & Marti, 2015). Intervention programs including transdiagnostic factors such as emotion regulation difficulties further have the advantage that they are likely to be preventive for a broad range of mental health issues (Gratz et al., 2015; Volkaert, Wante, Vervoort, & Braet, 2018). In Switzerland, an example of a prevention program that promotes self-esteem and a positive body image, supported by important health promotion institutions such as the "Gesundheitsförderung Schweiz" (among others), is "Bodytalk PEP" of the competence center "PEP"[11] for youth from the age of 12 years up. However, as far as known, there are currently no profound universal prevention programs available for emotion regulation difficulties.

Future prevention programs targeting at emotion regulation difficulties should take into account that interactive programs are more effective than didactic programs and should encompass more than just one session. Moreover, prevention programs (universal, selective/ indicative interventions) might be more effective if they are delivered by a trained professional (who for instance visits school) than by endogenous providers (e.g. teachers; Stice et al., 2007). A recent study on the effectiveness of a selective prevention program for older youths (mean age 22.2, *SD*=7.1) at risk of disturbed eating provided important evidence that beside clinician led prevention programs, their application via peer-leading and the internet is effective (Stice, Rohde, Shaw, & Gau, 2020). This extends possibilities to further spread innovative prevention programs in the general population. Based on the raised awareness due to Covid19 of the general population and health care system for the importance of mental health issues (Torales, O'Higgins, Castaldelli-Maia, & Ventriglio, 2020), it might be the right time to increase prevention efforts for BED/ LOC.

5.4.2 Treatment of Binge-Eating Disorder and Loss of Control Eating

Emotion regulation difficulties might be one mechanism of change underlying treatments of BED and LOC (Mallorqui-Bague et al., 2018). This is in line with an emerging consensus that interventions on transdiagnostic mechanisms in the treatment of mental disorders such as BED/ LOC should be emphasized, reflecting their complexity, dimensional nature and high comorbidity (Dalgleish, Black, Johnston, & Bevan, 2020; Holmes et al., 2018). Standard CBT-E, the current treatment of choice for BED in adults, provides no

[11] PEP „Prävention Essstörungen Praxisnah" is a competence center for the prevention of EDs in Switzerland (https://pepinfo.ch/de/index.php).

comprehensive interventions on emotion regulation difficulties while being not fully efficacious for 50-60% of patients (in terms of being abstinent from binge-eating). Therefore, current evidence-based treatments might benefit in terms of efficacy from being enriched or complemented with interventions on emotion regulation difficulties (Gratz et al., 2015; Sloan et al., 2017). A treatment approach that might indeed especially be interesting with regard to emotion regulation difficulties as well as cognitive distortions in BED and LOC is acceptance-commitment therapy (ACT; Manlick, Cochran, & Koon, 2013). For instance, ACT focuses on emotional avoidance of individuals with EDs by learning to accept and validate negative emotional states and by training affect and distress tolerance. Furthermore, rather than focusing on cognitive restructuring and reappraisal such as in standard CBT-E, ACT puts an emphasis on accepting intrusive thoughts (resulting from body dissatisfaction, body-related cognitive distortions etc.). Thus, individuals learn to defuse respectively achieve psychological distance from their thoughts, feelings, and urges. However, there is preliminary evidence that ACT as well as other third wave CBT approaches that put a more profound emphasis on emotion regulation difficulties than CBT-E such as DBT or ICAT-BED provide no better treatment outcome in terms of core BED symptoms as well as emotion regulation deficits (Hilbert et al., 2019; Linardon, Fairburn, Fitzsimmons-Craft, Wilfley, & Brennan, 2017; Peterson et al., 2020). Based on these findings, unified transdiagnostic treatments on emotion regulation difficulties that focus on the whole process of emotion regulation from interventions on emotional awareness to the acceptance and tolerance of emotions, not only on the emotional but also on the behavioral, cognitive and psychophysiological level, might be particularly interesting. Such a comprehensive treatment of emotion regulation difficulties is provided by Berking and Lukas's (2015) *Affect Regulation Training (ART)*[12]. There is evidence that CBT enriched with ART (ART + CBT) outperforms alone-standing CBT in the treatment of mental disorders such as depression by improving emotional regulation skills and well-being, and reducing depressive symptoms (Berking, Ebert, Cuijpers, & Hofmann, 2013; Berking et al., 2008). Profound treatments on emotion regulation difficulties are further of particular clinical utility with regard to comorbid disorders as they address a wide range of psychopathology and might further improve treatment implementation fidelity across disorders (Gratz et al., 2015; Hogue & Dauber, 2013; Sloan et al., 2017). To increase the salience and the utility for individuals with BED and LOC, it seems reasonable to adapt

[12] German version of ART: Training emotionaler Kompetenzen (TEK; Berking, 2010)

treatments like ART to contents that are especially relevant for them and are likely to trigger typical negative emotions, related thoughts and behaviors. As emphasized in *publication 2*, this could include appearance-based rejection sensitivity. Individuals with BED and LOC should thereby be trained to transmit achieved (interpersonal) emotion regulation skills to any other situation eliciting emotional distress. For instance, emotion regulation trainings could promote the emotional confrontation with negative body-related feelings, which might help to reduce body dissatisfaction (Prefit, Candea, & Szentagotai-Tatar, 2020). The induction of body-related cognitive distortions (by the vivid imagination of fattening foods or body ideals) could make such negative body-related feelings more accessible during treatment sessions. *Publication 1* indicates that no gender specific adaptions with regard to mechanisms through which interventions on emotion regulation difficulties (and also body-related cognitive distortions) work might be necessary. However, some adaptions for male patients are needed as for instance the implementation of the male body ideal with related disturbed eating and weight control behaviors.

Overall, paired with the key contents of CBT-E (e.g. structured and regular meals, coping with binge-eating/ LOC) and defusion approaches from ACT, comprehensive emotion regulation trainings seem promising. However, such profound interventions on emotion regulation difficulties might not be necessary and cost-effective for everyone given that approximately half of affected individuals are abstinent from binge-eating after evidence-based treatments (Hilbert et al., 2019; Linardon et al., 2018) and that also standard CBT-E has positive effects on emotion regulation capacities (Gratz et al., 2015; Sloan et al., 2017). *Publication 3* thereby underlines the importance of assessing emotion regulation difficulties right at the beginning of a treatment. Moreover, there is well-established evidence that *rapid response* to treatment (defined as 65-70% reduction of binge-eating episodes during the first four weeks of treatment) provides good prognosis of treatment success in BED (mediator of treatment outcome; Linardon et al., 2017; Vall & Wade, 2015). Therefore, profound interventions on emotion regulation difficulties might be especially useful for those individuals who show pronounced problems in this regard at treatment begin and/or for individuals who do not experience significant improvements in emotion regulation difficulties respectively core BED symptoms within the first treatment sessions. This suggests that more *tailored evidence-based interventions* are needed, which are adapted in their content and intensity to specific needs and characteristics of individuals with BED/ LOC (Nacke et al., 2019). Support for tailored interventions stems from a recent study from Germany, indicating that current treatments as usual for EDs might be

overdosed, which provides no additional benefit for patients while being cost intensive (Beintner & Jacobi, 2018).

The findings of Beintner and Jacobi (2018) could also reflect that still only 6 – 35% of clinicians report adhering to evidence-based treatments for EDs (Waller, 2016), indicating that more efforts are needed to close the gap between science and practice (Lilienfeld et al., 2013). This might become even more relevant with growing efforts to implement innovative approaches such as blended treatments (BEAT) and online CBTgsh (BED-Online) into daily practice. While *publication 2* showed that new ways of applying treatments are well accepted among affected individuals, a substantial group of therapists is rather skeptical with regard to the efficacy of such treatments (Schröder et al., 2017), even though they are officially recommended in current guidelines (AWMF, 2019). However, Covid19 may have opened doors and video-delivered therapy is booming (Mochari-Greenberger & Pande, 2021). A current meta-analysis provides the important evidence that video-delivered therapy is equally efficacious than conventional face-to-face therapy (Fernandez et al., 2021). This has important implications for blended treatments and online CBTgsh. For instance, experiences from *publication 2* (BEAT) imply that blended treatments might not substantially reach more youth with LOC than conventional therapy given that individuals still need to come to treatment facilities for face-to-face sessions. Therefore, blended treatments such as BEAT might benefit in terms of treatment access if face-to-face sessions are conducted online via video (due to Covid19 some of the BEAT workshops already had to be conducted via video tools and it seems to work good for youth with LOC). Experiences *from publication 2* and *3* respectively BEAT and BED-Online further indicate that therapist workload in self-help treatments is still high. Against the background that video-therapy works well, online CBTgsh should effectively lead to less time investment for therapists to increase its benefit in terms of treatment accessibility and cost effectiveness compared to video-therapies.

5.5 Implications for Further Directions of Research

The present thesis provides important implications for further research. As highlighted, *publication 1* indicates that more studies on the interplay of emotion regulation difficulties with other relevant etiological factors in the development and maintenance of BED/LOC are needed in clinical and also younger populations, where emotion regulation abilities mature and consolidate (Blakemore & Mills, 2014; King et al., 2018). There is an urgent need for large prospective community studies to clarify the causal influence of emotion

regulation difficulties on the development of BED and LOC (Aguera et al., 2019). Such community studies should start before the onset of puberty respectively before major risk factors such as body dissatisfaction, interpersonal problems and emotion regulation difficulties become more salient, and enduring into late young adulthood when the mean age of onset of full-threshold BED has passed. Furthermore, studies on the distinctive relevance of specific aspects of overall emotion regulation difficulties for specific symptoms of BED/ LOC are needed as the few existing findings are inconsistent (e.g. Gianini et al., 2013; Whiteside et al., 2007). Even though *publication 1* indicates no gender differences in the mechanism of how emotion regulation difficulties relate to BED and LOC, this should be done separately in men and women to compare eventual gender differences with regard to specific aspects of emotion dysregulation. Beside its trait-like assessment, emotion regulation difficulties should further be assessed state-like in daily life and in the lab to clarify its impact and interplay with negative affect on specific binge/LOC episodes (Munsch et al. in progress). The EMA study by Svaldi et al. (2019) should thereby be supplemented by the state assessment of overall emotion regulation difficulties (e.g. in time awareness and understanding of emotions) instead of specific emotion regulation strategies. The assessment of cognitive factors such as body-related cognitive distortions should be included in EMA studies to evaluate their state impact on binge-eating/LOC relative to emotion regulation difficulties. Moreover, there is increasing interest in the relevance of elevated positive affect in the research field of emotion regulation difficulties (McRae & Gross, 2020). Therefore, emotion regulation difficulties should be investigated in interrelation with increased positive affect in EMA studies with regard to binge-eating/LOC (Nicholls, Devonport, & Blake, 2016). Most EMA studies have assessed negative affect before and after binge-eating episodes (Haedt-Matt & Keel, 2011). However, it seems important that future EMA studies also assess negative (and positive) affect in relation to state emotion regulation difficulties and cognitive distortions *during* binge-eating episodes. This might provide further evidence for potential negative reinforcement processes occurring during episodes of binge-eating, for which data are so far inconsistent (Dingemans et al., 2017). In the lab, negative affect and emotion regulation difficulties could be activated by the induction of interpersonal stress such as being rejected by others. Participants might then be asked about their current perceived state ability to regulate emotions and their urge to eat while simultaneously psychophysiological indicators of emotion (respectively stress) regulation capacity such as heart rate variability (HRV) could be assessed (Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012). This is what

is currently done within a comprehensive research project "i-BEAT" on LOC in youth running at the Division of Clinical Psychology and Psychotherapy of the University of Fribourg (Munsch et al. in progress), where peer rejection is induced in virtual reality (VR) applying the Cyberball game (Hartgerink, van Beest, Wicherts, & Williams, 2015).

Publication 2 and *3* indicate that more research is needed on the influence of pretreatment emotion regulation difficulties as well as their change during treatment on BED/ LOC treatment outcome in different treatment approaches (i.e. face-to-face CBT and online CBTgsh). Moreover, studies are needed that evaluate whether individuals with specific characteristics such as increased problems with emotion regulation benefit more from higher-threshold face-to-face therapy than from lower-threshold online CBTgsh (or vice versa; Linardon et al., 2017). A current study indicates that for increased emotion regulation difficulties this might not be the case (Anderson et al., 2020). Such profound knowledge allows to develop potentially efficacious and cost-efficient *stepped care approaches*, where individuals are assigned to low-threshold or higher-threshold interventions based on their needs. A recent RCT on 191 obese individuals with BED compared a stepped care approach, in which non-responders of BWL switched to CBT augmented with either placebo or weight-loss medication, with pure BWL. The stepped care approach did not differ from BWL in terms of remission (abstinence from binge-eating: 66.5% vs 74.4%). Within stepped care, weight loss medication improved outcomes for BED and obesity compared to placebo (Grilo et al., 2020). This study indicates that there is much room for further research on the strategy of stepped care. For instance, future studies should investigate how much support is actually needed in online CBTgsh across different ages with regard to the development of stepped care approaches. As there is preliminary evidence that also unguided self-help is beneficial for adults with BED, the question about the intensity of guidance might be more important with regard to attrition (Hilbert et al., 2019). In this line, BEAT (*publication 2*) has shown to be intensive for therapists in offering guidance while not necessarily reaching more youth than in face-to-face therapy. Therefore, a next step is to implement BEAT in a full online setting (online CBTgsh). This is done within the i-BEAT project, where the single and additive benefit to standard CBT-E of an online guided emotion regulation module is investigated (Munsch et al. in progress). Beside further developments in the field of online CBTgsh for individuals with BED and especially LOC, new technologies open the possibility for a wide range of potentially helpful interventions (Holmes et al., 2018). Mobile Apps and other online applications to replace paper-pencil work sheets and to foster self-monitoring might be

more appealing but seem not to improve treatment efficacy (e.g. Cardi et al. 2020; Keshen et al., 2020; Mazzeo et al., 2016; Neumayr, Voderholzer, Tregarthen, & Schlegl, 2019). However, mobile chatbots, for example, could support patients at home to utilize emotion regulation skills to prevent or shorten binge/LOC episodes. This might be especially helpful as in such critical situations support from the therapist is not available (Fairburn & Patel, 2017).

5.6 Final Conclusion

The present thesis made a contribution to the research on the relevance of emotion regulation difficulties in the etiology and treatment of BED and LOC. It was highlighted that BED must be considered dimensionally as LOC in youth is not only a precursor of full-threshold BED but is associated with substantial psychosocial impairment in these vulnerable age group (Tanofsky-Kraff et al., 2020). Further, in contrast to body-related cognitive distortions, emotion regulation difficulties might not directly translate into BED symptoms such as binge-eating and LOC but might rather describe a fundamental transdiagnostic factor influencing how individuals deal with daily stressors and other etiological factors, making them either more vulnerable or resilient regarding the development and maintenance of LOC and BED. Importantly, there might be more similarities than differences between genders in the mechanisms that lead to disturbed eating behaviors and general ED pathology. Therefore, it might not be necessary to adapt current evidence-based treatments for men with regard to the mechanisms of how they work but rather to gender specific contents (e.g. male body ideal and related disturbed eating behaviors). The present thesis addressed current challenges in the health care provision of BED and LOC by providing evidence that innovative treatment approaches such as blended treatments, including interventions on interpersonal emotion regulation difficulties, are efficacious for youth with LOC in terms of reductions of core LOC and depressive symptoms. In online CBTgsh, individuals with increased emotion regulation difficulties show worse treatment outcome. Therefore, supplementing CBT-E treatments with transdiagnostic interventions on emotion regulation difficulties might not only improve treatment efficacy but might also be economic with regard to comorbid disorders (instead of providing additional disorder specific treatments). Further research is needed to develop stepped care approaches, in which suggestions are made for whom such emotion regulation interventions might especially be beneficial, who benefits from low-threshold interventions

such as online CBTgsh and who needs higher-threshold treatment offers in terms of face-to-face therapy.

6 References

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Appendix

A) Publication 1

The Mediating Role of Emotion Regulation Difficulties and Cognitive Distortions in the Association between Body Dissatisfaction and Eating Disorder Pathology: A Gender Comparison

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Abstract

Body dissatisfaction is an established risk and maintaining factor of disordered eating and unhealthy weight-control behavior in women and men. Evidence on gender differences in underlying mechanisms relating body dissatisfaction and eating disorder (ED) pathology is scarce but crucial for improvements of gender-specific treatment. We investigated gender differences in mediating mechanisms and evaluated a path model of mediation based on cross-sectional questionnaire data in a community sample of 418 women and 141 men. Body dissatisfaction was included as predictor, ED pathology as outcome, emotion regulation difficulties and body-related cognitive distortions as mediators, and body mass index (BMI), internalization of the body ideal and pressure to meet the body ideal as covariates. Body dissatisfaction was strongly associated with ED pathology in both genders *(total effect)* also after controlling for both mediators *(direct effect)*. Emotion regulation difficulties did not reveal to be a relevant mediator, but body-related cognitive distortions partially mediated the association between body dissatisfaction and ED pathology in both genders. No gender differences were found in the multiple-group path model of mediation between body dissatisfaction and ED pathology. The present findings highlight the importance of body dissatisfaction and body-related cognitive distortions in etiological models of ED pathology of both genders.

Keywords: eating disorder, body dissatisfaction, body-related cognitive distortion, emotion regulation, gender

Introduction

With lifetime prevalence rates for anorexia nervosa, bulimia nervosa and binge eating disorder of 0.9–3.6%, 0.5–2.4% and 1–4%, respectively among women, and of 0.1–0.3%, 0.1–0.9% and 0.4–2%, respectively among men (Hudson, Hiripi, Pope, & Kessler, 2007; Keski-Rahkonen & Mustelin, 2016; Udo & Grilo, 2018), eating disorders (ED) are more frequent in women of the general population than in men, and thus are typically perceived as female disorders. However, research on ED pathology in men is rare (Murray et al., 2017) and there is evidence that certain subclinical symptoms of disordered eating, such as recurrent binge eating, might be nearly as frequent in men as in women (Hilbert, de Zwaan, & Braehler, 2012; Hudson et al., 2007; Lydecker & Grilo, 2018; Mitchison & Mond, 2015). Further, it can be assumed that the prevalence of full-blown EDs in men has so far been underestimated due to female-oriented ED measurements in questionnaire-based studies, the reduced treatment seeking behavior in men and the tendency of male participants to prematurely terminate participation in epidemiological studies (Murray et al., 2017; Schaefer et al., 2018; Wyssen, Bryjova, Meyer, & Munsch, 2016). There is evidence from two large Australian community studies that ED symptoms similarly impair health related quality of life and psychosocial functioning in both genders (Bentley, Monda, & Rodgers, 2014; Mitchison, Mond, Slewa-Younan, & Hay, 2013). Moreover, cross-sectional data from a large Swedish clinical data base containing 6921 women and 235 men with EDs indicate that both, women and men suffer from a high proportion of mental comorbidities (Ulfvebrand, Birgegard, Norring, Hogdahl, & von Hausswolff-Juhlin, 2015), which underlines the clinical relevance of ED pathology in both genders.

