



Relations between pure dietary and dietary-negative affect subtypes and impulsivity and reinforcement sensitivity in binge eating individuals

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ABSTRACT

To investigate potential predictors of the severity of binge eating disorder (BED), two subtypes of patients with the disorder, a pure dietary subtype and a dietary-negative affect subtype, were identified. This study investigated the relationships between the two subtypes and impulsivity and reinforcement sensitivity. Ninety-two women meeting threshold and subthreshold criteria for BED diagnosis filled out questionnaires to determine eating disorder severity, impulsivity and reinforcement sensitivity before and after participating in an online guided self-help program for BED. Cluster analyses revealed a pure dietary subtype ($N = 66$, 71.7%) and a dietary-negative affect subtype ($N = 26$, 28.3%). Compared to the pure dietary subtype, the dietary-negative affect subtype reported a higher frequency of objective binge episodes, more severe eating disorders, higher urgency scores (defined as a tendency to act rashly in the context of negative affect), a greater sensitivity to punishment, and a higher dropout rate during treatment. These findings suggest that BED patients in the dietary-negative affect subtype exhibit heightened anxiety and are highly impulsive, especially in contexts of negative affect. For these individuals, psychological interventions for BED should focus on inhibiting automatic responses to negative emotions.

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1. Introduction

Cognitive behavioral therapy (CBT) has been found to be effective for the treatment of binge eating disorder (BED; Wilfley et al., 2002). A recent study showed that guided CBT-based self-help intervention was a first-line treatment option for the majority of BED patients (Wilson, Wilfley, Agras, & Bryson, 2010). Despite these positive findings, the literature also indicates that a significant proportion of patients remain symptomatic after treatment. Moreover, very few studies have investigated factors that predict BED treatment outcomes (Wilson, Grilo, & Vitousek, 2007). The identification of specific factors that maintain BED and hinder recovery would promote the development of more customized treatments.

1.1. Dietary and dietary-negative affect subtypes

In studies of potential predictors of BED outcomes, two binge eating subtypes have regularly emerged from cluster analyses in samples of patients with eating disorders: a pure “dietary” subtype, characterized by dietary restraint, and a “dietary-negative affect” subtype,

characterized by dietary restraint and negative affect. Previous studies of bulimic patients have revealed that the dietary-negative affect subtype, also termed the dietary-depressive subtype, is associated with higher levels of concern regarding their eating, shape, and weight, higher levels of social maladjustment, and a poorer response to treatment than the pure dietary subtype (Grilo, Masheb, & Berman, 2001; Stice & Agras, 1999; Stice & Fairburn, 2003). These findings are consistent with proposals such as Stice's dual-pathway model of bulimia nervosa (BN; Stice, 1994, 2001), which claim that both dieting and negative affect play a role in the development and maintenance of bulimia nervosa.

Recent studies have replicated the distinction between these subtypes in individuals with BED (Grilo, Masheb, & Wilson, 2001b; Masheb & Grilo, 2008; Stice et al., 2001). Stice et al. (2001) described a pure dietary subtype (64% of the whole sample) and a dietary-negative affect subtype (36%) in a sample of 159 women with BED. The dietary-negative affect subtype displayed a higher frequency of objective binge episodes and greater concern regarding their eating, shape, and weight, as well as higher levels of lifetime psychiatric disorders and social maladjustment than the pure dietary subtype. Moreover, the dietary-negative affect classification predicted negative outcomes after dialectical behavior therapy in a sample of 58 women suffering from BED (Stice et al., 2001).

Grilo et al. (2001b) demonstrated the stability of classification involving these subtypes, finding significant consistency at two points in time that were four weeks apart. They tested whether 101

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individuals with BED could be classified along the dimensions of dietary restraint and negative affect. Cluster analyses revealed a dietary subtype (67.3%) and a dietary-negative affect subtype (32.7%). For 82% of the cases, the individuals were classified into the same subtypes four weeks later. Alternative approaches that classified individuals with BED based on the presence of Major Depressive Disorder (MDD) or frequency of binge eating were found to be less informative than subtyping based on dietary restraint and negative affect because subgroups defined according to the presence of MDD or frequency of binge eating did not exhibit distinctive differences (Grilo et al., 2001b). Grilo et al. (2001b) found that while the subtypes did not differ with regard to gender, body mass index (BMI), or frequency of binge eating, the dietary-negative affect subtype had significantly greater concerns with regard to eating, weight, and shape, higher levels of body dissatisfaction, and higher impulsivity than the dietary subtype.