Even though previous research underlines the importance of ED pathology in both genders, there is still considerably less knowledge about the development and maintenance of ED pathology in men compared to women. This is crucial, as more knowledge on shared versus differential etiological mechanisms is strongly needed to further improve current

treatment approaches in both genders which are still almost exclusively based on research in women. So far, there is evidence that body dissatisfaction (in this study defined as the degree to which individuals are concerned about and dissatisfied with their appearance, including related thoughts, beliefs, feelings and behaviors), affecting up to 70% of women and 60% of men of the general population (Fiske, Fallon, Blissmer, & Redding, 2014), represents one of the most potent and frequent risk factors for the development of ED pathology in both women and men (e.g., Neumark-Sztainer, Paxton, Hannan, Haines, & Story, 2006; Stice, Marti, & Durant, 2011). However, body dissatisfaction derives from gender-specific body ideals: a thinness-oriented body ideal in women (Swami et al., 2010), and a two-dimensional muscularity-/ slenderness-oriented body ideal in men (Tylka, 2011). This might explain why women generally report higher thinness-related shape and weight concerns, purging behavior and extreme dietary restriction (see Mitchison & Mond, 2015 for a review), while men are more likely to report muscularity-related shape and weight concerns and dietary regimen with high protein intake and food supplements or steroids (e.g., Blashill, 2014; Hoffmann & Warschburger, 2017; Karazsia, Murnen, & Tylka, 2017; Mitchison & Mond, 2015). Although body dissatisfaction is associated with ED pathology in both, women and men (Dakanalis et al., 2015; Stice et al., 2011; Wyssen, Bryjova, et al., 2016), current research indicates that this association might be stronger for women (e.g., Hughes & Gullone, 2011; Neumark-Sztainer et al., 2006; Sharpe et al., 2018; Turel et al., 2018). For instance, a recent meta-analysis showed that behavioral components of body dissatisfaction such as body checking, although not body avoidance, is more strongly associated with ED pathology in women than in men (Walker, White, & Srinivasan, 2018).

While body dissatisfaction is frequent in the general population, a much smaller percentage of young women and men develop clinically relevant ED pathology. This leads to the conclusion, that intermediary mechanisms with the potential to relate body dissatisfaction to ED pathology, which may be gender specific, are relevant and need to be

understood to further elaborate etiological models and treatment strategies. The well-known dual-pathway model of ED pathology developed by Stice (2001) has been confirmed in various cross-sectional and longitudinal studies, mostly in nonclinical female samples (e.g., Stice, 2001; Stice & Van Ryzin, 2019). According to Stice's model, body dissatisfaction contributes to ED pathology via a dieting and a negative affect pathway which both mediate the association between body dissatisfaction and ED pathology. In order to adhere to the thinness-oriented body ideal, young women restrict the quantity and the type of food, which leads to psychological and physiological mechanisms promoting disturbed eating and compensatory behavior (Stice, 2001). Data on the dieting pathway are controversial, probably due to a conflation of dieting (energy restriction) and dietary restraint (the cognitive attempt to restrict energy intake regardless of the actual food intake) (e.g., Sehm & Warschburger, 2017; Stice, 2001; Van Strien, Engels, Van Leeuwe, & Snoek, 2005). The negative affect pathway emphasizes the impact of body dissatisfaction on mood (often assessed through self-esteem and depressive symptoms), which in turn provokes ED pathology as an attempt to regulate negative mood (Stice, 2001). The evidence on the negative affect pathway usually stems from cross-sectional- and longitudinal studies in the female general population (e.g., Dakanalis et al., 2014; Stice & Van Ryzin, 2019) and in clinical samples (Van Strien et al., 2005), while this model has only rarely been applied to men. Among the few studies carried out in male nonclinical samples, there is only little support for the negative affect pathway in men. Therefore, it might be concluded that the role of negative affect in relating body dissatisfaction and ED pathology is less important in men than in women (Brechan & Kvalem, 2015; Cruz-Saez, Pascual, Wlodarczyk, & Echeburua, 2018; Heywood & McCabe, 2006).

Besides negative affect, emotion regulation difficulties represent another important factor in the development and maintenance of ED pathology in both genders (e.g., Agüera et al., 2019; Lavender et al., 2015). Emotion regulation is defined as an enduring tendency

to be aware of emotions, to understand, accept and modulate emotions as well as the ability to maintain goal-directed behavior in negative affective states (Gratz & Roemer, 2004) and might be highly important when it comes to relate the effect of body dissatisfaction to ED pathology due to its trait like character (Sehm & Warschburger, 2017). The relevance of emotion regulation difficulties has been supported by findings of a cross-sectional study in a community sample of 234 adolescent girls (Sim & Zeman, 2006) and in a student sample of 132 young men (Griffiths, Angus, Murray, & Touyz, 2014). Both studies underline that emotion regulation difficulties, but not negative affect predicts ED pathology when directly comparing both variables in the same model, indicating that the ability to cope with negative affect is more important than the severity of experienced negative affect. In contrast, negative affect might be more important in relation to body dissatisfaction (Sim & Zeman, 2006).

According to a review by Nolen-Hoeksema (2012), emotion regulation strategies are similarly related to psychopathology in both genders. However, there is preliminary evidence that women with EDs might have greater emotion regulation difficulties than men with EDs (Agüera et al., 2019) and a recent meta-analysis reveals that the increased awareness and understanding of emotions, both so-called bottom up aspects in the process of emotion regulation (Berking & Lukas, 2015; Nolen-Hoeksema, 2012), are associated with decreased ED pathology, especially in women (Prefit, Candea, & Szentagotai-Tatar, 2019).

Currently, there are two studies that investigated the mediating role of emotion regulation difficulties in the association between body dissatisfaction and ED pathology, but no data on a direct comparison of women and men. In this line, Sim and Zeman (2005) found a partially mediating role of self-reported negative affect, poor awareness of emotion and dysfunctional coping with negative emotions on the association between body dissatisfaction and bulimic symptoms in 234 US school girls. This mediating role of

emotion regulation difficulties was not confirmed in a recent questionnaire-based study of our research group, applying a path model of mediation in 123 young men. While emotion regulation difficulties did not mediate the effect of body dissatisfaction on ED pathology, body-related cognitive distortions in terms of "Thought-Shape-Fusion" (TSF: Shafran, Teachman, Kerry, & Rachman, 1999) partially did. The path model of mediation explained 43% of the total variance in ED pathology (Wyssen, Bryjova, et al., 2016).

Cognitive distortions include irrational beliefs about the closeness of the association between thoughts and the physical world, in which TSF describes a specific cognitive distortion mechanism in ED pathology (Shafran et al., 1999). Typical TSF beliefs are that simply vividly imagining eating a forbidden food increases the likelihood of gaining weight or changing shape, or that such thinking about eating a forbidden food is as morally objectionable as actually eating that particular food (Shafran et al., 1999). According to an integrative approach of ED pathology (Culbert, Racine, & Klump, 2015), TSF is likely to be one of the processes relating body dissatisfaction to ED pathology not only in men (Wyssen, Bryjova, et al., 2016) but also in women. The relevance of TSF for ED pathology in women is underlined by the finding that women with EDs report higher TSF values than women of the general population (Coelho et al., 2013; Coelho, Ouellet-Courtois, Purdon, & Steiger, 2015; Wyssen et al., 2018) and that increased TSF is associated with increased ED pathology such as shape, weight and eating concerns or restrictive food intake in women with ED (Shafran & Robinson, 2004), as well as in women and men of the general population (Dubois, Altieri, & Schembri, 2016). The only study comparing the association between body-related cognitive distortions in terms of TSF and ED pathology in women and men shows that TSF is associated with a broader spectrum of ED pathology in women than in men (Dubois et al., 2016), indicating that the influence of cognitive distortions in relating body dissatisfaction to ED pathology might be even more pronounced in women than in men.

To conclude, the current evidence highlights the relevance of body dissatisfaction in the development and maintenance of ED pathology in women and men but there are still open questions regarding potential underlying mechanisms relating body dissatisfaction to ED pathology and moreover whether these mechanisms are gender specific. Enhanced knowledge on these mechanisms in both genders will not only help to adapt and improve current treatment approaches to gender specific needs, but also reduce treatment barriers, which is especially needed in men (Murray et al., 2017). Based on the dual pathway approach (Stice, 2001), the current study for the first time investigates the role of emotion regulation difficulties and the ED-specific cognitive distortion TSF as potential mechanisms relating the effect of body dissatisfaction to ED pathology in a Swiss sample of 418 women and 141 men, consisting mostly of students. Since previous studies showed that BMI, sociocultural pressure to reach the female and male body ideal as well as the internalization of these body ideals are associated with ED pathology (Stice, 2001, 2016), we included these characteristics as covariates.

Based on the reviewed literature, we *first* assumed body dissatisfaction to predict increased emotion regulation difficulties, which in turn predicts increased ED pathology in women, resulting in a *mediation effect* of emotion regulation difficulties in the association between body dissatisfaction and ED pathology in women (Sim & Zeman, 2005). According to our previous findings (Wyssen, Bryjova, et al., 2016) we did not expect such a *mediation effect* of emotion regulation difficulties in men. *Second*, we expected that increased body dissatisfaction predicts increased body-related cognitive distortions (TSF), which in turn predicts enhanced ED pathology in both genders (*mediation effect* of cognitive distortions: Wyssen, Bryjova, et al., 2016; Wyssen, Coelho, Wilhelm, Zimmermann, & Munsch, 2016). However, we assumed that this *mediation effect* would be stronger for women than for men (Dubois et al., 2016). *Third*, we assumed for both genders that the association between body dissatisfaction and ED pathology remains

significant but becomes smaller after controlling for the *mediating effects* of emotion regulation difficulties and cognitive distortions (*direct effect* of body dissatisfaction on ED pathology). However, the strength of this *direct effect* of body dissatisfaction on ED pathology was expected to be stronger in women than in men (Hughes & Gullone, 2011; Neumark-Sztainer et al., 2006; Wyssen, Bryjova, et al., 2016).

Methods

Participants and procedure

The present sample includes cross-sectional data of 141 men and 418 women of the general population including questionnaire-based substudies related to a multicenter study conducted at the Department of Clinical Psychology and Psychotherapy of the University of Fribourg and the Department of Clinical Child and Adolescent Psychology of the Ruhr-University of Bochum (for the design of the main study, see Munsch, 2014). The type of substudy had no effect on the path coefficients in the present path model of mediation. The main study, including substudies, had been approved by the local ethic committees in Switzerland (reference no. of the cantonal ethics approval: 023/12-CER-FR) and Germany (reference no. 142, ethical committee of the Faculty of Psychology at the Ruhr University of Bochum). Participants of the present study have solely been recruited at Swiss study sites between 2012 and 2016 through mailing lists, flyers and advertisements on the website of the University of Fribourg. The age range of the overall sample was 16 – 47 years (M=23.27, SD=4.44). Altogether 54% of the participants were Swiss, 37% were German, 4.5% reported another nationality and 4.5% did not provide information on their nationality. Almost three quarters (72.3%) of the participants were students, 21.3% were employed, 0.4% unemployed, and for 6.1% the occupation status was not available. All participants were fluent in German.

After providing a signed informed consent, participants received a link and were

asked to complete an online questionnaire assessing body dissatisfaction, ED pathology, emotion regulation difficulties and body-related cognitive distortions, as well as body mass index (BMI), sociocultural body ideal related aspects and socio-demographics.

Measures

Sociodemographics

Participants were asked to provide age, gender, nationality and occupation status.

Body dissatisfaction

The German adaption of the short-version of the Body Shape Questionnaire (BSQ-8C; original version by Evans and Dolan, 1993; Fragebogen zum Figurbewusstsein, FFB; German version by Pook, Tuschen-Caffier and Stich, 2002) was used to assess body dissatisfaction. The BSQ-8C consists of eight items that refer to feelings about one's own appearance and body shape during the last four weeks (such as "have you been afraid that you might become fat/ fatter?"). Each item is rated on a scale ranging from 1 (never) to 6 (always). The shortened version of the BSQ has good convergent and discriminant validity as well as reliability (Evans & Dolan, 1993; Pook, Tuschen-Caffier, & Brahler, 2008). Cronbach's α in the present study was .91 in the total sample (.91 in women and .89 in men).

Eating disorder pathology

ED pathology was assessed by selected subscales of the Eating Disorder Examination-Questionnaire (EDE-Q; German version Hilbert & Tuschen-Caffier, 2016): *the restraint subscale* (e.g., "on how many of the past 28 days have you tried to exclude from your diet any foods that you like in order to influence your shape or weight?"), the *eating concern subscale* (e.g., "have you had a definite fear of losing control over eating?"), the *number of days with binge eating* over the past 28 days and the *number of events of self-induced vomiting, taking laxatives and excessive exercise to influence shape and weight* over the

past 28 days. The coding of the *number of days with binge eating* and *number of compensatory events* was conducted according to Wyssen et al. (2016): 0 days/events=0, 1-5 days/events=1, 6-12 days/events=2, 13-15 days/events=3, 16-22 days/events=4, 23-27 days/events=5, 28 days and more=6. The internal consistency of the EDE-Q global score is known to be good for women (Cronbach's α=.94) and for men (Cronbach's α=.91; Hilbert et al., 2012). Cronbach's α in the present study for the EDE-Q global score was .94 in the total sample (.94 in women and .93 in men) and .85 for the new ED pathology outcome variable (.84 in women and .86 in men).

Emotion regulation difficulties

Emotion regulation difficulties were assessed by the global score of the Difficulties in Emotion Regulation Scale (DERS; original version by Gratz & Roemer, 2004; German version by Ehring, Fischer, Schnulle, Bosterling, & Tuschen-Caffier, 2008), which consists of 36 items including *nonacceptance of emotional responses* (e.g., "when I'm upset, I become angry with myself for feeling that way"), *difficulty in engaging in goal directed behavior* while experiencing negative emotions (e.g., "when I'm upset, I have difficulty getting work done"), *impulse control difficulties* when being upset (e.g., "when I'm upset, I feel out of control"), *lack of emotional awareness* (e.g., "I pay attention to how I feel), *limited access to emotion regulation strategies* (e.g., "when I'm upset, I believe there is nothing I can do to make myself feel better"), and *lack of emotional clarity* (e.g., "I have difficulty making sense out of my feelings"). Items were rated on a scale ranging from 1 (almost never: 0-10%) to 5 (almost always: 91-100%) with higher sum scores indicating greater emotion regulation difficulties. Cronbach's α for the global score in the present sample was .88 (.89 in women and .87 in men) and therefore slightly lower than values denoted in the literature (α=.93 for the DERS global score; Gratz & Roemer, 2004).

Body-related cognitive distortions – thought-shape fusion (TSF)

The German short version of the Thought-Shape Fusion Trait questionnaire (TSF; original version by Coelho et al., 2013; German version by Wyssen et al., 2018) was used to assess body-related cognitive distortions in response to the imagination of food cues. The German short version by Wyssen et al. (2018) consists of 14 items assessing the TSF concept (*concept scale:* e.g., "I feel fatter after thinking about eating fattening/ "forbidden" foods.") and 4 items to capture the clinical impact of TSF-like thoughts. Only the TSF concept scale was used in the present study. Each item is rated on a scale ranging from 0 (not at all) to 4 (completely). The German short-version of the TSF questionnaire demonstrated good internal consistency in a non-clinical female sample (α=.90; Wyssen et al., 2018). This scale has not yet been validated for the male population. Cronbach's α for the concept scale in this sample was .90 (.91 in women and .88 in men).

Perceived sociocultural pressure to meet the body ideal and body ideal internalization

Perceived social pressure from media to meet the depicted body ideals and the internalization of these body ideals were assessed through the subscales *pressure* and *internalization* of the 16-item German version of the Social Attitudes Toward Appearance Questionnaire (SATAQ; original version by Heinberg, Thompson, & Stormer, 1995; SATAQ-G; German version by Knauss, Paxton, & Alsaker, 2009). Two gender-specific versions of the SATAQ-G were used to adapt to gender-related body ideals (e.g., "I wish I looked like a model" in the female version, versus "I wish I looked like a bodybuilder" in the male version). Each item was rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The subscales *pressure* and *internalization* of the German version showed good internal consistency with a Cronbach's α of .85 and .84 in a mixed gender sample (Knauss et al., 2009). The Cronbach's α was .89 (.90 in women and .86 in

men) for the pressure subscale in the present sample, and .88 (.88 in women and .89 in men) for the internalization subscale.

Body Mass Index (BMI)

BMI was calculated based on self-reported weight and height which was assessed by the EDE-Q. The BMI was calculated by dividing the weight in kilograms by the square of height in meters (kg/m^2).

Statistical analysis

A path model of mediation was set up with body dissatisfaction as predictor, ED pathology as outcome variable and emotion regulation difficulties and body-related cognitive distortions as mediators (Wyssen, Bryjova, et al., 2016). BMI, perceived social pressure from media to meet the transmitted body ideals and the internalization of these body ideals were all included as covariates. The path model of mediation is shown in Fig. 1. To test whether the path coefficients concerning direct, indirect, and total effects (via emotion regulation difficulties and cognitive distortions) between body dissatisfaction and ED pathology differed between women and men, we additionally set up a multiple-group path model of mediation with gender as grouping factor. Most analyses were performed using the software package R, version 3.1.3, 2015, including the R package “lavaan” (Rosseel, 2012) for the analysis of path models. Descriptive statistics were obtained with the Statistical Package for Social Sciences (SPSS version 23). Variables were checked for normality and all variables (including all covariates) had to be log-transformed. Hypotheses and the analytic plan were both specified before data was collected.

Results

Sample characteristics

Women and men did not differ in age ((women: *M*=23.19, *SD*=4.75; men: *M*=23.53, *SD*=3.36), *t*(551)=–.80, *p*=.426), but women were more often Swiss than German or of other nationalities, while male participants were more often German, $\chi^2(2, N=534)=40.99$, $p<.001$. In addition, the ratio between being student or employed/ unemployed was larger in the female than in the male sample (Fisher's exact test, $p<.001$).

Descriptive values of the variables included in the path model of mediation are displayed by gender in Table 1. Women reported higher levels of body dissatisfaction, body-related cognitive distortions and ED pathology (women also scored significantly higher on the mean global score of the EDE-Q than men ((women: *M*=0.84, *SD*=0.86; men: *M*=0.62 *SD*=0.77), *t*(557)=3.34, *p*=.001)), and lower levels emotion regulation difficulties compared to men.

Considering relevant clinical patterns in the present sample, 7.9% (*n*=33) of the female and 7.8% (*n*=5) of the male sample self-reported eating disorder symptoms above the clinical cut-off of 2.3 for women (Mond, Hay, Rodgers, Owen, & Beumont, 2004) and 1.68 for men (Schaefer et al., 2018) of the EDE-Q global score. Additionally, 13.4% (*n*=56) of women and 11.3% (*n*=16) of men scored one standard deviation above the mean value of the newly created dependent variable ED pathology. At least mild body dissatisfaction was present in 32.8% (*n*=137) of women and 11.3% (*n*=16) of men, according to the corresponding cut-off value for mild body dissatisfaction of >18 of the BSQ described by Evans and Dolan (1993). Another 14.6% (*n*=61) of women and 11.3% (*n*=16) of men showed increased TSF values above the 84.1th percentile (percentile referring to the mean plus one standard deviation computed separately for women and men). 6.2% (*n*=26) of the participating women and 12.1% (*n*=17) of the participating men reported elevated emotion regulation difficulties, according to the cut-off of 98.71 for women and 99.45 for men in

the DERS global score (mean plus one standard deviation according to Gratz & Roemer, 2004).

Insert Table 1 here

Path model of mediation in female participants

In the following, unstandardized coefficients are reported, while standardized coefficients are shown in brackets in Fig.1.

Controlling for covariates, the *total effect* of body dissatisfaction on ED pathology was significant (c=0.33, SE=0.03, p<.001). Increased body dissatisfaction predicted both increased emotion regulation difficulties (a_1=0.23, SE=0.04, p<.001) and increased cognitive distortions (TSF; a_2=1.32, SE=0.13, p<.001). While emotion regulation difficulties did not predict ED pathology (b_1=–0.04, SE=0.04, p=.286), cognitive distortions were a positive predictor for increased ED pathology (b_2=0.05, SE=0.01, p<.001). *Mediation effects* were quantified by calculating *indirect effects* of body dissatisfaction via emotion regulation difficulties and cognitive distortions on ED pathology. The *indirect pathway* of body dissatisfaction on ED pathology via emotion regulation difficulties was not significant (a_1*b_1=–0.01, SE=0.01, p=.299), whereas the *indirect pathway* via cognitive distortions was (a_2*b_2=0.07, SE=0.02, p<.001). Also, the *indirect pathway* via cognitive distortions was significantly stronger than the *indirect pathway* via emotion regulation difficulties (a_1*b_1 - a_2*b_2=–0.08, SE=0.02, p<.001). The *direct effect* of body dissatisfaction on ED pathology, controlling for emotion regulation difficulties, cognitive distortions and covariates, was smaller than the *total effect*, but remained significant (c'=0.27, SE=0.03, p<.001). The covariance between the residuals of the two mediators emotion regulation difficulties and cognitive distortions was .03 (p=.004). The covariates BMI and perceived pressure to meet to body ideal were not

significantly associated with ED pathology (BMI: b=0.05, SE=0.07, p=.484; SATAQ_pres: b=-0.03, SE=0.02, p=.153), whereas the internalization of the body ideal revealed to be significantly related to ED pathology (SATAQ_intern: b=0.06, SE=0.03, p=.018). The path model of mediation explained 51.9% of the total variance in ED pathology in the female sample.

Path model of mediation in male participants

Controlling for covariates, the *total effect* of body dissatisfaction on ED pathology was significant (c=0.43, SE=0.06, p<.001). Increased body dissatisfaction predicted both increased emotion regulation difficulties (a_1=0.37, SE=0.07, p<.001) and increased cognitive distortions (a_2=1.46, SE=0.25, p<.001). While emotion regulation difficulties did not predict ED pathology (b_1=–0.08, SE=0.06, p=.170), higher cognitive distortions predicted increased ED pathology (b_2=0.08, SE=0.02, p<.001). The *indirect pathway* of body dissatisfaction on ED pathology via emotion regulation difficulties was not significant (a_1*b_1=–0.03, SE=0.02, p=.153), whereas the *indirect pathway* via cognitive distortions was (a_2*b_2=0.11, SE=0.04, p=.002). Also, the *indirect pathway* via cognitive distortions was stronger than the *indirect pathway* via emotion regulation difficulties (a_1*b_1 - a_2*b_2=–0.14, SE=0.04, p=.001). The *direct effect* of body dissatisfaction on ED pathology, controlling for emotion regulation difficulties, cognitive distortions and covariates, was smaller than the *total effect*, but remained significant (c'=0.35, SE=0.07, p<.001). The covariance between the residuals of the two mediators cognitive distortions and emotion regulation difficulties was .02 (p=.108). None of the covariates were significantly associated with ED pathology (BMI: b=0.10, SE=0.13, p=.412; SATAQ_pres: b=–0.02, SE=0.03, p=.509; SATAQ_intern: b=–0.03, SE=0.04, p=.504). The path model of mediation explained 58.3% of the total variance in ED pathology in the male sample.

Insert Figure 1 here

Multiple-group path model of mediation for gender differences

Women and men did not differ in the *total effect* of body dissatisfaction on ED pathology (difference b=–0.10, SE=0.06, p=.116). Further, there was no significant gender difference in the influence of body dissatisfaction on emotion regulation difficulties (b=–0.13, SE=0.08, p=.093) and on cognitive distortions (b–=0.13, SE=0.28, p=.642), nor of emotion regulation difficulties (b=0.04, SE=0.07, p=.546) and cognitive distortions (b=–0.02, SE=0.02, p=.371) on ED pathology. Moreover, there was no significant difference between women and men in the strength of the *indirect pathways* of body dissatisfaction on ED pathology via emotion regulation difficulties (b=0.02, SE=0.02, p=.36) and cognitive distortions (b=–0.04, SE=0.04, p=.337). The elevated effect of the *indirect pathway* from body dissatisfaction via cognitive distortions on ED pathology relative to the *indirect pathway* via emotion regulation difficulties did not differ between women and men (b=0.06, SE=0.05, p=.218). Finally, there was also no significant difference between women and men in the *direct effect* of body dissatisfaction on ED pathology, controlling for emotion regulation difficulties, cognitive distortions and covariates (b=–0.08, SE=0.07, p=.273). Associations between ED pathology and the covariates BMI (b=–0.05, SE=0.15, p=.728), perceived pressure to meet the body ideal (b=–0.01, SE=0.04, p=.814), and internalization of the body ideal (b=0.09, SE=0.05, p=.065) were all comparable between women and men. Also, a path model in which all corresponding path coefficients were constrained to be equal between women and men, led to an overall model fit that was not worse compared to the unconstrained path model in which all path coefficients were freely estimated for each gender group (χ^2 /5=8.80, p=.117).

Discussion

The main objective of this study was to examine gender differences in a previously established path model of mediation of ED pathology (Wyssen, Bryjova, et al., 2016), in which body dissatisfaction was assumed to be related to ED pathology via the two mediators emotion regulation difficulties and body-related cognitive distortions TSF, using data of predominantly students of the general population.

A substantial part of women and men reported relevant body dissatisfaction (44.1%), emotion regulation difficulties (18.3%), body-related cognitive distortions (25.9%) and ED pathology (24.7% according to the ED pathology variable in the path model of mediation and 15.7% according to the EDE-Q total score). This is in line with the results from previous representative studies which have shown that a large proportion of young adults of the general population is affected by the mentioned symptoms of subthreshold psychopathology (e.g., Fiske et al., 2014; Hilbert et al., 2012).

In line with the current literature (e.g., Bentley et al., 2014; Dubois et al., 2016; Fiske et al., 2014), women reported higher body dissatisfaction, body-related cognitive distortions and ED pathology than men, although effect sizes were only small to moderate. It has to be taken into account that these differences might even be smaller, as they might partially be due to the female-based questionnaires, which could neglect patterns that are specifically relevant for men such as muscularity concerns and related weight-shape control behaviors (e.g., the use of food supplements and steorids: Schaefer et al., 2018). As such, the present findings highlight the relevance of ED pathology and related features in both, women and men. In contrast to previous studies, which found no significant gender differences in self-reported overall emotion regulation difficulties in healthy women and men using the DERS global score (e.g., Anderson, Reilly, Gorrell, Schaumberg, & Anderson, 2016; Gratz & Roemer, 2004; Weinberg & Klonsky, 2009), men in the present study reported higher levels of overall emotion regulation difficulties than women. This is

an important finding, which is underlined by existing evidence that the DERS can be equally reliable applied in women and men (Ritschel, Tone, Schoemann, & Lim, 2015). However, findings on the DERS global score should be interpreted with caution as findings on gender differences in the DERS subscales in adult and adolescent community samples, assessing specific bottom-up aspects of the emotion regulation process, remain rather inconsistent (Agüera et al., 2019; Gratz & Roemer, 2004; Neumann, van Lier, Gratz, & Koot, 2010; Weinberg & Klonsky, 2009). Considering the DERS subscales in the present sample, men exhibited more pronounced difficulties than women in all DERS subscales (*clarity*, *nonacceptance*, *goals*, *impulse* and *strategies* with Cohen's *d* ranging from 0.20 to 0.66, for more information see Table A, supplementary material), except that women reported to be less aware of their emotions than men (*awareness,* Cohen's $d = 0.28$; see Gratz and Roemer, 2004 for more information on the subscales). Taking into consideration that the review of Nolen-Hoeksema (2012), including experimental and questionnaire-based studies, indicates relevant gender differences in certain aspects of emotion regulation such as that women report a larger repertoire and more frequent use of conscious emotion regulation strategies than men, further research is needed to gain increased knowledge on gender differences in self-reported emotion regulation capacities and specific bottom-up aspects in the process of emotion regulation.

Contrary to our *first hypothesis* and even though body dissatisfaction significantly predicted emotion regulation difficulties in women and men, emotion regulation difficulties did not predict ED pathology in both genders, and therefore did not mediate the effect of body dissatisfaction on ED pathology, neither in women nor men. While this missing *mediation effect* for men has already been demonstrated in our previous study (Wyssen, Bryjova, et al., 2016) it is still surprising for women (Sim & Zeman, 2005). However, the present missing mediation effects of emotion regulation difficulties do not imply that emotion regulation difficulties have a negligible role in the association between body

dissatisfaction and ED pathology. For instance, we examined in the present study the proposed path model of mediation in a community sample of young female and male adults with overall normative emotion regulation difficulties. In clinical samples of ED patients, where emotion regulation difficulties are elevated (e.g., Agüera et al., 2019), the mediating role of emotion regulation difficulties in the association between body dissatisfaction and ED pathology might be more important than in community samples (Prefit et al., 2019). Additionally, emotion regulation difficulties might play a more important role in the association between body dissatisfaction and ED pathology during adolescence than during young adulthood as there is evidence that from middle adolescence up to middle adulthood, the repertoire and use of adaptive emotion regulation strategies increases along with neurohormonal changes (Somerville, Jones, & Casey, 2010; Zimmermann & Iwanski, 2014). In our study, body dissatisfaction does trigger emotion regulation difficulties but these do not translate directly to ED pathology. It can nevertheless be assumed that emotion regulation difficulties increase or weaken the influence of body dissatisfaction on ED pathology, as reported in Dakanalis et al., (2015) and Hughes and Gullone (2011). Thus, emotion regulation difficulties impact on ED pathology, but do not represent a sufficient condition to elicit ED pathology. Finally, the DERS does not explicitly assess specific "cognitive" emotion regulation strategies such as rumination and thought suppression (Pjanic, Bachmann, Znoj, & Messerli-Burgy, 2013) which both have been linked to ED pathology (Nolen-Hoeksema, 2012; Smith, Mason, Anderson, & Lavender, 2019). There is evidence for gender specific associations of these emotion regulation strategies with distinct ED symptoms (Opwis, Schmidt, Martin, & Salewski, 2017; Smith et al., 2019), which should be considered in further studies investigating gender differences in the *mediation effect* of emotion regulation difficulties relating body dissatisfaction to ED pathology.

Consistent with our *second* hypotheses and the findings of our previous study (Wyssen, Bryjova, et al., 2016), increased body dissatisfaction in both genders predicted increased body-related cognitive distortions, which in turn predicted increased ED pathology (significant *mediation effect* of cognitive distortions). However, contrary to our expectation, the strength of this partial *mediation effect* (cognitive distortions did no fully relate body dissatisfaction to ED pathology, indicated by a significant *direct effect* of body dissatisfaction on ED pathology) did not differ between women and men. In other words, women and men who are dissatisfied with their body seem to experience an elevated susceptibility to food-related cognitive distortions such as the feeling of gaining fat by the mere thought or sight of fattening/forbidden food, which in turn increases ED pathology in both genders. In contrast to emotion regulation difficulties which is associated with various correlates of psychopathology (Berking & Wupperman, 2012), previous questionnaire-based studies (Wyssen et al., 2018) and data on the effects of experimentally induced body-related cognitive distortions in terms of TSF (e.g., Coelho et al., 2015) in female clinical and community samples provide evidence that body-related cognitive distortions describe a specific psychopathological correlate of ED pathology. It might be assumed that the close relatedness of this cognitive distortion to ED pathology and its relevance as a daily stressor in everyday life might explain why even in our community sample of women and men, body-related cognitive distortions turned out to partially mediate the association between body dissatisfaction and ED pathology; this is not the case for emotion regulation difficulties, which rather represent a proxy of general psychopathology. However, there is evidence that emotion regulation difficulties influence the psychological impacts of daily stressors such as the daily exposure to fattening/ forbidden foods and body ideal stimuli (Humbel et al., 2018). Therefore, further research on the role of emotion regulation difficulties in the association between cognitive distortions and ED pathology in women

and men could contribute to a better understanding of etiological mechanisms of ED and related potential gender differences.

In line with our expectations (*third* hypotheses) and with previous findings that highlighted the importance of body dissatisfaction for the development and maintenance of ED pathology in women and men (e.g., Dakanalis et al., 2015; Stice et al., 2011), body dissatisfaction strongly predicted ED pathology in our study in both genders, even after controlling for the two mediators body-related cognitive distortions and emotion regulation difficulties (*direct effect* of body dissatisfaction). However, contrary to our expectations and previous studies mostly conducted in adolescents (e.g., Hughes & Gullone, 2011; Neumark-Sztainer et al., 2006), this association was not stronger for women than for men. In adolescence, a vulnerable phase regarding the onset of increased body dissatisfaction and ED pathology especially for girls (Klump, 2013), gender differences in the association between body dissatisfaction and ED pathology might be more relevant than in adulthood. Further, body dissatisfaction has been defined and assessed heterogeneously in different studies. While some studies defined body dissatisfaction as being dissatisfied with specific body parts (e.g., Stice & Desjardins, 2018), we used a broader definition of the concept of body dissatisfaction, including preoccupation and dissatisfaction with body weight- and shape, body-related negative feelings and body concerns (Wyssen, Bryjova, et al., 2016). There is preliminary evidence, mainly for adolescents, that different aspects of body dissatisfaction or body image respectively are distinctively associated with different outcomes of ED pathology (e.g., Allen, Byrne, McLean, & Davis, 2008; Mitchison et al., 2017; Oellingrath, Hestetun, & Svendsen, 2016) and that these associations differ in their relative importance for female and male individuals. For example, a recent study by Sharpe et al. (2018) found that in a community sample of 1830 adolescents, dissatisfaction with specific body parts was cross-sectionally associated with unhealthy weight- and shape regulation (e.g., vomiting, diet pills) in girls and boys, but only in girls with binge eating

and dieting. The same study found that other correlates of body dissatisfaction, such as overvaluation of shape and weight were associated with dieting and unhealthy weight- and shape regulation but not with binge eating in female and male adolescents, whereas preoccupation with weight and shape was associated with all aspects of disturbed eating in both genders. The authors further found different gender specific associations of body dissatisfaction and ED pathology in a longitudinal analysis over 15 years compared to cross-sectional analysis. Thus, future research should emphasize to disentangle e.g., our path model of mediation for gender-specific associations between different aspects of body dissatisfaction and ED pathology in women and men.

The findings of the present study should be interpreted with several limitations in mind. First of all, the cross-sectional nature of the study does not allow to draw conclusions about the causality of the associations of variables included in the path model of mediation. Second, some of the questionnaires applied in this study, such as the EDE-Q and BSQ might not fully cover male ED pathology and body dissatisfaction, neglecting for example muscularity-based shape and weight concerns and related disturbed eating- and weight control behaviors (Murray et al., 2017). Third, almost three-quarter of the participants were students and therefore the present findings cannot be fully generalized to young adult non-students, to young adolescents or middle age cohorts nor to clinical samples. Fourth, the size of the male sample (n=141) was relatively small, thereby limiting the power to detect gender differences for specific coefficients (including *total*, *indirect* and *direct effects*) in the multiple-group path model. Finally, the present path model of mediation is based on self-report data, where the effect of retrospective recall bias or a social desirability response bias cannot be excluded.

In summary, our findings support the strong association between body dissatisfaction and ED pathology in both, women and men. While difficulties with emotion regulation were less important as a mediator in this association in both genders, our path model of

mediation emphasized that even low levels of body-related cognitive distortions partially mediate the association between body dissatisfaction and ED pathology in women and men and that this *mediation effect* is equally important for both genders. The present path model of mediation was equally applicable to both genders and explained 58.3% of the total variance in ED pathology in the male sample and 51.9% in the female sample. This finding underlines the validity of the path model of mediation and the importance of body dissatisfaction and cognitive distortions in the development and maintenance of ED pathology in our sample in both genders; with more similarities than differences than previously assumed by previous research. However, according to Brechan and Kvalem (2015), more research is needed in order to specify the relation between body dissatisfaction, mediators and ED pathology, depending on different ED symptoms (e.g., restraint eating, binge eating and compensatory behavior) and gender.

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Authors contribution

The main responsibility for the study design and project management was with the principal investigator of the study SM. All authors conducted this research project and contributed to the data collection and data analyses. FF drafted the first version. AM performed the final data analyses. All authors read and commented on drafts and approved the final manuscript. The present manuscript has not been peer-reviewed previously.

Declarations of interest

None

Research data for this article

Open data up on request from the ethics committee of the department of Psychology, University of Fribourg, Switzerland (https://www3.unifr.ch/psycho/en/department/ethics-com/)

Tables and Figures

Table 1

Descriptive statistics (range, medians, means, standard deviations) and gender differences for variables included in the path model of mediation.

	Women (*n*=418)					Men (*n*=141)						
Variable	*n*	Range	*Mdn*	*M*	*SD*	*n*	Range	*Mdn*	*M*	*SD*	*t*(df)	*d*
ED pathology outcome variable (EDE-Q)	417	0-4.07	0.21	0.42	0.56	141	0–3.71	0.07	0.34	0.59	2.61(556)**	0.28
Body dissatisfaction (BSQ-8C)	389	8-46	15	16.96	7.22	136	8-39	11	12.90	5.92	6.64(523)***	0.68
Body-related cognitive distortions (TSF)	418	0-37	2	3.90	6.14	132	0-28	1	2.92	5.43	2.45(548)*	0.24
Emotion regulation difficulties (DERS global score)	398	37-143	65	68.79	18.14	125	30-141	75	78.35	20.89	-4.85(521)***	0.51
BMI (kg/m^2)	418	15.24-34.72	21.12	21.62	2.82	141	18.22-41.58	22.86	23.44	3.64	-6.34(557)***	0.56
Perceived pressure (SATAQ pressure)	418	5-25	14	13.56	5.52	133	5-23	11	11.01	4.99	4.60(549)***	0.46
Internalization (SATAQ internalization)	418	6-30	14	14.15	6.10	133	6-30	13	13.86	6.18	0.50(549)	0.05

Note. To allow the interpretation of the data regarding cut-offs, descriptive data being reported were back transformed from log-transformed variables while *t*- and *p*-values were obtained using log-transformed variables. EDE-Q=Eating Disorder Examination Questionnaire; BSQ-8C=short version of the Body Shape Questionnaire; TSF=Thought Shape Fusion; DERS global score=Difficulties in Emotion Regulation Scale, global score; BMI=Body Mass Index; SATAQ pressure=Social Attitudes Toward Appearance Questionnaire, pressure subscale; SATAQ internalization=Social Attitudes Toward Appearance Questionnaire, internalization subscale.