Another study compared two types of sub-categorization methods for BED (Masheb & Grilo, 2008). Seventy-five overweight patients presenting with BED were categorized into a dietary subtype (71%) or a dietary-negative affect subtype (29%) using cluster analyses. Patients were also classified into two groups based on self-evaluation of shape or weight, which appeared to significantly predict the post-treatment severity of the eating disorder. In contrast, subtyping on the basis of dietary restraint and negative affect predicted the post-treatment frequency of binge episodes. Compared to patients in the pure dietary group, patients in the dietary-negative affect group reported eating disorders that were more severe, and a higher percentage of these patients reported DSM-IV (American Psychiatric Association, 1994) lifetime Axis I diagnoses, particularly anxiety disorders.

1.2. Impulsivity and eating disorders

Grilo et al. (2001b) found higher impulsivity scores for the dietary-negative affect subtype than for the pure dietary subtype. Given the inherently impulsive nature of binge eating, several studies have examined impulsivity as a potential mechanism responsible for the maintenance of binge eating in eating disorders. Despite its theoretical importance, a meta-analysis revealed that the correlation between impulsivity and eating disorders was weak but significant (Stice, 2002). These divergent results might be due to the complexity of the impulsivity construct. Impulsivity is multifaceted and can be decomposed into four partially independent dimensions (S. P. Whiteside & Lynam, 2001): *urgency*, a tendency to act rashly in the context of negative affect; *lack of perseverance*, difficulty staying focused on boring or difficult tasks; *lack of premeditation*, a tendency to act without considering the consequences; and *sensation seeking*, a tendency to pursue thrilling activities and novelty. According to Van der Linden, Rochat, and Billieux (2006), these four aspects of impulsivity might be related to specific cognitive mechanisms and motivational processes. They suggest that three dimensions of impulsivity are associated with deficits in inhibitory functions, with urgency related to the inability to deliberately suppress dominant responses, lack of premeditation related to decision-making abilities and lack of perseverance to a vulnerability to intrusive thoughts or images. The fourth dimension, sensation seeking, might be associated with the motivational process of reward sensitivity.

In keeping with this perspective, Reinforcement Sensitivity Theory proposes that two independent motivational systems, reward sensitivity and punishment sensitivity, are related to the personality traits of impulsivity and anxiety, respectively (Corr, 2004). Gray and McNaughton (2000) characterize the reward sensitivity dimension as being related to the behavioral approach system (BAS) that regulates activation and engagement responses, while the punishment sensitivity dimension is related to the behavioral inhibition system (BIS) that regulates anxiety, avoidance and fear responses. Both

dimensions are viewed as relevant to the understanding of eating disorders and have been investigated in several studies (Harrison, O'Brien, Lopez, & Treasure, 2010).

A meta-analytic review of 50 studies (Fischer, Smith, & Cyders, 2008) examined the relationship between impulsivity and bulimic symptoms in patients with BN. The largest effect size was found for urgency, revealing that these patients found it difficult to inhibit a dominant response in the context of negative affect. Several authors have suggested that both negative emotions and cognitive difficulties in coping with them play an important role in the maintenance of binge eating (U. Whiteside et al., 2007; Wisner & Telch, 1999). Another recent meta-analysis (Harrison et al., 2010) reviewed 21 studies evaluating differences in reinforcement sensitivity in eating disordered and control groups. This meta-analysis found that few studies examined this characteristic in individuals with eating disorders and study findings were heterogeneous. Altogether, these studies indicate that compared to control individuals, BN patients are more sensitive to both reward and punishment. Heightened sensitivity to reward has been held to play a role in the onset of binge urges and the desire to binge (Dawe & Loxton, 2004). Heightened reward sensitivity to food cues has also been observed in BED patients using functional magnetic resonance imaging (fMRI; Schienle, Schafer, Hermann, & Vaitl, 2009). The higher sensitivity to punishment observed in BN patients also indicates that these individuals experience more anxiety, which is consistent with the elevated rate of anxiety disorders found in this population (Kaye, Bulik, Thornton, Barbarich, & Masters, 2004).