*$p<.05$

**$p<.01$

***$p<.001$

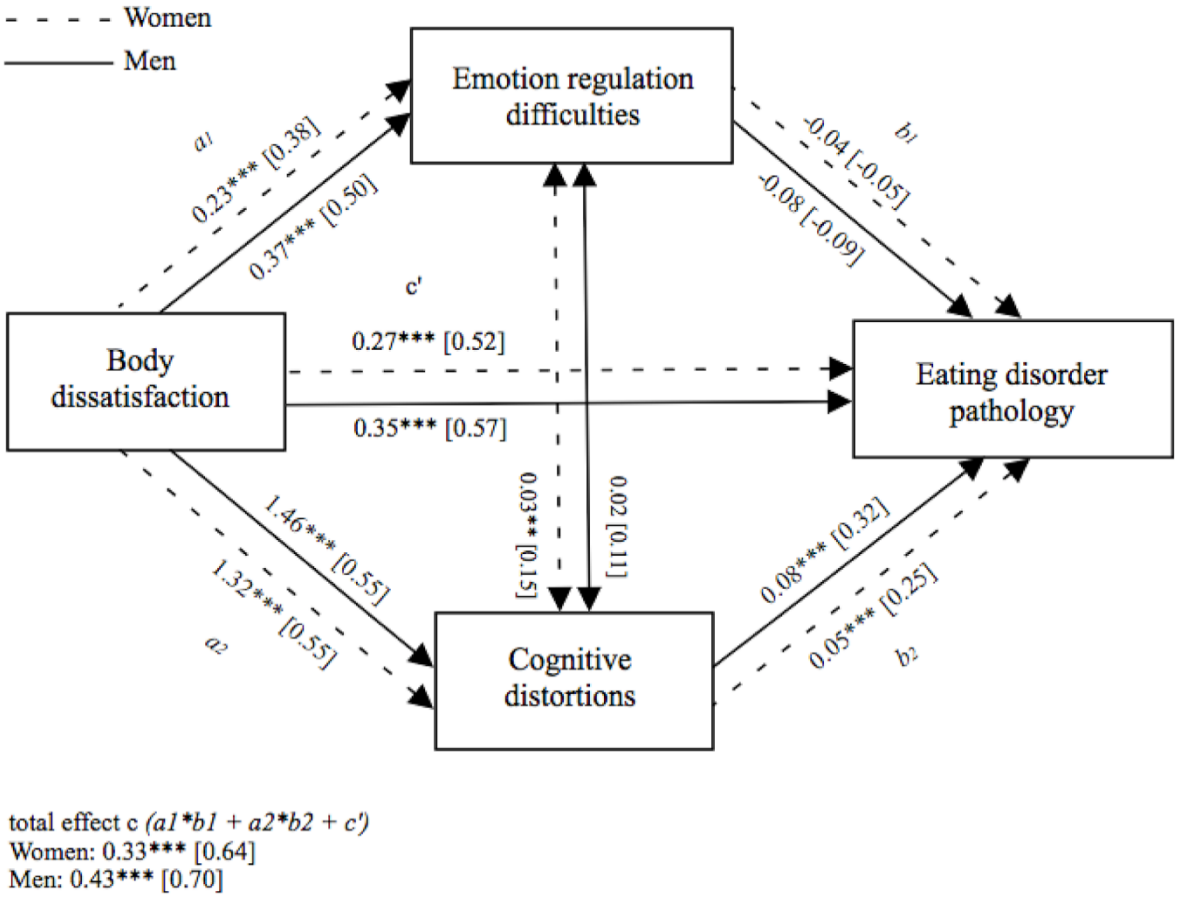

Figure 1. The path model of mediation of ED pathology in women and men.

Note. Unstandardized coefficients are reported, followed by standardized coefficients in brackets.

** p<.01. *** p<.001

Supplemental Material

Table A

Means, standard deviations and gender differences in the DERS subscales.

	Women			Men					
DERS Subscales	*n*	*M*	*SD*	*n*	*M*	*SD*	*t*(df)	*p*	*d*
Nonacceptance	398	11.28	4.57	124	13.28	5.49	-3.85(520)	<.001	0.42
Goals	398	10.88	4.42	124	13.09	4.44	-5.04(520)	<.001	0.50
Impulse	398	9.78	3.76	125	12.23	4.32	-6.18(521)	<.001	0.63
Awareness	398	13.89	4.36	125	12.70	4.20	2.88(521)	.004	0.28
Strategies	398	13.76	5.35	124	17.60	7.14	-6.22(520)	<.001	0.66
Clarity	398	9.19	3.10	125	9.80	3.24	-2.16(521)	.031	0.20

Note. To allow the interpretation of the data regarding cut-offs, descriptive data being reported were back transformed from log-transformed variables while *t*- and *p*-values were obtained using log-transformed variables. DERS = Difficulties in Emotion Regulation Scale.

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B) Publication 2

BEAT Pilot Study: Binge-Eating Adolescent Treatment - Efficacy and Acceptance of a Blended Treatment Program for Youth with Loss of Control Eating

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Abstract

Objective: Loss of control eating (LOC) is the most prevalent form of ED pathology in youth, but research on evidence-based treatment in this group is scarce. We assessed for the first time the efficacy and acceptance of a blended treatment program for youth between 14 and 24 years with LOC (Binge-eating Adolescent Training, *BEAT*). **Method:** 24 youths (mean age 19.08 years, *SD*=3.49) participated in three face-to-face workshops and six email-guided self-help sessions, followed by two e-mail sessions 3 and 11 weeks after the end of active treatment. All patients completed a two-weeks waiting-time period before treatment begin (within-subject waitlist control design). **Results:** The number of weekly LOC episodes strongly decreased during both the waiting-time and the active treatment period and remained more or less on the same level during the subsequent three months follow-up. While abstainer rates, body weight as well as appearance-based rejection sensitivity did not change, both general ED pathology and depressive symptoms improved from pretreatment to posttreatment assessment. Treatment satisfaction among completers was high, while the dropout rate was 33.3% during the waiting-time- and active treatment period. **Discussion:** This first blended treatment study *BEAT* might be well suited to decrease core symptoms of LOC and depressive symptoms. More research is needed to find out what interventions might decrease appearance-based rejection sensitivity, increase weight change and reduce dropout rates.

Keywords: loss of control eating (LOC), guided self-help, blended treatment, depressiveness, appearance-based rejection sensitivity, acceptance, efficacy.

Introduction

Binge-eating disorder (BED) is characterized by recurrent binge-eating episodes without compensatory behavior (DSM-5; APA, 2013). BED is the most prevalent eating disorder (ED) in youth (including adolescents and young adults aged 14 to 24 years according to the definition of the UN, https://en.unesco.org/youth; Marzilli, Cerniglia, & Cimino, 2018). However, a substantial group of youth experiences loss of control while eating smaller respectively subjectively large (i.e. not necessarily objectively large as required for binge-eating and BED) amounts of food. Therefore, in youth the term loss of control eating (LOC) is commonly used, defined as the feeling of being unable to control food intake irrespective of the consumed food amount (Tanofsky-Kraff, Schvey, & Grilo, 2020). Approximately 23% of youth of the general population reported at least one and another roughly 10% at least four LOC episodes during the past month (Schlüter, Schmidt, Kittel, Tetzlaff, & Hilbert, 2016), while in weight-loss treatment seeking groups, nearly 50% reported past or current LOC (Glasofer et al., 2007). There is evidence that LOC represents a more salient marker of ED pathology than the mere amount of food intake, especially at a young age (Goldschmidt, 2017). LOC relates (both cross-sectionally and prospectively) with increased distress, general- and eating related pathology and increased body weight (Goldschmidt et al., 2008; Shomaker et al., 2010; Sonneville et al., 2013; Tanofsky-Kraff et al., 2011). The clinical relevance of LOC is further underlined, as experiencing less than one weekly LOC episode is associated with increased ED pathology (Schlüter et al., 2016). In a current meta-analysis to approximate the Global Burden of Disease from EDs, subclinical EDs such as LOC together with threshold BED accounted for the majority of subject burden and impairment (Santomauro et al., 2021). Moreover, repeated LOC is associated with the onset of partial or full-threshold BED in approximately 50% of youth (Tanofsky-Kraff et al., 2011). A recent meta-analysis further revealed that LOC remains relatively persistent during the natural course of 15 years in youth of the general population

(Romano et al., 2020). Therefore, the transition from late adolescence to young adulthood may be a period of particular risk for the persistence of LOC (Goldschmidt, Wall, Zhang, Loth, & Neumark-Sztainer, 2016).

Initial research on the development and maintenance of LOC in youth indicates that interpersonal stressors such as appearance-related rejection experiences interact with deficits in emotion regulation (referred to as interpersonal emotion regulation), which promotes dysfunctional eating behavior such as LOC (Ambwani, Roche, Minnick, & Pincus, 2015; De Paoli, Fuller-Tyszkiewicz, & Krug, 2017; Elliott et al., 2010; Ranzenhofer et al., 2014). Youth with LOC are especially concerned about rejection (Blakemore & Mills, 2014) and tend to expect being excluded based on one's own appearance (appearance-based rejection sensitivity; Downey & Feldman, 1996; Park, 2007).

Even though LOC represents a frequent ED pathology in youth and has detrimental consequences (Marzilli et al., 2018), research on efficacious treatment options is scarce. Studies on full syndrome BED in youth indicated a significant undersupply (Forrest, Smith, & Swanson, 2017; Mohler-Kuo, Schnyder, Dermota, Wei, & Milos, 2016) with limited availability and accessibility of adequate treatment resources being the most important treatment barriers (Ihde-Scholl & Rössler, 2019; Innes, Clough, & Casey, 2017).

In adults, psychotherapy represents the treatment of choice for BED (AWMF, 2019; NICE, 2017), with most evidence for cognitive-behavioral (CBT) and interpersonal psychotherapy (IPT). Existing findings indicated that face-to-face psychotherapy (mostly CBT) might outperform CBT-based structured self-help (including unguided and guided respectively online and offline formats) in terms of treatment efficacy of key BED and depressive symptoms and in terms of dropout rates (Ghaderi et al., 2018; Hilbert et al., 2019; Schlup, Munsch, Meyer, Margraf, & Wilhelm, 2009; Vocks et al., 2010). However, structured self-help shows satisfying treatment outcomes and offers the advantage of

increasing the accessibility and flexibility, especially if provided online (Aardoom, Dingemans, Spinhoven, & Van Furth, 2013). Furthermore, guidance and the online format improve attrition rates in structured self-help for adults (Beintner, Jacobi, & Schmidt, 2014; Hilbert et al., 2019). Therefore, structured guided self-help is recommended to reduce core features as a first line treatment of BED and LOC in stepped care approaches (NICE, 2017). Nevertheless, body weight most often is not reduced in BED or LOC treatments (Hilbert et al., 2019).

In youth with LOC, the few existing pilot studies point to the efficacy of face-to-face psychotherapy as well as of online guided self-help (DeBar et al., 2013; Jones et al., 2008; Kamody, Thurston, Pluhar, Han, & Burton, 2019; Mazzeo et al., 2016; Safer, Lock, & Couturier, 2007; Shomaker et al., 2017; Tanofsky-Kraff et al., 2014). For instance, DeBar et al. (2013) found in their pilot study on 26 girls between 12 and 18 years with recurrent LOC, that participating in a face-to-face CBT with of eight core and four supplemental sessions decreases LOC episodes and improves shape-, weight-, and eating concerns compared to delayed treatment as usual (TAU-DT). Another study on the efficacy of a 16 weeks semi-structured online guided self-help CBT with an integrated behavioral weight loss intervention in a sample of 105 overweight male and female high school students at the age of 15 years with LOC found that self-help CBT decreased LOC at posttreatment and 9 months afterwards, compared to a waitlist group. In addition, interestingly, youths who received online guided self-help CBT showed lower BMI values as well as a greater reduction of weight- and shape concerns at 9 months follow up compared to the participants of the waitlist condition (Jones et al., 2008).

Treatment approaches combining face-to-face psychotherapy with the accessibility and flexibility of new technologies such as online structured self-help are named *blended treatments* (Andersson, Titov, Dear, Rozental, & Carlbring, 2019; Erbe, Eichert, Riper, & Ebert, 2017). Blended treatments have been shown to be efficacious in depressive youth

(Kooistra et al., 2019; Sethi, Campbell, & Ellis, 2010; Thase et al., 2018), while there is no such data in BED or LOC research in youth nor adults.

In sum, accessible and appealing evidence-based treatment options for youth suffering from LOC, including interventions on important age-specific maintaining factors such as appearance-related rejection sensitivity, are scarce. Therefore, we developed the first blended treatment program *BEAT* (Binge-Eating Adolescent treatment – a training program for adolescents and young adults with LOC), which consists of three face-to-face group or single workshops and six email-guided self-help sessions. The current pilot study assesses this program's efficacy during the active treatment and at 11 weeks follow-up. Applying a two weeks' wait-list control design, we expected that the active treatment, compared to the waiting time period, leads to a significant reduction of weekly LOC episodes and depressive symptoms. At posttreatment relative to pretreatment, we expected an increase in abstinence from LOC and a decrease in general ED pathology and appearance-based rejection sensitivity but no changes in BMI-SDS. We additionally explored therapist's and patient's ratings of treatment effects in clinical global impression (Guy, 1976), Finally, we investigated youth's acceptance of *BEAT* in terms of the satisfaction with treatment and dropout rates.

Methods

Participants

Overall, 24 youths (23 female, one male participants) were included in the pilot study and 16 patients (all female) completed the posttreatment assessment and 3-month follow-up of *BEAT* (see Fig. 1). The recruitment of participants in the present sample took place between May 2018 and September 2020 at the division of clinical psychology and psychotherapy of the University of Fribourg (Switzerland). The recruitment was promoted via public advertisements on webpages and fitness centers, media, as well as cooperating clinicians,

healthcare institutions and foundations. Inclusion criteria were the presence of LOC at least once during the last 6 months up to threshold BED according to the DSM-5 (APA, 2013), age between 14 and 24 years (according to the term youth defined e.g. by the UN) and written informed consent. Exclusion criteria were the presence of another medical or psychological condition requiring prior treatment (e.g. acute substance abuse, psychosis, suicidality), current Bulimia Nervosa or Anorexia Nervosa, pregnancy, the lack of sufficient German language skills, and concurrent participation in a diet-or weight loss program or in an ED psychotherapy (participation in other psychological treatments than ED specific psychotherapy was not an exclusion criteria due to feasibility reasons).

Insert Figure 1 here

Study design and procedure

The *BEAT* pilot study represents a repeated-measures (within-subjects) waitlist control design. After giving informed consent, participants completed pretreatment assessment in which online questionnaires were provided and mental disorders assessed in a clinical interview. Thereafter, eligible participants completed a two-weeks waiting time (up to week 2; for a detailed overview of study weeks, assessments and study periods see Table 1) before starting with the first session of the active treatment. The active treatment lasted 9 weeks (up to week 11), including 9 weekly sessions (one session per week) and the posttreatment assessment (week 11), in which online questionnaires were provided again. The follow-up period included 11 weeks (up to week 22) with two follow-up assessments three and 11 weeks after the posttreatment assessment (at weeks 14 and 22), i.e. one and three months after the 9th session of the active treatment.

Insert Table 1 here

Face to face workshops during the active treatment were conducted in groups of max. three patients or in a single setting to avoid long waiting times. Email-guided self-help sessions were processed by patients at home. The *BEAT* program is based on an evidence-based CBT treatment manual for adults with BED that was developed by our research group (Fischer, Meyer, Dremmel, Schlup, & Munsch, 2014; Munsch, Wyssen, & Biedert, 2018; Schlup et al., 2009) and adapted to youth in terms of simplification and adequacy of language and interventions. *BEAT* further encompasses a training in interpersonal emotion regulation such as coping with rejection and ARS. During the three workshops that lasted approximately 90–180 minutes (depending on the workshop and the group- or single setting), all ED specific interventions as well as interventions on interpersonal emotion regulation were discussed and prepared. The email-guided self-help sessions lasted approximately 30–60 minutes per session and were thought to support patients in implementing interventions that were discussed and prepared during the workshops in daily life. The content of each *BEAT* session is summarized in Table 2. All treatment sessions were manualized and standardized. However, for some of our youngest patients, sessions had to be further adapted in terms of length, without changing the session's content.

Insert Table 2 here

Each patient was assigned to one of four therapists for guidance. All therapists were postgraduated psychologists in CBT training, supervised by SM. After each email-guided self-help session, patients sent their notes, questions and worksheets to their therapist via email. Therapists provided written feedback via email within three days according to standardized topic and text templates (available from the authors) that were derived and adapted for *BEAT* from previous email- and online based BED treatment programs for

adults (Munsch et al., 2019; Wyssen, Forrer, Meyer, & Munsch, 2019). All feedback messages were then individualized to the specific needs of the individual patient.

The *BEAT* pilot study (DRKS00023706) was approved by the local ethic committee in Switzerland (study ID of the cantonal ethics approval: 2018-00230) and conforms the Declaration of Helsinki. All patients gave written informed consent prior their study participation (see Munsch et al., in progress for the study protocol).

Measures

Sociodemographics. At pretreatment assessment participants were asked to provide age, gender, nationality and occupation status.

Diagnostic interview for mental disorders, short version (Mini-DIPS; Margraf & Cwik, 2017). LOC and further mental disorders were assessed by the Mini-DIPS, a structured interview to assess mental disorders according to the DSM-5 (APA, 2013), which was conducted by phone before the start of *BEAT* (pretreatment) and one week after the 9th session of the active treatment (posttreatment). The Mini-DIPS has good reliability and validity in outpatient, inpatient and community samples (Margraf, 1994; Margraf, Cwik, Pflug, & Schneider, 2017).

The following two online self-report questionnaires were assessed weekly during the waiting time period, before each sessions of the active treatment, at posttreatment as well as before one and three-months follow-up sessions (total of 14 assessment points).

Weekly Binges Questionnaire (WBQ; Munsch et al., 2007). The WBQ was used to assess the frequency of self-reported weekly LOC episodes by asking youth about the number of episodes in which they experienced loss of control over a perceived unusual large amount of food. It's important to note that self-report assessment of objectively large amounts of food has shown to be less reliable than interview-based assessment (Marzilli et al., 2018). Similarly, the definition of an objective large amount of food and its

differentiation from smaller respectively normative food amounts, not fulfilling the criteria of a binge-eating episode according to the DSM-5 (APA, 2013), is difficult due to different growth-dependent needs of energy intake and age-dependent limited access to high quantities of food (Tanofsky-Kraff et al., 2011). Therefore, in youth samples the WBQ assesses LOC (loss of control eating irrespective of the amount of food) rather than binge-eating. At posttreatment assessment, patients subjective evaluation of changes from pretreatment to posttreatment in the amount of food during a LOC episode ("I have no LOC episodes anymore"; "the amount of food during a LOC episode decreased", "the amount of food during a LOC episode did not change"; "the amount of food during a LOC episode increased") and the subjective feeling of loss of control ("I have no feeling of loss of control anymore"; "the feeling of loss of control decreased", "the feeling of loss of control did not change"; "the feeling of loss of control increased") were also assessed with the WBQ. The WBQ shows high convergent validity relative to ecological momentary assessment (Munsch et al., 2009).