Given the association between impulsivity and binge eating found in BN patients, the current study examined these associations in BED patients, who were classified into two subtypes found to be relevant for the detection of eating disorder severity. The aims of the study were to:

1. Replicate the classification of two subtypes based on dietary restraint and negative affect previously described by Stice and Agras (1999) and Stice et al. (2001) in a population of patients suffering from threshold and subthreshold BED;
2. Explore relationships between BED maintenance and different dimensions of impulsivity by comparing measures of eating disorder severity, impulsivity, reinforcement sensitivity, and response to treatment in these two subtypes.

2. Method

2.1. Participants

The study included 92 women who took part in two studies from 2008 to 2009 to evaluate the degree of acceptance and efficacy of a guided, online CBT-based self-help program (Study 1 $N=22$; Study 2 $N=70$).

The Study 1 sample (Carrard, Crépin, Rouget, Lam, Golay, et al., 2011) was composed of 22 participants seeking treatment for an eating disorder. Participants were recruited from an obesity consultation waiting list at the University Hospitals of Geneva, Switzerland. To meet eligibility criteria, participants had to be females between the ages of 20 and 70 years with a BMI between 30 and 50. Fifty-five percent ($N=12$) of our participants fully met the DSM-IV criteria for BED, and 45% ($N=10$) met the subthreshold criteria. To meet subthreshold criteria for BED in this study, participants had to exhibit at least one binge eating episode per month for the preceding three months. While this is a low threshold, the optimal diagnosis threshold for the frequency of binge eating has yet to be determined (Wilson & Sysko, 2009). Using that threshold, Crow, Agras, Halmi, Mitchell, and Kraemer (2002) demonstrated that BED and subthreshold BED were highly similar.

The Study 2 sample (Carrard, Crépin, Rouget, Lam, Golay, et al., 2011) was composed of 74 participants recruited from the community

through advertisements in newspapers and on websites. The advertisements stated that respondents would be invited to subscribe to a new online self-help program for BED treatment. Participants had to be women from 20 to 60 years of age. Fifty-eight percent ($N=43$) of participants fully met the DSM-IV criteria for a diagnosis of BED, while 42% ($N=31$) met the subthreshold criteria. In Study 2, participants had to exhibit at least one binge eating episode each week for the preceding three months to be classified as meeting subthreshold criteria for BED. Participants were randomly assigned to one of two groups of 37 individuals: (a) a treatment group that immediately started the online program for a period of six months, and (b) a waiting list group that started the online program after a six-month waiting period. In the waiting list group, four participants dropped out before starting the online treatment so that a total of 70 participants participated in the online program.

Altogether, 92 participants received treatment in Studies 1 and 2. Their mean age was 38.13 years ($SD=11.98$, range 21 to 70) with a mean BMI of 30.60 ($SD=6.30$, range 19.37 to 49.72). Fifty participants (54.3%) had a BMI equal to or greater than 30; 22 participants (23.9%) had a BMI under 25; 20 (21.7%) had a BMI between 25 and 29.9; 25 (27.2%) had a BMI between 30 and 34.9; 20 (21.7%) had a BMI between 35 and 40; and 5 (5.4%) had a BMI over 40.

2.2. Diagnostic assessment

The French version of the *Eating Disorders in Obesity* questionnaire (EDO; Carrard & Crépin, 2007; original version: de Man Lapidoth, Ghaderi, Halvarsson-Edlund, & Norring, 2007) was used to evaluate eating disorders. The EDO is a self-report questionnaire based on the DSM-IV criteria for the diagnosis of BED. Compared to the *Eating Disorder Examination* (EDE; Fairburn & Cooper, 1993), the EDO exhibits good psychometric properties with regard to the ability to detect eating disorders (Cohen's $\kappa=0.67$) and binge eating (Cohen's $\kappa=0.63$; de Man Lapidoth et al., 2007). To ensure that respondents understood the questions and definitions, participants in both studies completed the EDO with a researcher's assistance.

2.3. Protocol

In each study, participants were asked to attend a face-to-face evaluation session before and after the online self-help treatment program. During the first session, inclusion criteria were verified and participants filled out the self-report questionnaires. After the assessment, the study protocol and use of the online program were explained. Participants were given six months to complete the self-help treatment program. After six months, they were asked to return to the hospital for a second face-to-face session with a researcher. During the post-treatment session, they completed the self-report questionnaires for a second time.

The local ethics committee approved the study protocol, and each participant signed a written informed consent form. Study procedures have been described in detail elsewhere (Carrard, Crépin, Rouget, Lam, Golay, et al., 2011; Carrard, Crépin, Rouget, Lam, Van der Linden, et al., 2011).