Beck Depression Inventory Fast Screening (BDI-FS; Beck, Brown, & Steer, 2013). The BDI-FS is a short version of the Beck Depression Inventory (Beck, Steer, & Brown, 1996), consisting of seven items and assesses depressive symptoms during the last seven days. The BDI-FS has satisfactory internal consistency (Cronbach's $\alpha = .84$) and convergent validity ($r = .67$; Kliem, Mossle, Zenger, & Brahler, 2014). Cronbach's α in the present sample was .81 at pretreatment assessment.

The following three online self-report questionnaires were assessed twice (pre- and posttreatment).

Eating Disorder Examination-Questionnaire (EDE-Q; Hilbert & Tuschen-Caffier, 2016). The EDE-Q assesses ED pathology during the last 28 days. It consists of 28 items, of which 22 items can be assigned to four subscales (*restraint eating*, *eating concerns* and *shape*-and *weight concerns)* and a global score. For the present study, only

the global score was used. The abstinence rate from LOC was defined as no LOC episodes during the last month, and was derived from item 15 of the EDE-Q, which assesses the number of LOC eating episodes similarly to the WBQ but during the last 28 days ("over the past 28 days, on how many days have you eaten an unusually large amount of food and have had a sense of loss of control at the time?"). The EDE-Q was also used to assess self-reported weight and height to calculate age and gender adjusted BMI (kg/m^2) standard deviation scores (BMI-SDS) according to the LMS method (Wabitsch & Moss, 2019). The EDE-Q subscales and the global score showed good internal consistency with Cronbach's α values ranging from .70 to .94 (Hilbert, de Zwaan, & Braehler, 2012). In the present study, Cronbach's α of the EDE-Q global score at pretreatment assessment was .93.

Appearance-based rejection sensitivity scale (ARS-D; Schmidt & Martin, 2017). To assess appearance-based rejection sensitivity, we applied a shortened and adapted version for youth of the German version of the ARS. In the present version of the ARS-D, 10 interpersonal situations are presented to participants (originally the ARS-D includes 15 situations). The ARS-D has good convergent and divergent validity and satisfying internal consistency with Cronbach's α of .90 (Schmidt & Martin, 2017). Cronbach's α of the present adapted ARS-D version at pretreatment assessment was .97.

Clinical Global Impression Scale (CGI; Guy, 1976). The CGI assesses the global clinical impression of patients by clinicians before and after treatment, applying three measures: the global severity of illness measure (CGI-S), the global improvement measure (CGI-I) and an efficacy index. The CGI-S was rated at pretreatment assessment and posttreatment assessment by therapists and additionally by patients. The CGI-I was rated at posttreatment assessment by therapists. In the present study, side effects being assessed within the efficacy index are reported. Findings regarding the validity of the CGI are inconsistent. While some studies supported the validity of the CGI in clinical trials (e.g. Hedges, Brown, & Shwalb, 2009), others criticized the CGI of being inconsistent, biased

and too general (Beneke & Rasmus, 1992; Busner, Targum, & Miller, 2009; Khan, Khan, Shankles, & Polissar, 2002).

The following online self-report questionnaire was assessed at posttreatment assessment.

Patient's subjective evaluation of the *BEAT* treatment program (own items). Patients reported their satisfaction with *BEAT* applying eight self-developed items based on the Working Alliance Inventory (WAI; Wilmers et al., 2008, "overall, how satisfied were you with *BEAT*?", "how much did *BEAT* help you to cope with LOC and the feeling of losing control while eating?", "do you think, *BEAT* is efficacious?", how much did you like the mix of email-guidance and workshops?", "how satisfied have you been with the support you received from your therapist?", "I think, another treatment would have been better for me", "would you participate again in *BEAT*?", "would you recommend *BEAT* to peers?"). Items were rated on a scale from 0 (not at all) to 10 (very much). While each item has been analyzed separately, items were additionally summarized to a mean treatment satisfaction score. To this end, the item "I think another treatment would have been better for me" had to be reversed. Cronbach's α in the present sample of the total score at posttreatment assessment was .91.

Statistical analyses

WBQ and BDI-FS were assessed regularly (altogether 14 times), allowing us to analyze their weekly temporal course using a discontinuous multilevel model (Singer & Willett, 2003), covering three study periods (waiting time, active treatment and follow-up). A linear course of time in weeks was estimated for each of the three phases, resulting in three fixed effects. A random intercept and, if this improved model fit, random slope coefficients for the three phases were also included in the model. For outcomes that were assessed only twice, at pretreatment and posttreatment (EDE-Q global score, BMI-SDS and ARS-D), the

multilevel model contained the factor time as the only fixed effect plus a random intercept. Effect sizes were computed according to Feingold (2009) for pre-post comparisons, whereby the standard deviation was estimated from the model based standard error of the pretreatment value, multiplied by the square root of the sample size (n=24). Finally, to assess the change in abstinence rate between pretreatment and posttreatment we used a generalized linear model based on a binomial distribution (abstinence y/n) with the factor time as the only effect.

To assess the change in the CGI-S scale between pretreatment and posttreatment, we used the Wilcoxon-test. For the WBQ, the Number Needed to Treat (NNT) for a significant treatment outcome during the active treatment relative to the waiting-time was calculated based on Cohens' d in both periods according to Preti (2015). The WBQ was transformed (ln[x+1]) prior to analyses and predicted means from the multilevel models were back-transformed for reporting. All other outcomes were left untransformed. The level of significance was set at .05.

We used descriptive statistics, i.e. means and standard deviations, to analyze patient's subjective evaluation of the *BEAT* program (own items).

Results

Sample characteristics

Mean age of patients was 19.08 years (*SD*=3.49). All patients were Swiss. Seven patients (29.2%) visited secondary school, four (16.7%) were in an apprenticeship, nine (37.5%) were inscribed at a University and four (16.7%) were employed.

Clinical sample characteristics at pretreatment and posttreatment assessment are reported in Table 3.

Insert Table 3 here

Efficacy of the *BEAT* blended treatment

Estimated means for primary and secondary outcomes derived from the multilevel models are shown in Table 4. Primary and secondary outcomes are reported subsequently.

Insert Table 4 here

Primary outcome

Abstinence rate. Abstinence rate increased from 4.2% (1 out of 24; 95%-CI=0.58%–24.3%) at pretreatment assessment to 12.5% (2 out of 16; 95%-CI=3.14%–38.6%) at posttreatment assessment (b=0.11, SE=0.12, z=0.94, p=.349, based on a generalized linear model).

Weekly LOC episodes (WBQ). The WBQ was assessed 14 times during the whole study, which allowed a detailed observation of the temporal course from pretreatment to 11-weeks follow-up (for individual time courses of each patient see supplemental material A). The WBQ linearly decreased during the two periods waiting-time (b=–0.12, SE=0.06, t(232)=–1.98, p=.048, d=0.44) and active treatment (b=–0.06, SE=0.01, t(232)=–4.61, p<.001, d=0.94; see Figure 2). The difference in the slopes of these two trendlines was comparatively small (b=0.06, SE=0.07, t(232)=0.94, p=.35, d=0.50) and combining the two time periods lead to a linear decrease of b=–0.07 (SE=0.01, t(202)=–6.92, p<.001, d=1.37) between pretreatment and posttreatment. During the subsequent follow-up period the WBQ remained more or less on the same level (b=–0.01, SE=0.01, t(232)=–0.40, p=.69, d=0.11), the corresponding trendline being less negative than that during the previous active treatment by b=0.05 (SE=0.02, t(232)=2.36, p=.02, d=0.83). NNT during the active treatment compared to the waiting-time was 3.61.

Insert Figure 2 here

Secondary outcomes

Depressive symptoms (BDI-FS). As for the WBQ, the BDI-FS being assessed 14 times during the whole study also allowed a detailed observation of the temporal course from pretreatment assessment to follow-up 2 (see Fig 3).

Insert Figure 3 here

Linear trend lines of the BDI-FS were b=–0.64 (SE=0.37, t(231)=–1.73, p=.08, d=0.36) during the waiting-time and b=–0.25 (SE=0.07, t(231)=–3.63, p<.001, d=0.62) during the active treatment and they did not differ much from each other (b=0.40, SE=0.40, t(231)=0.98, p=.328, d=0.26). When combining these two time periods, the BDI-FS linearly decreased between pretreatment and posttreatment by b=–0.29 (SE=0.07, t(201)=–4.43, p<.001, d=0.91). During the subsequent follow-up period, the BDI-FS remained more or less on the same level (b=0.07, SE=0.07, t(231)=0.98, p=.328, d=0.22), the corresponding trendline being less negative than that during active treatment phase by b=0.32 (SE=0.09, t(231)=3.59, p<.001, d=0.84).

General ED pathology (EDE-Q global score) and BMI-SDS. The EDE-Q global score decreased between pretreatment and posttreatment by b=–0.11 (SE=0.03, t(15)=–4.22, p<.001, d=0.85), whereas BMI-SDS did not (b=–0.02, SE=0.01, t(15)=–1.48, p=.159, d=0.31).

Appearance-based rejection sensitivity (ARS-D). The ARS-D did not substantially decreased (b=–0.29, SE=0.17, t(15)=–1.76, p=.099, d=0.32) between pretreatment and posttreatment assessment.

Clinical global impression outcome. Detailed descriptive values of the CGI-S ratings by therapists and patients at pretreatment and posttreatment as well as CGI-I rating at posttreatment by therapists are presented in Table 5. CGI-S ratings by therapists (z=-3.46,

p=.001) and by patients (*z*=-2.46, *p*=.014) were significantly improved at posttreatment compared to pretreatment. No negative side effects of treatment were reported by therapists at posttreatment.

Insert Table 5 here

Acceptance of the *BEAT* program

Dropout rates

Of the 24 patients being enrolled at pretreatment assessment, eight patients (33.3%, 95%-CI=16.9%–53.2%) terminated the *BEAT* program prematurely (dropouts): Of these, one (12.5%) dropped out after the pretreatment assessment in the waiting-time period and seven (87.5%) during the nine treatment sessions of the active treatment. No dropouts occurred during the follow-up period. Considering dropout reasons, for one patient (12.5%) the *BEAT* program was too demanding, especially the email-guided self-help sessions, two patients (25%) cancelled the first workshop due to time issues or illness, one patient (12.5%) had developed a physical illness that needed prior treatment and for four patients (50%) dropout reasons were unknown as they didn't reply to emails and phone calls. Compared to participants who remained in the study, those who terminated *BEAT* prematurely were on average c. 3.9 years younger (*b*=3.87, *SE*=1.30, *p*=.007), but did otherwise not differ with respect to pretreament values of ARS, BDI-FS, EDE-Q global score, BMI, and WBQ ($p \geq .094$ for all comparisons).

Patient's subjective evaluation of the *BEAT* program

Mean treatment satisfaction of the completers (*n*=16) at posttreatment assessment was 8.86 (*SD*=1.22) on a scale from 0–10 (0=not at all satisfied, 10=very much satisfied). Results of the single item analyses are presented in Table 6.

Insert Table 6 here

Discussion

In the present pilot study, we evaluated for the first time the efficacy of a blended treatment program, *BEAT,* in youth with LOC. We employed a within-subject waitlist control design and assessed the program's effects on abstinence rates, the number of weekly LOC episodes (primary outcomes) as well as on ED pathology, BMI-SDS, appearance-based rejection sensitivity and depressive symptoms (secondary outcomes) up to 11 weeks after the end of the active treatment.

Participation of youths in *BEAT* led to a slight increase in the percentage who did experience zero LOC during the last 4 weeks from pretreatment (4%) to posttreatment (12.5%). This abstinence rate of 12.5% at posttreatment lies significantly below abstinence rates of approx. 50% for face-to-face and 45% for online structured self-help treatments (mostly based on CBT) in adults (Hilbert et al., 2019; Linardon, 2018). Compared with previous studies of our group on BED in adults, the abstinence rate after *BEAT* was lower than in a face-to-face group setting (39%, Schlup et al., 2009), but comparable to that from our recent e-mail guided self-help program (15%, Wyssen et al., 2019). Further, abstinence rates were also markedly smaller than the abstinence rate of 92.3% that has been reported 3 months after treatment begin in the only CBT based study (face-to-face) in youths with LOC reporting abstinence rates (DeBar et al., 2013). Such marked discrepancies in abstinence rates among studies have also been found in the meta-analysis of Hilbert et al. (2019) on face-to-face therapy and structured self-help treatments for adults and are based on differences in treatment length, definition of abstinence rates and statistics (e.g. intent-to-treat versus completer analysis) that have been applied. For instance, DeBar et al. (2013) defined abstinence from LOC as zero LOC episodes at posttreatment, while we defined it as zero LOC episodes during the last 28 days according to the common definition of abstinence in BED treatment studies in adults (Linardon, 2018), which partly explains higher abstinence rates in the DeBar's study. Moreover, we included youth with LOC of

fewer frequencies than required for BED according to the DSM-5 (APA, 2013), compared to DeBar et al. (2013) who only included youth with LOC episodes at least once a week during the last three months. Besides different treatment lengths and definitions of abstinence rates, this might explain why the abstinence rate in our study at pretreatment assessment was already 4% and then increased only slightly compared to DeBar et al. (2013) who started with an abstinence rate of 0%. Further treatment studies on LOC in youth did not report any data on abstinence rates (e.g. Jones et al., 2008; Kamody et al., 2019; Mazzeo et al., 2016).

The number of weekly LOC episodes did not only decrease during the active treatment but already during the waiting-time and temporal declines of weekly LOC episodes were comparable between the two weeks waiting-time period and the active treatment. Note here that it was not ethical to let youth wait longer than for two weeks to start the treatment, but this waiting period was probably too short to reliably assess the natural course of LOC episodes or depressiveness without treatment. The observed improvements occurring already while waiting are in line with previous studies (Wyssen et al., 2019). These findings might be explained by relatively high spontaneous remission rates in the early stage of LOC and BED (Goldschmidt et al., 2016; Stice & Shaw, 2002) and by the activation of common treatment factors, such as hope for successful treatment (Enck & Zipfel, 2019; Kirsch, Wampold, & Kelley, 2016; Wyssen et al., 2019). Nevertheless, if the treatment effect is summarized in terms of NNT, which was based on the total reduction of the number of self-reported weekly LOC episodes (WBQ) across the nine weeks of treatment, relative to the two weeks of the waiting period, the active treatment reached a moderate to high NNT of 3.6 (Cohen, 1988; Wampold & Imel, 2015). Moreover, the evaluation of the overall efficacy from pretreatment to posttreatment (combining waiting-time and active treatment) revealed a strong effect with respect to the reduction of the number of weekly LOC episodes during *BEAT* from 2.82 LOC episodes

per week at pretreatment to 0.85 LOC episodes per week at posttreatment (d=1.37). During the follow-up period the number of LOC episodes per week remained stable, which confirmed our expectation that the reduction of weekly LOC episodes was maintained in adolescents' daily life up to three months after the end of treatment.

In line with most findings from previous research on short-term treatment effects (e.g. DeBar et al., 2013; Hilbert et al., 2019; Schlup et al., 2009; Wyssen et al., 2019), general ED pathology (restraint eating, eating concerns as well as shape- and weight concerns) was strongly reduced between pretreatment and posttreatment assessment, whereas BMI-SDS remained relatively stable. The maintenance of BMI-SDS might indicate that early treatment of LOC could prevent the trajectory of growing weight gain in untreated youth (e.g. Micali et al., 2015). The long-term efficacy of *BEAT* on BMI-SDS should be investigated, as the study of Jones et al. (2008) on youth with LOC indicates a long-term reduction in BMI of less than 2.5%.

The treatment study *BEAT* included interventions targeting interpersonal emotion regulation to cope with rejection and appearance-based rejection sensitivity for the first time, but measures on appearance-based rejection sensitivity showed only a non-significantly negative trend between pretreatment and posttreatment assessment. In our study, the training to cope with rejection experiences and appearance-based rejection sensitivity was only initiated in the second half of the active treatment. Considering that appearance-based rejection sensitivity represents an enduring and trait-like disposition in the maintenance of LOC (Park, 2007), the present positive trend should be reevaluated by providing a prolonged duration of specific interventions on appearance-based rejection sensitivity.

Depressive symptoms decreased during the active treatment but started to ameliorate already during the waiting-time, which again points to a potential positive expectation and to a strong interaction between depressiveness and LOC (Enck & Zipfel, 2019; Kirsch et

al., 2016). In contrast to an email-guided self-help program for adults with BED (Wyssen et al., 2019), where depressive symptoms remained stable during treatment, depressive symptoms overall strongly decreased during *BEAT* from pretreatment to posttreatment (d=0.99) and remained stable during the follow-up period. While improvements in depressive symptoms in youth with LOC have also been reported in the face-to-face CBT by DeBar et al. (2013), youth participating in the only existing online guided self-help CBT, did not benefit (Jones et al., 2008).

We further assessed the therapist and participant's impressions of general improvement by applying the CGI. The severity of illness in the CGI-S decreased from markedly ill at pretreament to mildly ill at posttreatment in therapists' respectively from moderately burdened to mildly burdened in youth's ratings. Further, neither therapist nor participants reported negative treatment side effects.

Secondly, we investigated the acceptance of the *BEAT* blended treatment with respect to dropout rates and patient's subjective evaluation of the program. The mean dropout rate of 33% (95 CI: 17–53%) lies within the large range of attrition that can be expected from online self-help treatments including one or more face-to-face contact in adults (6-40%; Aardoom et al., 2013). Moreover, previous treatment studies on LOC in youth also showed that a substantial part of youth did not attend all treatment sessions (DeBar et al., 2013) nor did they regularly use an online program (Jones et al., 2008a). In addition, the overall mean dropout rate of approximately 28.5% in youth participating in different outpatient mental health care treatment studies (de Haan, Boon, de Jong, Hoeve, & Vermeiren, 2013) indicate that attrition in youth with mental disorders is generally challenging. It's noteworthy that youths who dropped out from *BEAT* were approximately 4 years younger (p=.007) than those who completed the program, implicating that blended treatments might be an efficacious and accessible treatment option for especially older youth (Beintner et al., 2014) or that treatment offers should be more age specific.

Despite of the considerable dropout rate, overall treatment satisfaction among patients who completed *BEAT* was high with a mean value of 8.86 out of 10. Moreover, patients strongly agreed to participate again in *BEAT* and would highly recommend it to peers.

There are several limitations considering the findings of the current pilot study. The sample size of the current study was small. The lack of an inactive control condition of comparable length makes it difficult to precisely contrast treatment effects against waiting-list effects. Moreover, our findings are not valid with respect to male youth. Due to Covid-19, we had to conduct some of the workshops via online video conferences during the lockdown from end of March to May 2020. Furthermore, some of the patients received additional psychotherapy while they were participating in *BEAT.*

To conclude, the present pilot study documents first evidence of the efficacy of a blended treatment program (*BEAT*) for youth aged 14 to 24 suffering from LOC including elements of CBT for EDs and interventions to improve interpersonal emotion regulation. Treatment effects were found for LOC psychopathology, co-occurring general ED pathology and depressive symptoms. In contrast, there were no relevant improvements of appearance-based rejection sensitivity. Patients who completed treatment with *BEAT* expressed high treatment satisfaction, but a considerable drop-out rate calls for more detailed analyses in attrition to blended and online treatments in this age group. Larger, randomized between-group control designs are needed to more thoroughly test the efficacy of *BEAT*.