2.4. Online self-help program

The online self-help program was composed of 11 modules incorporating CBT techniques for the treatment of binge eating. Each module included a description of the theoretical basis for the treatment and exercises that had to be completed immediately in the program. The online self-help program included the guidance of a counselor to ensure that participants fully understood the theory and the exercises. The counselors were psychologists who were given direct access to the participants' online treatment program so that they could verify that participants had successfully completed the exercises, answer participants' questions about the program content and

provide encouragement. Participants were instructed to send their counselor a weekly e-mail through a secured channel to ensure regular guidance.

2.5. Self-report questionnaires

2.5.1. Eating Disorder Examination – Questionnaire (EDE-Q)

The EDE-Q (Fairburn & Beglin, 1994; Mobbs & Van der Linden, 2006) is a widely used self-report instrument that consists of 28 items. It includes four eating disorder subscales that evaluate restraint, eating concern, shape concern and weight concern. In addition to subscores from these four scales, the EDE-Q provides an overall eating disorder severity score along with an evaluation of symptom frequency. Higher EDE-Q scores reflect greater severity and/or frequency of symptoms. The assessment requests information for the previous 28 days. For patients with BED, the EDE-Q exhibits good psychometric qualities (Grilo, Masheb, & Wilson, 2001a) and test-retest reliability (Reas, Grilo, & Masheb, 2006). The overall score and frequency of objective binge episodes from the questionnaire were used as measures in the current study and the score for the dietary restraint subscale was included in the variables introduced into the cluster analysis. Cronbach's alphas for the overall score and the dietary restraint subscale were 0.85 and 0.76, respectively, indicating good reliability.

2.5.2. Three-Factor Eating Questionnaire (TFEQ)

The TFEQ (Luch, 1995; Stunkard & Messick, 1985) is a widely used 51-item inventory designed to measure the three dimensions of dietary restraint, disinhibition, and hunger, with higher scores reflecting higher levels of these characteristics. The dietary restraint subscale was introduced into the cluster analysis. The Cronbach's alpha for the dietary restraint subscale was 0.83, indicating good internal consistency.

2.5.3. UPPS Impulsive Behavior Scale (UPPS)

The UPPS (Van der Linden et al., 2006; S. P. Whiteside & Lynam, 2001) is a 45-item self-report evaluation of Whiteside and Lynam's four dimensions of impulsivity: *urgency*, *lack of perseverance*, *lack of premeditation* and *sensation seeking*, with higher scores indicating higher levels of impulsivity. In the French version of the instrument, the validity of the four factors has been assessed using confirmatory factor analysis (Van der Linden, d'Acremont et al., 2006). Cronbach's alphas were 0.87 for urgency, 0.83 for lack of perseverance, 0.88 for lack of premeditation, and 0.81 for sensation seeking, indicating good internal consistency.

2.5.4. Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ)

The French version of the SPSRQ (Lardi, Billieux, d'Acremont, & Van der Linden, 2008; Torrubia, Avila, Molto, & Caseras, 2001) is a 35-item questionnaire with two subscales, sensitivity to punishment and sensitivity to reward, which has a factorial structure similar to the original English version (Lardi et al., 2008). The French version differs from the English version (Torrubia et al., 2001) by using a 4-point scale instead of "yes/no" responses and by eliminating 13 problematic items. Higher scores reflect greater sensitivity. Cronbach's alphas were 0.89 for sensitivity to punishment, and 0.84 for sensitivity to reward, indicating good internal consistency.

2.5.5. Beck Depression Inventory – II (BDI)

The BDI (Beck, Steer, & Brown, 1996) is a 21-item self-report inventory of cognitive, affective and somatic symptoms of depression. Total scores range from 0 to 63, with a higher score indicating a more severe condition. Cronbach's alpha was 0.88, indicating good internal consistency.

Table 1
Baseline differences between dietary and dietary-negative affect subtypes.

	Dietary subtype		Dietary-negative affect subtype		<i>t</i> (90)	Partial η^2
	<i>N</i> = 66		<i>N</i> = 26			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Physical measure						
Age	39.06	(12.23)	35.77	(11.18)	1.19	1.5%
BMI	30.09	(6.11)	31.89	(6.74)	1.23	1.7%
Binge eating						
EDE-Q OBE frequency	10.21	(11.56)	18.46	(14.79)	2.55 *	8.2%
Eating disorder severity						
EDE-Q total	2.88	(0.76)	3.98	(0.87)	6.00***	28.6%
Impulsivity						
UPPS urgency	32.83	(5.62)	36.65	(5.92)	2.89**	8.5%
UPPS lack of premeditation	23.62	(5.14)	22.54	(5.99)	0.87	0.8%
UPPS lack of perseverance	19.71	(4.22)	20.38	(5.28)	0.64	0.5%
UPPS sensation seeking	28.03	(7.22)	28.46	(6.11)	0.27	0.1%
Reinforcement sensitivity						
SPSRQ punishment	42.62	(8.58)	53.04	(7.89)	5.36***	24.2%
SPSRQ reward	35.85	(7.59)	38.08	(7.34)	1.28	1.8%

Note: * $p < .05$; ** $p < .01$; *** $p < .001$; *M* = means; *SD* = standard deviations; Partial η^2 is the proportion of variation accounted for by the variable; BMI = Body Mass Index; EDE-Q = Eating Disorder Examination – Questionnaire; OBE = objective binge episodes; UPPS = UPPS Impulsive Behavior Scale; SPSRQ = Sensitivity to Punishment and Sensitivity to Reward Questionnaire.

2.5.6. Rosenberg Self-Esteem Scale (RSES)

The RSES (Rosenberg, 1965; Vallières & Vallerand, 1990) is a 10-item scale which provides a global score of self-esteem. Higher scores reflect higher levels of self-esteem. Cronbach's alpha was 0.87, indicating good internal consistency.

2.6. Statistical analyses

All statistical analyses were conducted using SPSS for Windows, version 17.0 (SPSS, Chicago, IL). Two participants in Study 1 and 12 participants in Study 2 dropped out during the online program and did not fill out the post-treatment questionnaires, resulting in missing data ($N = 14$, 15.2%). Missing data were imputed using the EM (Expectation Maximization) algorithm. This algorithm is based upon maximum likelihood imputation and provides estimates of missing data from latent variables found in the data matrix. It is considered the state-of-the-art method for single imputation (Schafer & Graham, 2002).

Participant scores on the EDE-Q restraint scale, the TFEQ restraint scale, the BDI and the RSES scales were submitted to a cluster analysis. Cluster analyses group cases on the basis of similarity in absolute levels on one or more variables. We performed a *K*-Means cluster analysis using the Quick cluster algorithm, following previous studies (Stice & Agras, 1999; Stice et al., 2001). The *K*-Means algorithm selects *k* participants, where *k* is the number of clusters requested, with well-separated non-missing values as initial centers. It then iteratively clusters participants into one of these groups based on squared Euclidean distances. After each case is assigned, the cluster center is updated before the next iteration. A two cluster solution was specified, based on the hypothesis that there would be a pure dietary subtype and a dietary-negative affect subtype. A non-hierarchical clustering algorithm rather than a hierarchical algorithm was used to avoid excessive influence of outliers on the classification (Stice & Agras, 1999). All cluster indicators were normally distributed.

T-tests for independent samples were conducted to compare the resulting subtypes on baseline characteristics. Analyses of covariance controlling for baseline scores (ANCOVAs) were performed to compare post-treatment outcomes of the subtypes. Fisher's exact tests were used for categorical data. Post-treatment abstinence from binge eating was defined as zero objective binge episodes for the previous 28 days as evaluated by the EDE-Q.

3. Results

3.1. Characteristics of both dietary and dietary-negative affect subtypes

Cluster analyses revealed a pure dietary subtype ($N = 66$, 71.7%) and a mixed dietary-negative affect subtype ($N = 26$, 28.3%). Age and BMI were similar between the groups (Table 1). For the 66 patients in the dietary subtype, 33 (50%) met the subthreshold criteria for BED diagnosis, while 33 (50%) fully met the BED diagnostic criteria. For the 26 patients in the dietary-negative affect subtype, 10 (38.5%) met the subthreshold criteria for BED diagnosis, and 16 (61.5%) fully met the BED diagnostic criteria. Fisher's exact test found no difference between the groups ($\chi^2(1) = 0.998$, $p = .360$).