Tables and Figures

Table 1

Overview of assessment points and study phases

week	assessment	period
0	pretreatment	waiting-time
1	waiting-time	
2	session 1 of the active treatment (email)	active treatment
3	session 2 of the active treatment (workshop)	
4	session 3 of the active treatment (email)	
5	session 4 of the active treatment (email)	
6	session 5 of the active treatment (workshop)	
7	session 6 of the active treatment (email)	
8	session 7 of the active treatment (email)	
9	session 8 of the active treatment (workshop)	
10	session 9 of the active treatment (email)	
11	posttreatment	follow-up
12		
13		
14	1-month follow-up	
15		
16		
17		
18		
19		
20		
21		
22	3-month follow-up	

Table 2

Main content of the BEAT active treatment sessions

Session	Type of session	Content
1	email 1	Introduction into *BEAT*, LOC eating and self-observation of eating behavior
2	workshop I	• Motivation • Goal of *BEAT* • LOC eating specific CBT - development and maintenance of LOC eating - regular eating - analyzing LOC eating episodes with ABC-model - developing coping strategies to overcome LOC eating (trigger- and reaction control) - working with emergency cards
3	email 2	• Individual goal attainment scale and etiological model • Typical difficulties in the previous treatment phase • Difficulties and improvements in coping with LOC eating
4	email 3	• Difficulties and improvements in coping with LOC eating • Interpersonal emotion regulation (real rejection and appearance-related rejection sensitivity) and its association with LOC eating • Self-observation of situations experiencing real rejection and appearance-based rejection sensitivity
5	workshop II	• Difficulties and improvements in coping with LOC eating • Interpersonal emotion regulation: Coping with real rejection experiences and appearance-based rejection sensitivity
6	email 4	• Difficulties and improvements in coping with LOC eating • Difficulties and improvements in coping with rejection experiences and appearance-based rejection sensitivity
7	email 5	• Difficulties and improvements in coping with LOC eating • Difficulties and improvements in coping with rejection experiences and appearance-based rejection sensitivity
8	workshop III	• Difficulties and improvements in coping with LOC eating • Difficulties and improvements in coping with rejection experiences and appearance-based rejection sensitivity • Coping with future difficulties
9	email 6	• Difficulties and improvements in coping with LOC eating • Difficulties and improvements in coping with rejection experiences and appearance-based rejection sensitivity • Individual coping with future difficulties and relapse prevention • Further goals
follow-up 1 and 2	email	• Coping with current difficulties and relapse prevention

Table 3

Clinical sample characteristics at pretreatment assessment and posttreatment assessment

	Pretreatment assessment (*n*=24)	**Posttreatment assessment (*n*=16)**
	Mean (*SD*) /% (*n*)	**Mean (*SD*) /% (*n*)**
BMI-SDS percentiles[a] (*%*, *n*)		
≤90	54.2 (13)	56.3 (9)
>90-97	20.8 (5)	37.5 (6)
>97-99.5	8.3 (2)	0
>99.5	16.7 (4)	6.3 (1)
Severity of LOC eating [b] (Mean, *SD*)	5.54 (1.35)	2.81 (1.28)
Changes in the amount of food [c] (*%*, *n*)		
No LOC eating episodes anymore		12.5 (2)
Smaller		68.8 (11)
Same		12.5 (2)
Larger		0
Changes in the feeling of LOC [d] (*%*, *n*)		
No loss of control experience anymore		18.8 (3)
Less intense		68.8 (11)
Same		6.3 (1)
More intense		0
Participants with comorbid disorders [e] (Mean, *SD*)	20.8 (5)	12.5 (2)
High negative affect (BDI-FS ≥ 10) [f] (Mean, *SD*)	25.0 (6)	0

BMI-SDS: body mass index standard deviation score, BDI-FS: Beck Depression Inventory Fast Screening.

[a] ≤90=normal weight; >90-97=overweight; >97-99.5=obesity; >99.5=sever obesity.

[b] severity rating of LOC by therapists on a scale from 0=absence to 8=severe.

[c] patient's subjective evaluation of changes in the amount of food consumed during a LOC eating episode from pretreatment assessment to posttreatment assessment. Smaller = the amount of food decreased; same = the amount of food did not change; larger = the amount of food increased. From one patient (6.3%) the information was not available.

[d] patient's subjective evaluation of changes in the feeling of control during a LOC eating episode from pretreatment assessment to posttreatment assessment. Less intense = the feeling of loss of control decreased; same = the feeling of loss of control did not change; more intense = the feeling of loss of control increased. From one patient (6.3%) the information was not available.

[e] at least one comorbid disorder.

[f] cut-off for severe depression according to Beck, Steer, and Brown (2000).

Table 4

Estimated means of primary and secondary outcomes from the multilevel model at assessment point pretreatment, posttreatment and follow-up one and two

	Pre-treatment (*n*=24)		**Post-treatment (*n*=16)**		**Follow-up assessment 1 (*n*=16)**		**Follow-up assessment 2 (*n*=16)**	
	Mean	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**
Primary outcome								
WBQ[a]	2.82	[2.09, 3.72]	0.85	[0.54, 1.21]	0.82	[0.54, 1.14]	0.74	[0.37, 1.28]
Secondary outcomes								
EDE-Q global score	3.57	[3.11, 4.03]	2.41	[1.86, 2.95]	-	-	-	-
BMI-SDS	1.29	[0.80, 1.79]	1.14	[0.62, 1.65]	-		-	
BDI-FS	6.05	[4.61, 7.48]	2.56	[1.62, 3.50]	2.77	[1.92, 3.62]	3.34	[1.88, 4.79]
ARS-D	13.61	[10.12, 17.11]	10.38	[6.38, 14.37]	-	-	-	-

WBQ: weekly binges questionnaire, EDE-Q global score: Eating Disorder Examination Questionnaire, global score, BMI-SDS: Body mass index standard deviation scores, BDI-FS: Beck Depression Inventory Fast Screening, ARS-D: Appearance-related rejection sensitivity.

[a] back-transformed from ln(x+1)

Table 5

Outcomes in the clinical global impression scale (CGI)

	Pretreatment (*n*=24)	**Pretreatment treatment completers (*n*=16)**	**Posttreatment (*n*=16)**
	Mean (*SD*) /% (*n*)	**Mean (S*D*) /% (*n*)**	**Mean (*SD*) /% (*n*)**
CGI-S therapist, Mean (*SD*)	5.17 (0.87)	5.13 (0.96)	3.25 (1.00)
not at all ill (1)	0	0	0
borderline mentally ill (2)	0	0	25 (4)
mildly ill (3)	4.2 (1)	6.3 (1)	37.5 (6)
moderately ill (4)	16.7 (4)	18.8 (3)	25 (4)
markedly ill (5)	37.5 (9)	31.3 (5)	12.5 (2)
severely ill (6)	41.7 (10)	43.8 (7)	0
among the most extremely ill patients ill (7)	0	0	0
CGI-S patient, Mean (*SD*)	4.08 (1.86)	4.63 (1.59)	3.19 (1.68)
not burdened at all (1)	20.8 (5)	12.5 (2)	31.3 (5)
borderline burdened (2)	4.2 (1)	0	0
mildly burdened (3)	0	0	12.5 (2)
moderately burdened (4)	16.7 (4)	12.5 (2)	37.5 (6)
markedly burdened (5)	41.7 (10)	56.3 (9)	12.5 (2)
severely burdened (6)	12.5 (3)	12.5 (2)	6.3 (1)
extreme severely burdened (7)	4.2 (1)	6.3 (1)	0
CGI-I therapist, Mean (*SD*)			2.31 (0.60)
very much improved (1)			6.3 (1)
much improved (2			56.3 (9)
minimally improved (3)			37.5 (6)
no change (4)			0
minimally worse (5)			0
much worse (6)			0
very much worse (7)			0

Note. CGI-S therapist: CGI severity scale therapist rating, CGI-S patient: CGI severity scale patient rating, CGI-I therapist: CGI improvement scale therapist rating.

Table 6

Treatment satisfaction with different aspects of *BEAT*

	Mean (*SD*)
Overall, how satisfied were you with *BEAT*?	8.88 (1.36)
How much did *BEAT* help you to cope with LOC eating and the feeling of losing control while eating?	8.44 (1.97)
Do you think *BEAT* is efficacious?	8.63 (1.45)
How much did you like the mix of email-guidance and workshops?	8.25 (1.95)
How satisfied have you been with the support you received from your therapist?	9.63 (0.72)
I think, another treatment would have been better for me.	1.44 (2.16)
Would participate again in *BEAT*?	9.25 (1.06)
Would you recommend *BEAT* to peers?	9.25 (1.29)

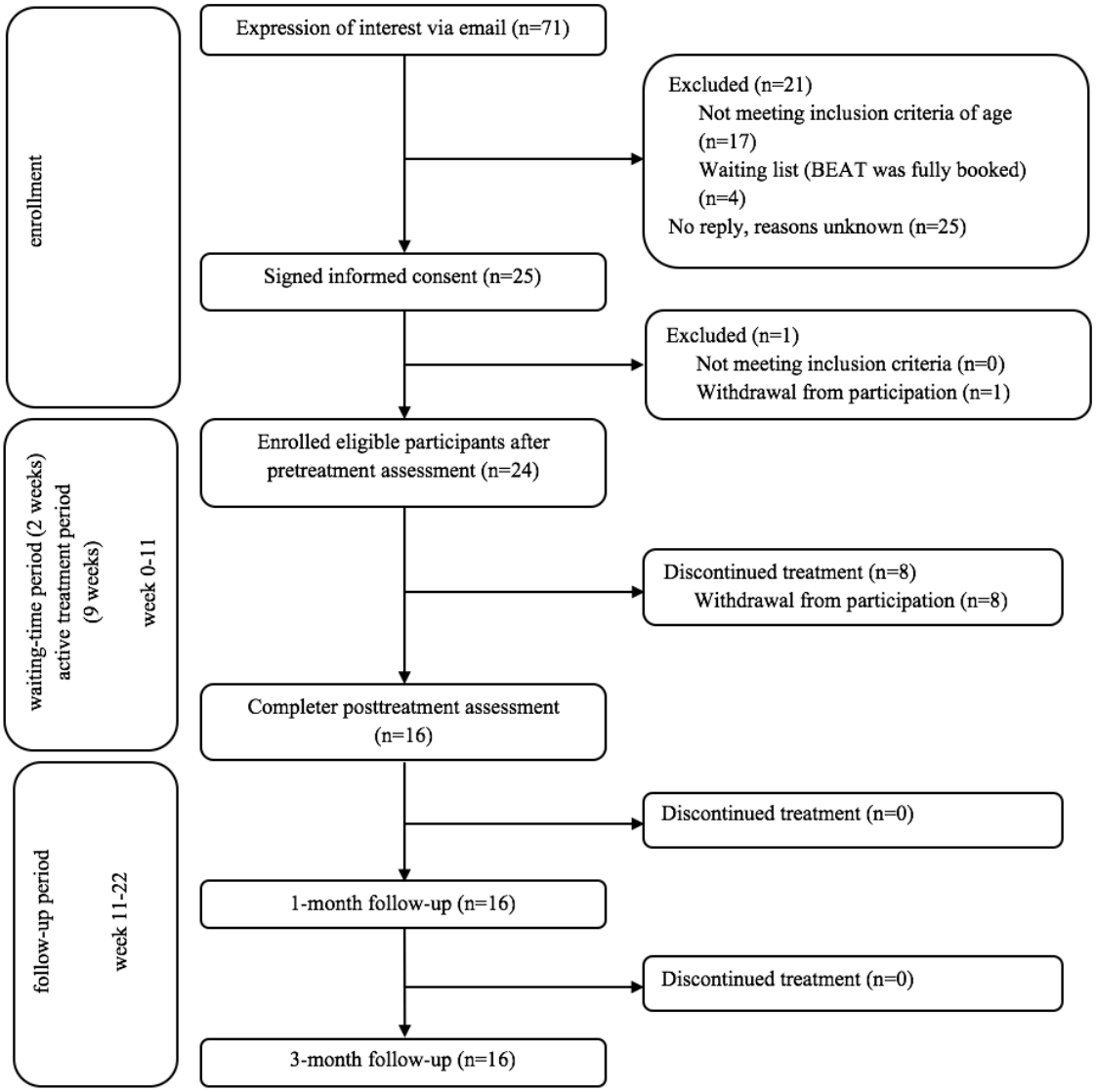

Figure 1. Participant flow diagram.

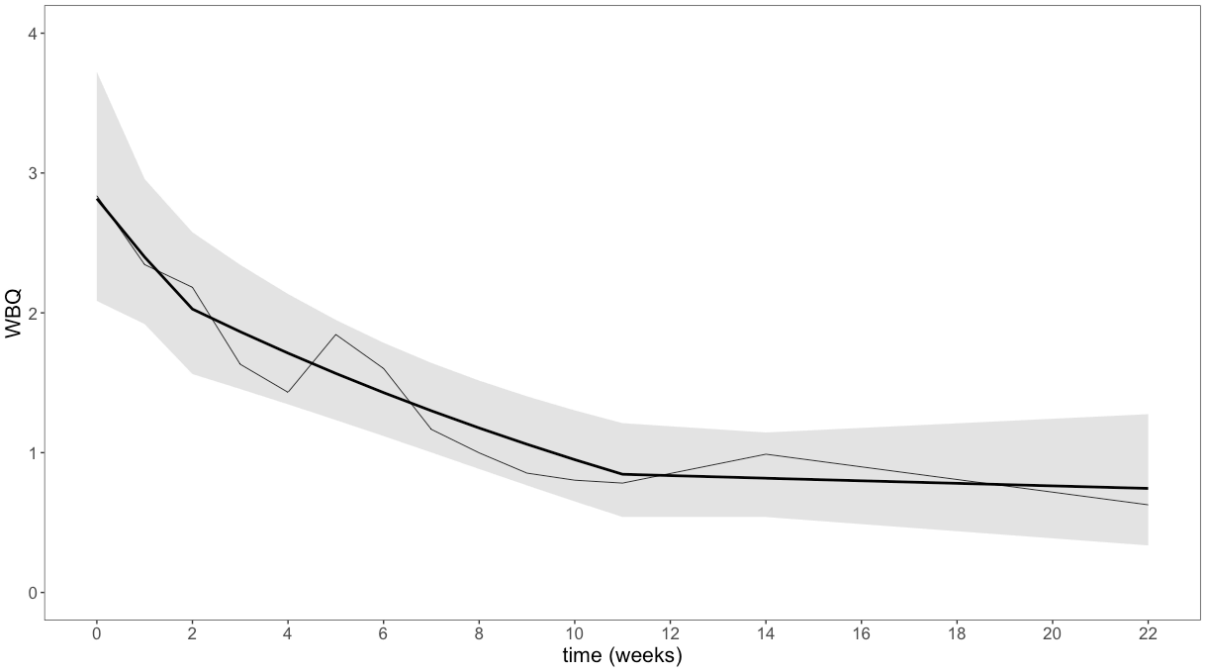

Figure 2. Temporal course of the WBQ from assessment points pretreatment (week 0) to follow-up 2 (week 22). The line in bold denotes the estimated trendline of the WBQ from the discontinues multilevel model with turning points set at week 2 and week 11. The values were back-transformed from ln(x+1). The thin line connects the arithmetic mean values of the WBQ at the different assessment points. These values were first transformed using ln(x+1), averaged and then back-transformed again to make them comparable to the predicted means form the model-based values. Shaded area denote ±1 standard error of the trend lines from the discontinues multilevel model. Waiting-time: week 0 – week 2, active treatment: week 2 – week 11, follow-up: week 11 – week 22.

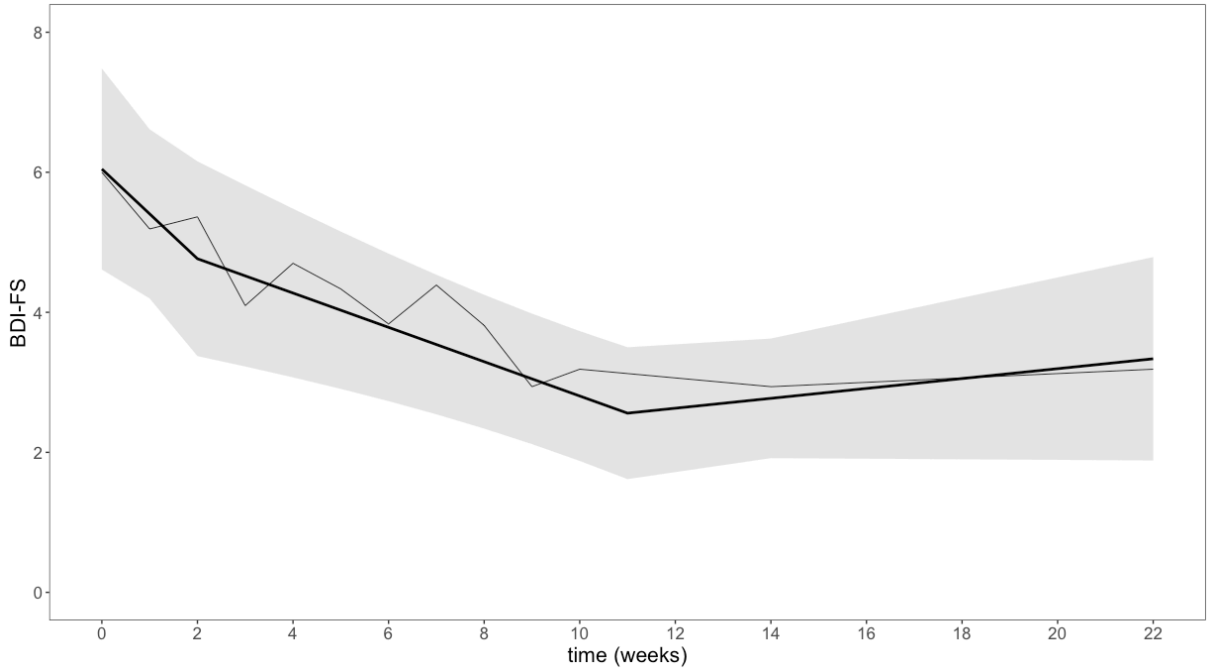

Figure 3. Temporal course of the BDI-FS from assessment points pretreatment (week 0) to follow-up 2 (week 22). See Figure 2. for further explanations.

Supplemental Material A

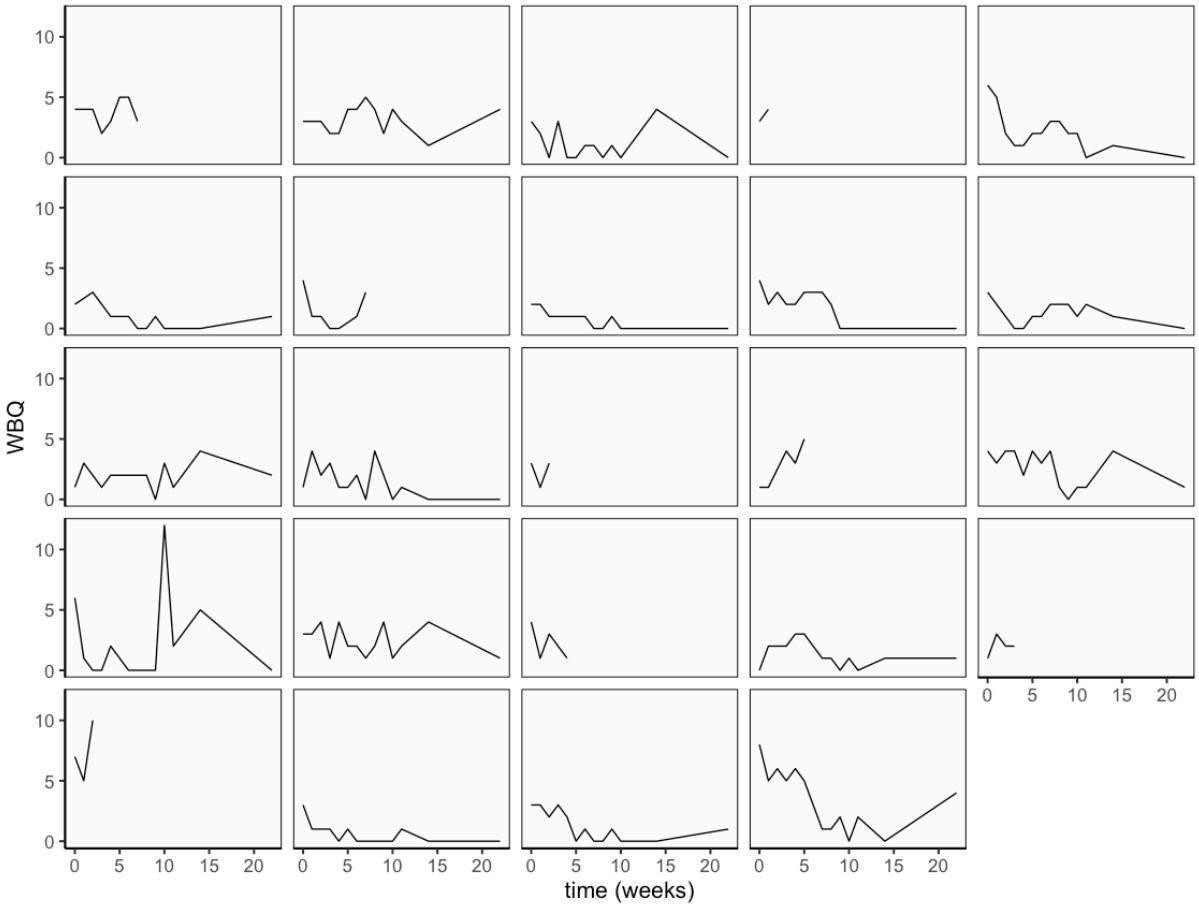

Figure A. Temporal courses of the WBQ for each patient based on observed (untransformed) data.

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C) Publication 3

The Influence of Emotion Regulation Difficulties on Short- and Long-term Treatment Outcome in an Online Guided Self-Help Program for Adults with Binge-Eating Disorder

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Abstract

Objective: CBT-based online guided self-help programs represent efficacious and accessible treatment options for adults with Bing-Eating Disorder (BED), but research on predictors of treatment outcome is scarce. This study aimed at investigating the predictive value of emotion regulation difficulties relative to negative mood on short- and longer-term treatment outcome in an online guided self-help program for BED above and beyond other predictors (age, gender, baseline BED severity). **Methods:** 63 adults (87% female, mean age 37.21 years) with BED participated. A hierarchical regression model approach was applied to assess the predictive power of emotion regulation difficulties and negative mood after controlling for more frugal predictors (age, gender, baseline severity). **Results:** Emotion regulation difficulties predicted weekly binge-eating frequency and ED pathology at posttreatment above and beyond age, gender and BED severity, and superior to negative mood. At 6-month follow-up, emotion regulation difficulties did not contribute to the prediction of both treatment outcomes. **Discussion:** Emotion regulation difficulties might be a relevant predictor of immediate treatment outcome in online guided self-help for adults with BED but might have lower impact on longer-term treatment outcome.

Keywords: Binge-Eating Disorder, psychotherapy, online guided self-help, predictors, treatment outcome, emotion regulation difficulties

Introduction

Binge-eating disorder (BED) is characterized by recurrent loss of control eating over large amounts of food in a certain time span without regular compensatory behavior (APA, 2013). BED is the most prevalent eating disorder (ED) in adults with lifetime prevalence rates ranging from 1.9 – 4% in women and from 0.3 – 2.5% in men (Keski-Rahkonen & Mustelin, 2016; Kessler et al., 2013; Mohler-Kuo, Schnyder, Dermota, Wei, & Milos, 2016). In overweight and obese individuals, prevalence rates of BED are markedly higher with up to 30 – 40% (Kessler et al., 2013). Over 70% of individuals with BED show comorbid mental disorders (Keski-Rahkonen & Mustelin, 2016; Kessler et al., 2013). Moreover, BED is associated with considerable disability-adjusted life-years (DALY), underlining the burden related to this disorder (Santomauro et al., 2021). CBT-based online guided self-help (online CBTgsh) programs have proven to be efficacious in the treatment of core symptoms of BED (Aardoom, Dingemans, Spinhoven, & Van Furth, 2013; Hilbert et al., 2019) and have the advantage to increase the accessibility of adequate treatment offers (Aardoom et al., 2013). Online CBTgsh programs are therefore suitable first line treatments in stepped care approaches (NICE, 2017; Wilson, Wilfley, Agras, & Bryson, 2010).

Despite evidence for online CBTgsh in BED, up to 65% of individuals with BED do not respond in terms of abstinence from binge-eating (e.g. Carrard, Crepin, Rouget, Lam, Golay, et al., 2011; Carrard, Crepin, Rouget, Lam, Van der Linden, et al., 2011; de Zwaan et al., 2017; Linardon, Messer, & Fuller-Tyszkiewicz, 2018) in contrast to approximately 40 – 50% in more intensive face to face CBT (de Zwaan et al., 2017; Hilbert et al., 2019; Linardon et al., 2018). Therefore, more knowledge on individuals' characteristics predicting treatment outcome of online CBTgsh is important.

Data on predictors of treatment outcome of online CBTgsh is scarce, and previous findings covering predictors across a range of psychological treatment formats of BED

(mostly based on CBT) are inconsistent (Grilo, 2017; Vall & Wade, 2015). Up to now, most studies evaluated the influence of demographic characteristics such as age and gender, and baseline severity of BED (Linardon, Garcia, & Brennan, 2017), while little is known about the impact of transdiagnostic concepts such as emotion regulation difficulties, even though emotion regulation difficulties are known to contribute to the development and maintenance of a large range of mental disorders (Berking & Wupperman, 2012; Kraiss, ten Klooster, Moskowitz, & Bohlmeijer, 2020; Svaldi, Griepenstroh, Tuschen-Caffier, & Ehring, 2012).

Regarding age, aggregated and metanalytic data of different psychological treatment approaches including online CBTgsh, lead to inconsistent findings, as some studies found older individuals to profit more in terms of binge-eating frequency and general ED pathology (Beintner, Jacobi, & Schmidt, 2014; Thompson-Brenner et al., 2013), while others found the opposite (Hilbert et al., 2019). Especially older studies on face-to-face CBTgsh found age not to be a predictor of treatment outcome in BED (Carter & Fairburn, 1998; Masheb & Grilo, 2008). Similar inconsistencies were found regarding the influence of gender on treatment outcome, where some research indicates that men benefit similarly from CBTgsh as women in terms of binge-eating frequency and ED pathology (Lydecker, Gueorguieva, Masheb, White, & Grilo, 2020; Shingleton, Thompson-Brenner, Thompson, Pratt, & Franko, 2015), whereas metanalytic findings showed that randomized controlled trials (RCTs) relying on samples with a higher proportion of women lead to greater reductions in binge-eating episodes (Hilbert et al., 2019).

Overall, findings indicate that increased BED severity at treatment begin leads to less improvement during treatment, but findings are less clear for longer-term treatment outcomes (Castellini et al., 2011; Munsch, Meyer, & Biedert, 2012; Thompson-Brenner et al., 2013; Vall & Wade, 2015). However, there are also studies on online and face-to-face CBTgsh that found binge-eating frequency at treatment begin not to be or even positively

related to improvements and recovery from binge-eating at posttreatment (Beintner et al., 2014; Hilbert et al., 2019; Wagner et al., 2016).

Emotion regulation difficulties, defined as trait-like problems regarding the awareness, understanding, acceptance and modulation of emotional responses to daily stressors as well as difficulties in controlling impulsive behavior and maintaining goal-directed behavior especially when experiencing negative mood (e. g. depressive symptoms; Gratz & Roemer, 2004), is assumed to be a fundamental mechanism in the development and maintenance of BED (e.g. Aguera et al., 2019; Brockmeyer et al., 2014; Culbert, Racine, & Klump, 2015; Dakanalis et al., 2014; Svaldi et al., 2012). For instance, emotion regulation difficulties predicted binge-eating and ED pathology severity in students and adults with BED (Carano et al., 2006; Dakanalis et al., 2014; Gianini, White, & Masheb, 2013; Lavender & Anderson, 2010), above and beyond negative mood, age and gender (Gianini et al., 2013; Sim & Zeman, 2006; Whiteside et al., 2007). In other words, binge-eating might not only be related to the mere severity of negative mood but also to deficits in the overall emotion regulation capacity, limiting the ability to functionally respond to and deal with increased negative mood (Dingemans, Danner, & Parks, 2017). Thus, emotion regulation difficulties may well qualify as predictor of BED treatment outcomes.

While several clinical trials, including CBTgsh (face-to-face respectively online) investigated the impact of negative mood in terms of depressiveness on treatment outcome in BED and found mixed results (e.g. Grilo, 2017; Lammers, Vroling, Ouwens, Engels, & van Strien, 2015; Masheb & Grilo, 2008; Ricca et al., 2010; Vall & Wade, 2015; Wagner et al., 2016), only few studies examined the predictive role of emotion regulation difficulties in immediate and longer-term treatment outcome (Lammers et al., 2015). For instance, a recent study by Anderson et al. (2020) on 112 adults with BED participating in a face-to-face CBTgsh or an emotion focused face-to-face therapy found lower levels of overall emotion regulation difficulties, assessed according to the Difficulties in Emotion

Regulation Scale (DERS; Gratz & Roemer, 2004), but not lower negative mood to predict improvement in binge-eating at 6-month follow-up, while neither variable predicted posttreatment outcome. This is in contrast to the results of a study on bulimia nervosa that found no associations between baseline emotion regulation difficulties assessed with the DERS questionnaire and face-to-face CBT outcome at posttreatment and at 4-months follow-up (Accurso et al., 2016). A recent review on alexithymia in EDs concluded that most data indicate that alexithymia at pretreatment is associated with poorer treatment outcome in EDs (Pinna, Sanna, & Carpiniello, 2015). Furthermore, a recent study found individuals with higher emotional impulsivity, negative urgency, but not behavioral impulsivity had smaller and slower reductions in binge-eating frequency and ED pathology than individuals with lower emotional impulsivity (Manasse et al., 2016). However, Anderson et al. (2020) did not find an association between negative urgency and BED short- and long term treatment outcome, underlining that previous findings on the predictive value of emotion regulation difficulties on BED treatment outcome are mixed.

In order to increase the knowledge on predictors of treatment outcome in online CBTgsh for BED, the objective of the present study was to assess the influence of demographic and clinical characteristics such as age, gender, BED severity, negative mood and overall emotion regulation difficulties in predicting treatment outcome in an online CBTgsh program in individuals with BED that has shown to be efficacious (Munsch et al., 2019; Wyssen et al. resubmitted). To this end we used a hierarchical regression model approach in which we assessed the influence of different sets of predictors on weekly self-reported binge-episodes and ED pathology. Thus, age and gender were entered first (first set of predictors), followed by the baseline variable of the respective outcome (second set), followed by negative mood and emotion regulation difficulties (third set). We were thereby particularly interested in whether transdiagnostic concepts such as negative mood and

emotion regulation difficulties were able to explain treatment outcome above and beyond what was already explained by the other predictors mentioned above.

Methods

Participants

A total of 63 adults with BED were included in the study "BED-Online". Participants were recruited via the outpatient center for psychotherapy at the department of psychology (University of Fribourg), via public advertisements, media, and cooperating clinicians. Individuals between 18 and 70 years with a primary diagnosis of BED according to DSM-5 (APA, 2013) as assessed with the Mini-DIPS (Margraf & Cwik, 2017) and who provided written informed consent were eligible to participate. Exclusion criteria included the presence of another psychological or medical condition that needed prior treatment, current pregnancy and the lack of sufficient German language or of technical skills to work with the program (both self-reported).

Mean age of participants was 37.2 years (*SD*=10.4) and the majority of participants were women (*n*=55, 87.3%). Most participants were Swiss (*n*=56, 88.9%), six (9.5%) were German and one Austrian (1.6%). 30 participants (47.6%) hold a university degree, 11 (17.4%) reported a higher education entrance qualification, 20 (31.7%) a degree from a professional school, and two (3.2%) had a lower educational attainment. 27 participants (42.8%) reported to be in simultaneous psychotherapeutic, psychotherapeutic and medical, or medical treatment during their participation in the BED-Online program.

Study protocol and procedure

The study design was a three-arm randomized controlled trial, which aimed at investigating the efficacy of the online CBTgsh program BED-Online, based on a CBT manual for adults that has demonstrated to be efficacious (Munsch, Wyssen, & Biedert,

2018). After giving informed consent, participants completed a set of self-report questionnaires and a structured clinical interview at baseline assessment to assess inclusion- and exclusion criteria, demographics and baseline psychopathology. Enrolled participants were randomly assigned (permuted block design; Lachin, Matts, & Wei, 1988) to an immediate treatment group (TG), a pure or a placebo-inspired waitlist control group (CG). No blinding procedure was applied. Participants in the TG immediately started with the active treatment of BED-Online, whereas participants who were allocated to both CGs completed a four-weeks waiting time after the baseline assessment before they started with the first session of the active treatment. After the four-weeks waiting time, individuals of the CGs started with the BED-Online program analogously to the immediate TG. For detailed information on the three-arm randomization procedure and the CGs see the study protocol of Munsch et al. (2019) and Wyssen and colleagues (resubmitted). To investigate predictors of treatment outcomes in the present study, the three groups were pooled.

The active treatment phase of the BED-Online program consisted of eight weekly online sessions, followed by three booster sessions one, three and six months after the last session of the active treatment. Treatment content was derived from a evidence-based CBT program for adults with recurrent binge-eating (Munsch et al., 2018) and implemented on the internet-based platform BED-Online. Each participant was guided by one of seven therapists. Therapists were psychotherapists or psychologists in postgraduate training in psychotherapy and received training and continuous supervision from SM and AW in delivering the BED-Online treatment. After each weekly session, therapists provided written feedback via a communication system (Vanhulst, Wyssen, Munsch, & Lalanne, 2020) integrated in the BED-Online platform on notes, worksheets and questions. Feedbacks were written according to standardized topic and text templates that were individualized to specific needs of the individual. For further information on the study procedure and treatment content, see (Munsch et al., 2019).

All participants completed questionnaires assessing predictor variables at baseline assessment. From 46 (73.1%) participants posttreatment questionnaires were obtained and 40 (63.5%) completed six-month FU-assessment.

The BED-Online study procedure was approved by the local ethic committee of the canton Bern in Switzerland (study ID of the ethics approval: 2017-00102). The study has been registered in the German Clinical Trials Register (DRKS00012355).

Measures

Diagnostic interview for mental disorders, short version (Mini-DIPS; Margraf & Cwik, 2017). The Mini-DIPS is a structured interview to verify the BED diagnosis and to assess further mental disorders according to the DSM-5. It was administered before the start of the treatment (baseline assessment), at posttreatment and 6-month follow-up. The Mini-DIPS has very satisfying results regarding acceptance, reliability, validity and interrater reliability in outpatient, inpatient and community samples (Margraf & Cwik, 2017).

Sociodemographics. At pre-assessment, participants were asked to provide age and gender.

Eating Disorder Examination-Questionnaire (Hilbert & Tuschen-Caffier, 2016). The EDE-Q assesses ED pathology during the last 28 days and consists of 28 items. 22 items can be allocated to four subscales (restraint eating, eating concerns, weight concerns, shape concerns) and a total score, which is calculated by the mean of the four subscales. In the present study, the total score in terms of general ED pathology is used as treatment outcome with its baseline level as predictor. The EDE-Q subscales and the total score demonstrated good internal consistency with Cronbach's α ranging from .70 to .97 (Hilbert, de Zwaan, & Braehler, 2012; Hilbert & Tuschen-Caffier, 2016). In the present sample, Cronbach's α of the EDE-Q global score at pre-assessment was .92.

Weekly Binges Questionnaire (WBQ; Munsch et al., 2007). The WBQ assesses regularity of eating, the frequency and characteristics of binge-eating as well as compensatory behavior during the last seven days. It consists of seven items, whereas in this study only item 5 on the frequency of binge-eating episodes during the last seven days was included as treatment outcome with its baseline level as predictor in the statistical analysis. The WBQ shows high convergent validity relative to ecological momentary assessment (Munsch et al., 2009).

Beck Depression Inventory Fast Screen (Beck, Brown, & Steer, 2013). The BDI-FS consists of seven items (short version of the BDI-II) and was used to assess depressive symptoms during the last seven days as predictor variable. The BDI-FS demonstrated satisfying convergent validity (*r*=.67; Kliem, Mossle, Zenger, & Brahler, 2014) and internal consistency (Cronbach's α=.84). Cronbach's α in the present sample at pre-assessment was .88.

Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004).
The DERS consists of 36 items and assesses difficulties in the process of emotion regulation on six subscales (lack of emotional awareness, lack of emotional clarity, nonacceptance of emotional responses, limited access to emotion regulation strategies, impulse control difficulties and difficulties in engaging in goal directed behavior while experiencing negative emotions) and a total score. In the present study, the DERS total score, which is calculated as total sum score, was used to assess overall emotion regulation difficulties as predictor. The DERS global score shows (Cronbach's α=.93; Gratz & Roemer, 2004). Cronbach's α of the global score in the present sample was .95.

Statistical analysis

All analyses were carried out for four different outcomes, i.e. for the two outcomes WBQ and EDE-Q total score at each of the two time points posttreatment and 6-month

follow-up. Two types of statistical models were implemented. We first used simple linear regression models to test the influence of each predictor separately. Second, we carried out a hierarchical linear regression model in which we sequentially entered three sets of predictors in the following order: 1) age and gender, 2) baseline variable of the respective outcome (WBQ or EDE-Q total score), 3) BDI-FS and DERS. The influence of a particular predictor was thereby controlled for any predictor contained in a set being previously entered. More specifically, in a first step we entered the first set of predictors, thereby applying a best subset regression procedure to determine the model with the best fit, based on test data using leave-one-out cross-validation. As measure of model fit, we used the root-mean square error (RMSE). The best fitting model (i.e. that with the lowest cross-validated RMSE), which could contain all predictors, some predictors or none was then selected and the predictor from the second set entered. The same procedure was repeated until the last set of predictors was entered, each time assessing the fit of the best fitting model, until obtaining the best fitting final model. In order to make coefficients for numeric (e.g. age) variables comparable among each other as well as with binary (e.g. gender) variables, numeric variables were divided by two times their standard deviation for the regression analysis (Gelman, 2008). All analyses were performed using R for statistical computing (version 3.2; R Development Core Team, 2018). Variables were checked for normality and the WBQ was log-transformed as most participants exhibited few binge-eating episodes at the end of treatment and 6-month follow-up with lower variability compared to pretreatment. Hypotheses and the analytic plan were both specified before data was collected.