Table 2 summarizes the mean scores for each subtype for the variables entered in the cluster analysis, as well as *t*-test values and partial η^2 for the group differences. The dietary subtype exhibited a mean EDE-Q restraint score of 1.79 ($SD = 1.26$) and the dietary-negative affect subtype had a mean score of 2.38 ($SD = 1.55$). These mean scores correspond to the average use of dieting behaviors in six to 12 of the previous 28 days. The dietary subtype exhibited a mean score of 8.58 ($SD = 4.50$), and the dietary-negative affect subtype had a mean score of 8.08 ($SD = 4.42$) on the TFEQ restraint scale. These results fall between the means for the non-dieting ($M = 6.0$; $SD = 5.5$) and dieting groups ($M = 14.3$; $SD = 3.6$) from the original validation study of the TFEQ (Stunkard & Messick, 1985). For the dietary subtype, a mean BDI score of 8.50 ($SD = 5.44$) was within the minimal range of depressive symptoms, whereas the mean BDI score of 25.77 ($SD = 7.14$) for the

Table 2
Characteristics of both dietary and dietary-negative affect subtypes.

	Dietary subtype		Dietary-negative affect subtype		<i>t</i> (90)	Partial η^2
	<i>N</i> = 66		<i>N</i> = 26			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
EDE-Q restraint	1.79	(1.26)	2.38	(1.55)	1.71	3.7%
TFEQ restraint	8.58	(4.50)	8.08	(4.42)	0.48	0.3%
BDI	8.50	(5.44)	25.77	(7.14)	12.51***	63.5%
RSES	20.20	(4.14)	13.46	(4.99)	6.63***	32.8%

Note: *** $p < .001$; *M* = means; *SD* = standard deviations; Partial η^2 is the proportion of variation accounted for by the variable; EDE-Q = Eating Disorder Examination – Questionnaire; TFEQ = Three-Factor Eating Questionnaire; BDI = Beck Depression Inventory – II, RSES = Rosenberg Self-Esteem Scale.

dietary-negative affect subtype was within the moderate range of depressive symptoms (Beck et al., 1996). The mean RSES score of 20.20 ($SD = 4.14$) for the dietary subtype indicates that group members had average self-esteem overall, whereas the mean RSES score of 13.46 ($SD = 4.99$) in the dietary-negative affect subtype indicates that group members tended to agree with statements expressing low self-esteem.

3.2. Baseline differences between dietary and dietary-negative affect subtypes

The two subtypes were compared with respect to the frequency of binge eating, the severity of the eating disorder, the four impulsivity dimensions, and the two reinforcement sensitivity dimensions (Table 1). Compared to the dietary subtype, the dietary-negative affect subtype was characterized by a higher frequency of objective binge episodes, greater eating disorder severity, higher urgency scores and greater sensitivity to punishment.

3.3. Subtype predictive validity

The frequency of objective binge episodes and the EDE-Q overall score were selected as treatment outcome variables. Differences in post-treatment abstinence and dropout rates for the two subtypes were evaluated with Fisher's exact test. As indicated by the ANCOVA, the post-treatment outcomes of the two subtypes did not differ with regard to the frequency of objective binge episodes ($F(1,89) = 2.38$, $p = .127$) or the EDE-Q overall score ($F(1,89) = 0.31$, $p = .860$). Post-treatment abstinence rates were similar for the two subtypes (33.3% of the dietary subtype and 30.8% of the dietary-negative affect subtype; Pearson's $\chi^2(1) = 0.056$, $p = 1.000$). Seven patients (10.6% of the group) in the dietary subtype and eight patients (30.8% of the group) in the dietary-negative affect subtype dropped out prior to completing the treatment program. This difference was significant (Pearson's $\chi^2(1) = 5.557$, $p = .028$).

4. Discussion

The first goal of the current study was to replicate the finding of specific subtypes of individuals with BED based on dietary restraint and negative affect in a sample of 92 women with BED recruited from a hospital waitlist and the community at large for evaluation of an online CBT-based self-help treatment program for BED. The second goal was to compare the severity of the disorder, impulsivity, reinforcement sensitivity, and the response to treatment for the pure dietary and the dietary-negative affect subtypes.

As in previous studies with this population, cluster analyses revealed a pure dietary subtype and a dietary-negative affect subtype. The proportional distribution of cases across the subtypes was similar to that found in other studies (Grilo et al., 2001b; Masheb & Grilo, 2008; Stice et al., 2001). Both subtypes exhibited comparable and moderate dietary restraint scores, suggesting that moderate dieting is a central feature of BED. Because scores on the dietary restraint scales typically have not been found to differ for the two subtypes, Masheb and Grilo (2008) have suggested that these scores be eliminated from the cluster procedure to avoid potential bias. As expected, the dietary-negative affect subtype reported higher negative affect than the pure dietary subtype. Although more individuals with subthreshold BED might be expected to fall into the pure dietary subtype, which is regarded as "less severe", in this study, the proportional distribution of individuals with threshold and subthreshold BED was similar across the subtypes. Because BMIs were similar between both subtypes, an association between obesity and depression would not have influenced this result. Rather, this finding is due to the fact that there is little evidence to support the validity and utility of the present DSM-IV criterion for BED of two binge episodes per

week (Wilson & Sysko, 2009). Individuals with subthreshold BED do not differ from individuals who fully meet criteria for the syndrome in either the severity of the disorder or the psychiatric distress reported (Striegel-Moore et al., 2000). Finally, this finding corresponds to the results of Grilo et al. (2001b), who found that classifying individuals based on frequency of binge eating was less informative than subtyping based on dietary restraint and negative affect.

When baseline data were compared, the results of the current study confirmed that the dietary-negative affect subtype exhibited more severe eating disorders and a higher frequency of objective binge episodes than the pure dietary subtype. Moreover, the subtypes also differed in urgency and sensitivity to punishment. These findings suggest that when individuals in the dietary-negative affect subtype experience powerful urges, they lack the cognitive resources to suppress dominant and automatic responses, especially in contexts involving negative affect. This cognitive impairment might promote binge eating as a coping strategy for negative emotions. The higher sensitivity to punishment of the dietary-negative affect subtype further suggests the presence of high anxiety sensitivity and a marked disposition toward avoidant attitudes in this group. These results are consistent with the higher lifetime rate of anxiety disorders and avoidant personality types found in this subtype in previous studies (Masheb & Grilo, 2008; Stice et al., 2001). These findings suggest that individuals in the dietary-negative affect subtype experience a heightened vulnerability to negative emotions and may cope by binge eating to distract attention from distress (Heatherton & Baumeister, 1991). Dawe and Loxton (2004) proposed that reward sensitivity was part of the drive to binge and that urgency contributed to the inability to control urges to binge. Heightened sensitivity to reward and sensitivity to punishment are associated with dysfunctional eating (Harrison et al., 2010; Loxton & Dawe, 2001). In this study, however, reward sensitivity did not distinguish the subtypes and was not related to severity of the disorder for the dietary-negative affect subtype. Sensitivity to reward would be a characteristic of BED and sensitivity to punishment would characterize the severity of the disorder.

In contrast to previous studies (Masheb & Grilo, 2008; Stice et al., 2001), the dietary-negative affect subtype was not found to predict post-treatment abstinence from binge eating, frequency of binge episodes, or disorder severity. However, there was a significantly higher dropout rate during treatment for the dietary-negative affect subtype. This may be due to the fact that more severely disordered individuals are less likely to continue online self-help treatment because it demands greater patient autonomy than face-to-face treatment does. Thus, there was a subtype difference in outcome for dropout rate but not for post-treatment symptoms. Length of treatment might prove to be more beneficial for more severe cases. A recent study that compared 8-session and 16-session CBT programs for BED found that the dietary-negative affect subtype had a poorer response to the short-term CBT than the dietary subtype, but there was no difference between the subtypes in their response to the long-term CBT (Schlup, Meyer, & Munsch, 2010). In the present study, the online self-help program continued for six months, which might have reduced any subtype differences in response to treatment.

Future studies should explore whether or not longer treatment can increase the benefits of treatment for the dietary-negative affect subtype. In addition, psychological interventions that focus on increasing cognitive flexibility, inhibiting automatic responses to negative emotions, and developing appropriate coping strategies should be evaluated in individuals whose BED is more severe, such as individuals in the dietary-negative affect subtype. Among the potential approaches, implementation intentions or "if-then" plans might enable individuals to resist powerful urges (Achtziger, Gollwitzer, & Sheeran, 2008). The implementation intention intervention is designed to attain a goal by identifying a specific cue to initiate the goal-directed response. An implementation intention has the format