Results

Descriptive Statistics

Descriptive statistics of predictors at baseline are presented in Table 1.

Insert Table 1 here

Predictor analysis

Descriptive values of the WBQ and the EDE-Q total score at baseline, posttreatment and 6-month follow-up and results of the simple linear and the hierarchical linear regression models for the outcomes WBQ and EDE-Q total score at posttreatment and 6-month follow-up are presented in Figures 1 and 2. Detailed results of the different steps involved in the hierarchical linear regression models are presented in Tables 1– 4 of the supplemental material.

Weekly binge-eating episodes.

Posttreatment. The best model predicting WBQ at posttreatment included gender, b=–0.13, 95% CI [–0.43, 0.17], $t(40)$=–0.89, p=0.381; β=–0.31, 95% CI [–1.02, 0.40], the baseline value of the WBQ, b=0.47, 95% CI [0.27, 0.66], $t(40)$=4.89, p<.001; β=0.59, 95% CI [0.35, 0.84] and the DERS, b=0.29, 95% CI [0.07, 0.52], $t(40)$=2.63, p<.05; β=0.32, 95% CI [0.08, 0.57]. The final model explained a significant and substantial proportion of variance, R^2=0.43, $F(3, 40)$=10.07, p<.001, adj. R^2=0.39.

6-month follow-up. The best model predicting WBQ at 6-month follow-up did not contain any predictor as none of them improved the model fit relative to the model without predictors.

Insert Figure 1 here

General ED pathology.

Posttreatment. The model providing the best fit in the prediction of the EDE-Q total score at posttreatment included gender, b=–0.07, 95% CI [-0.42, 0.27], $t(41)$=–0.43, p=.669; β=–0.17, 95% CI [-0.95, 0.62], the baseline value of the EDE-Q total score, b=0.37, 95% CI [0.09, 0.64], $t(41)$=2.70, p<.05; β=0.38, 95% CI [0.10, 0.67], and the DERS, b=0.29, 95% CI [0.03, 0.56], $t(41)$=2.21, p<.05; β=0.30, 95% CI [0.03, 0.58]. The final model explained a significant and substantial proportion of variance of the EDE-Q total score, R^2=0.35, $F(3, 41)$=7.25, p<.001, adj. R^2=0.30.

6-month follow-up. At 6-month follow-up the baseline value of the EDE-Q total score, b=0.23, 95% CI [-0.14, 0.60], $t(37)$=1.25, p=.218; β=0.21, 95% CI [-0.13, 0.55] as well as the BDI-FS, b=0.25, 95% CI [-0.09, 0.59], $t(37)$=1.50, p=.141; β=0.25, 95% CI [-0.09, 0.59] were included in the final model predicting the EDE-Q total score, although both predictors were not significant. The final model explained a significant and moderate proportion of variance, R^2=0.15, $F(2, 37)$=3.26, p=.050, adj. R^2=0.10.

Insert Figure 2 here

Discussion

The objective of this study was to evaluate the predictive value of a range of sociodemographic and clinical factors based on previous research. More concretely, we examined if the efficacy of an online CBTgsh program (Munsch et al., 2019) for individuals with BED can be estimated in advance when knowing an individual's age, gender, BED severity, negative mood and emotion regulation difficulties prior to treatment start. We were specifically interested in the relevance of difficulties in emotion regulation in predicting an individual's progress during the therapy after considering the influence of

age, gender and BED, and if the predictive value of difficulties in emotion regulation were more important than negative mood (Gianini et al., 2013; Sim & Zeman, 2006; Whiteside et al., 2007).

In our study, treatment outcomes of weekly binge-eating episodes and general ED pathology (both after the end of treatment and at 6-month follow-up) were independent of patients' age, which is consistent with findings from early studies on face-to-face CBTgsh in adults (Carter & Fairburn, 1998; Masheb & Grilo, 2008). It remains to be determined whether age represents a more important predictor during adolescence, as online CBTgsh programs demand higher self-regulation capacities compared to face-to-face therapy (Beintner & Jacobi, 2017; King, McLaughlin, Silk, & Monahan, 2018). In contrast to previous findings (Hilbert, 2019; Lydecker et al., 2020; Shingleton et al., 2015), male gender improved the overall model compared to not including any predictors, but only at posttreatment. At 6-months follow-up, gender did not substantially predict weekly binge-eating frequency and general ED pathology (i.e. the models without predictors provided better model fit). It has to be reevaluated if men signing up for online treatment studies regularly display better immediate treatment outcome than women and whether gender influences treatment outcome differently in face-to-face than in online treatment formats (Udo & Grilo, 2018).

Largely consistent with previous findings, a higher severity of BED predicted a worse treatment outcome (e.g. Beintner et al., 2014; Masheb & Grilo, 2008; Vall & Wade, 2015; Wagner et al., 2016). Pretreatment levels of binge-eating frequency and ED pathology emerged as the strongest predictors of weekly binge-eating episodes and ED pathology directly after treatment, providing additional and more important information about treatment outcome compared to gender. The present findings might indicate that individuals with high symptom severity at pretreatment benefit but still reveal more severe binge-eating and ED pathology at posttreatment. Therefore, the conclusion that the high

predictive value of symptom severity at treatment start underlines that online CBTgsh may be especially useful for patients with lower BED severity at treatment begin, should be reevaluated (Wilson, Wilfley, Agras, & Bryson, 2010). While baseline ED pathology still predicted its respective value at 6-months follow-up, albeit less than at posttreatment, baseline weekly binge-eating frequency did not contribute to the prediction of weekly binge-eating episodes at 6-months follow-up. Thus, individuals with higher and lower frequency of weekly binge-eating reported comparably frequent weekly binge-eating episodes at 6-months follow-up.

Emotion regulation difficulties predicted weekly binge-eating episodes and general ED pathology at the end of treatment to a larger extent than negative mood when controlled for predictors such as gender and baseline BED severity. Studies on the development and maintenance of BED have underlined the importance of emotion regulation difficulties in addition to negative mood in predicting the severity of key BED symptoms (Gianini et al., 2013; Sim & Zeman, 2006). In this line, this study represents the first treatment study providing evidence that baseline emotion regulation difficulties may have more negative impact on immediate treatment outcome in CBTgsh than the mere severity of negative mood. However, this effect was temporary, as at 6-month follow-up, neither negative mood nor emotion regulation difficulties contributed to the prediction of weekly binge-eating episodes in our study. In addition, while negative mood and emotion regulation difficulties similarly predicted the severity of ED pathology at 6-months follow-up, only negative mood was selected in the best model. These finding can be interpreted based on a recent cross-sectional self-report study on adults with BED, where emotion regulation difficulties were associated with increased binge-eating frequency in the presence of high but not low depression (Kenny, Singleton, & Carter, 2017). In participants of BED treatment trials, reporting elevated negative mood at treatment start, emotion regulation might interact with negative mood and therefore particularly predict the immediate treatment outcome. As

mood usually improves during BED treatment (Hilbert, 2019), the effect of trait-like emotion regulation difficulties might influence longer-term treatment effects less.

This is the first study that investigated the incremental predictive value of emotion regulation capacity in an online CBTgsh program. The present findings suggest that increased emotion regulation difficulties independently predict higher binge-eating frequency and ED pathology severity at the end of treatment even when accounting for the other meaningful predictors gender and baseline weekly binges respectively ED pathology. Moreover, emotion regulation difficulties contributed more meaningfully to the prognosis of immediate treatment outcome than mere negative mood, underlining its role in the maintenance of BED (Culbert et al., 2015). For clinicians the present findings indicate that, albeit gender and BED severity already provide predictive information about posttreatment outcome, the standardized assessment of emotion regulation difficulties contribute to a more reliable prognosis of immediate treatment outcome of weekly binge-eating episodes and ED pathology. Conversely, only the severity of ED pathology at treatment start and negative mood slightly improved the prediction of longer-term treatment outcome of ED pathology, whereas temporally more distal improvements in weekly binge-eating seem to be independent of prominent sociodemographic and clinical characteristics. The long-term prognosis of treatment outcome is generally more difficult than the prediction of posttreatment outcome given the longer temporal distance and the wide range of influencing factors. For instance, individual differences in the amount and severity of the experience of daily life stressors or critical life-events during the longer-term treatment course might be more influential than age, gender or disorder related characteristics at treatment start (Grilo et al., 2012).

Our findings must be interpreted considering several limitations. The present sample size was relatively small, limiting power to detect small predictor effects, whereas other effects might have been overestimated. The relatively small variance in WBQ at

posttreatment and follow-up impeded the detection of predictors altogether and may partly explain smaller effects compared to the prediction of EDE-Q total score. Further, participants were primarily Swiss and well-educated, limiting generalizability to other samples. Finally, the EDE-Q might not fully cover male or other genders' BED pathology (e.g. muscularity-based shape and weight concerns; Smith et al., 2017), which in turn might bias results on the predictive value of gender.

To conclude, the present study underlines the value of the assessment and utilization of emotion regulation difficulties when it comes to predict BED treatment outcomes in an online CBTgsh program. Further studies should investigate whether individuals with BED and high difficulties in emotion regulation especially profit from treatments which specifically address emotion regulation (Anderson et al., 2020).

Tables and Figures

Table 1

Descriptive statistics (means and standard deviations of predictor variables at baseline)

	N = 63	
Predictor	*M (SD)/ % (n)*	*range*
Age	37.21 (10.43)	20 – 59
Gender (female)	87.3 (55)	
Baseline EDEQ total score	3.35 (2.38)	0 – 14
Baseline WBQ	3.12 (1.21)	0.26 – 5.30
BDI-FS	4.54 (3.37)	0 – 14
DERS global score	91.90 (26.18)	47 – 150

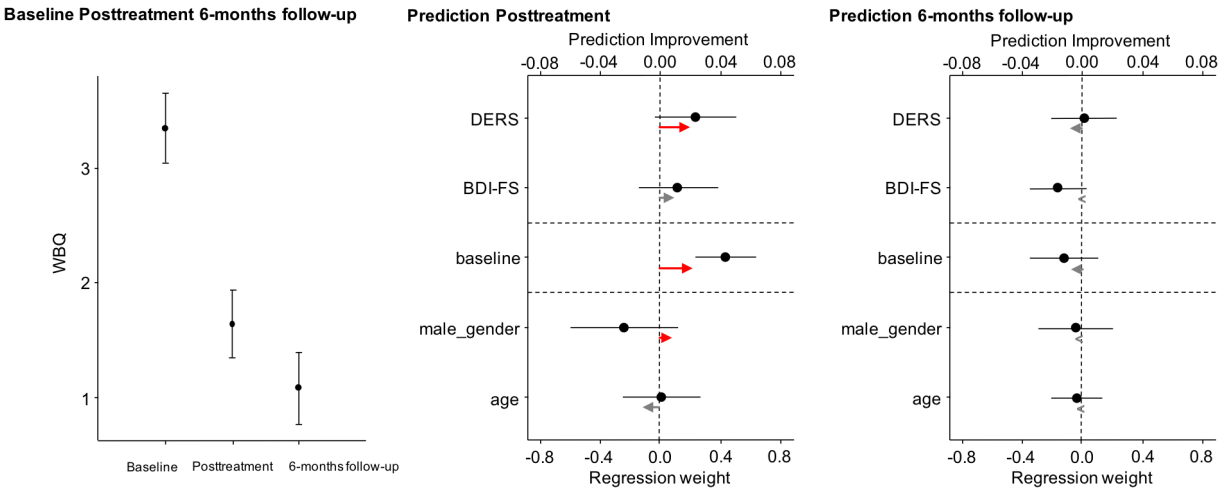

Figure 1. Descriptive values (means and error bars) of the WBQ at baseline, posttreatment and 6-month follow-up (left panel), and results of the hierarchical linear regression model of the WBQ at post-treatment (center panel) and 6-month follow-up (right panel). Black filled circles in the center and right panel denote regression coefficients based on a simple linear regression model with each predictor being tested in turn (i.e. independently of all other predictors) with black horizontal solid lines indicating 95% confidence intervals. The three sets of predictors of the hierarchical linear regression model are visually separated by dashed horizontal lines. Arrows indicate for each predictor whether it improved (arrows pointing to the right) or worsened (arrows pointing to the left) the model fit relative to the best model from the last regression step, and a red arrow indicates that this particular predictor was selected for the best fitting final model. As an example, BDI-FS improved the model fit of the outcome WBQ at posttreatment relative to the best model from the previous step (indicated by arrow pointing to the right), but worsened the model fit when added together with the better-performing predictor DERS and was therefore not selected for the best fitting final model (indicated by a grey rather than a red arrow).

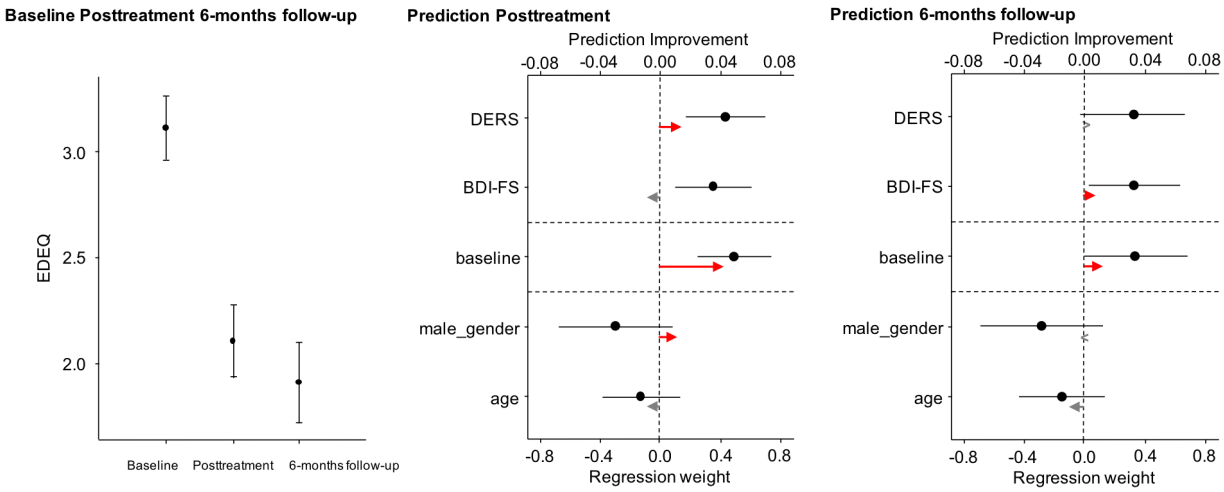

Figure 2. Descriptive values (means and error bars) of the EDE-Q total score at baseline, posttreatment and 6-month follow-up (left panel), and results of the hierarchical linear regression model of the EDE-Q total score at posttreatment (center panel) and 6-month follow-up (right panel). See Figure 1 for further explanations.

Supplemental Material

Table A1

Three step hierarchical linear regression model for the outcome WBQ at posttreatment

age	male gender	baseline outcome	BDI-FS	DERS	RMSE	hierarchical step
					0.4213	step 1
0.01 [-0.26, 0.27]					0.4307	
	-0.24 [-0.6, 0.13]				**0.4161**	
0.1 [-0.19, 0.39]	-0.3 [-0.71, 0.11]				0.4250	
	-0.21 [-0.52, 0.1]	**0.43 [0.22, 0.63]**			**0.3963**	step 2
	-0.15 [-0.46, 0.15]	0.47 [0.27, 0.67]	0.21 [-0.02, 0.43]		0.3885	step 3
	-0.13 [-0.43, 0.17]	**0.47 [0.27, 0.66]**		**0.29 [0.07, 0.52]**	**0.3781**	
	-0.12 [-0.42, 0.18]	0.48 [0.28, 0.67]	0.08 [-0.17, 0.34]	0.25 [-0.02, 0.51]	0.3822	

Note. Lower RMSE values indicated better model fit based on leave-one-out cross-validation. The best fitting model in each step is highlighted in bold. First, age, gender and the combination of these two predictors were tested with gender providing best model fit. Based on the best model in the first step, the baseline value of the WBQ was added in the second step and further improved the model fit. In the third step, BDI-FS, DERS and a combination of them were tested. All three variants in step 3 improved the model accuracy compared to the best model from step 2 with the model adding the DERS only providing the best model fit. Baseline outcome = baseline value of the outcome WBQ; BDI-FS = Beck Depression Inventory Fast Screen; DERS = Difficulties in Emotion Regulation Scale; RMSE = root-mean square error.

Table A2

Three step hierarchical linear regression model for the outcome WBQ at 6-month follow-up

age	male gender	baseline outcome	BDI-FS	DERS	RMSE	hierarchical step
					0.2803	step 1
-0.03 [-0.21, 0.14]					0.2825	
	-0.04 [-0.3, 0.21]				0.2838	
-0.03 [-0.22, 0.17]	-0.03 [-0.31, 0.26]				0.2871	
		-0.12 [-0.35, 0.11]			0.2856	step 2
			-0.16 [-0.36, 0.03]		0.2816	step 3
				0.01 [-0.21, 0.24]	0.2856	
			-0.21 [-0.43, 0.01]	0.12 [-0.12, 0.36]	0.2823	

Note. see table A1 for further explanations. No model improved model accuracy compared to the model without predictors.

Table A3

Three step hierarchical linear regression model for the outcome EDE-Q total score at posttreatment

age	male gender	baseline outcome	BDI-FS	DERS	RMSE	hierarchical step
					0.4470	step 1
-0.14 [-0.4, 0.13]					0.4549	
	-0.31 [-0.69, 0.07]				**0.4379**	
-0.06 [-0.35, 0.23]	-0.27 [-0.7, 0.15]				0.4516	
	-0.11 [-0.47, 0.25]	**0.47 [0.2, 0.74]**			**0.3969**	step 2
	-0.10 [-0.46, 0.26]	0.38 [0.08, 0.69]	0.16 [-0.12, 0.44]		0.4044	step 3
	-0.07 [-0.42, 0.27]	0.37 [0.09, 0.64]		0.29 [0.03, 0.56]	0.2856	
	-0.07 [-0.43, 0.28]	**0.36 [0.06, 0.66]**	**0.03 [-0.28, 0.34]**	**0.28 [-0.03, 0.58]**	**0.2823**	

Note. see table A1 for further explanations. Baseline outcome = baseline value of the outcome EDE-Q total score.

Table A4

Three step hierarchical linear regression model for the outcome EDE-Q total score at 6-month follow-up

age	male gender	baseline outcome	BDI-FS	DERS	RMSE	hierarchical step
					0.4723	step 1
-0.14 [-0.43, 0.15]					0.4797	
	-0.28 [-0.69, 0.13]				0.4733	
-0.07 [-0.4, 0.25]	-0.24 [-0.7, 0.22]				0.4876	
		0.35 [0, 0.69]			**0.4616**	step 2
		0.23 [-0.14, 0.60]	**0.25 [-0.09, 0.59]**		**0.4560**	step 3
		0.29 [-0.06, 0.64]		0.27 [-0.09, 0.63]	0.4576	
		0.22 [-0.15, 0.60]	0.18 [-0.19, 0.55]	0.19 [-0.2, 0.59]	0.4593	

Note. see table A1 for further explanations. baseline outcome = baseline value of the outcome EDE-Q total score.

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