of an “if-then” plan of action: “If situation X arises, then I will do Y” (Gollwitzer, 1993, 1999). The mental link between the cue and the action created by the implementation of the intention is thought to increase the cognitive accessibility of the critical cue and facilitate its access, even under conditions of cognitive load (Gollwitzer, 1999). In the presence of the cue, the response is automatically initiated and executed without further conscious intent (Achtziger et al., 2008). Several studies have demonstrated that this simple procedure leads to more frequent goal attainment, particularly when goals are difficult to achieve (Gollwitzer & Sheeran, 2006). Cues are typically external events or situations. However, Achtziger et al. (2008) found that internal states could also function as cues and that implementation intentions could be used to control negative internal states such as craving. In one study, undergraduate students were instructed to rehearse an if-then plan (e.g., “If I think about pizza, then I will ignore that thought!”) to maintain their dieting goal despite intrusive food cravings. Snack food consumption was significantly reduced in participants who implemented the intention compared to control participants (Achtziger et al., 2008). Implementation intentions can automatically link appropriate coping responses to negative external events or inner states (Achtziger et al., 2008). This type of intervention might prove effective for members of the dietary-negative affect subtype, who more frequently exhibit automatic responses to negative affect, by enabling them to use strategies other than binge eating to cope with negative feelings.

The current study had a number of limitations. We did not report fit statistics to provide a straightforward evaluation of the quality of the classification generated by the cluster analyses (Aldenderfer & Blashfield, 1984). Recently, latent class analysis has been used to examine the heterogeneity of BED diagnoses (Sysko, Hildebrandt, Wilson, Wilfley, & Agras, 2010). Latent class analyses also provide a way to detect which individuals are most likely to respond to different treatment approaches. Sysko et al. (2010) identified four distinct groups of individuals and compared the responses to treatment for each group for interpersonal psychotherapy, a behavioral weight loss program, and a CBT-based guided self-help program. Individuals in a group comparable to the dietary-negative affect subtype, who exhibited higher levels of eating disorder symptoms and psychopathology and had the highest depression scores, had a better response to interpersonal psychotherapy than to the behavioral weight loss or CBT-based guided self-help programs. This suggests that it would be worthwhile to evaluate the effectiveness of interpersonal psychotherapy for patients in the dietary-negative affect subtype. Another limitation of the present study was the use of self-report questionnaires, which can be compromised by memory biases or social desirability, to assess eating disorder psychopathology, impulsivity and sensitivity to reinforcement. An assessment of binge eating among BED patients (Wilfley, Schwartz, Spurrell, & Fairburn, 1997) found low levels of agreement between EDE and EDE-Q that did not achieve significance. Inconsistencies between the instruments were held to be due to the disorganized nature of binge eating episodes in BED, which makes it more difficult for individuals with BED to identify and recall episodes of binge eating. Use of self-report measures might have influenced the study findings regarding the extent to which subtype predicts the frequency of objective binge episodes following treatment. A structured interview such as the EDE or the use of self-monitoring diaries might have provided a more reliable assessment of the frequency of objective binge episodes. The results of the present study could also be confirmed in future studies by using behavioral tasks to evaluate impulsivity and sensitivity to reinforcement (e.g., the Iowa Gambling Task: Bechara, Damasio, Tranel, & Damasio, 1997; Go/No-Go: Dougherty, Mathias, & Marsh, 2003). Finally, the use of a cross-sectional design made it impossible to draw causal inferences. Longitudinal studies are needed to explore whether the elevated rates of urgency or sensitivity to punishment found in the dietary-negative affect subtype are a cause or a consequence of the severity of the eating disorder.

5. Conclusion

In conclusion, this study identified two subtypes of individuals suffering from BED: a pure dietary subtype and a dietary-negative affect subtype. Compared to the pure dietary subtype, the dietary-negative affect subtype exhibited greater disorder severity, a higher frequency of binge episodes and a higher dropout rate during the on-line CBT guided self-help program. Individuals in the dietary-negative affect subtype also reported higher urgency and sensitivity to punishment, suggesting a greater vulnerability to negative affect and a reduced ability to use coping strategies other than binge eating. Treatment that targets cognitive flexibility, inhibition of automatic responses and the development of coping strategies for anxiety management might be particularly useful for these individuals.

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Contributors

Isabelle Carrard, Christelle Crépin, Alain Golay and Martial Van der Linden designed the study and wrote the protocol. Isabelle Carrard and Christelle Crépin collected the data and conducted the research. Grazia Ceschi and Martial Van der Linden provided literature research. Isabelle Carrard wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

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