

1 **Problematic eating behaviors and psychopathology in patients undergoing**
2 **bariatric surgery: the mediating role of loss of control eating**

3

4 **RUNNING TITLE: LOSS OF CONTROL AND EATING BEHAVIORS**

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1 **Abstract**

2 **Objective:** This study compares different problematic eating behaviors (PEBs;
3 objective(OBE)/subjective(SBE) binge-eating and compulsive (CG)/non-compulsive
4 (NCG) grazing) in relation to the severity of loss of control (LOC) and
5 psychopathology. We also investigate LOC as a mediator between PEBs and
6 psychopathology. **Methods:** This cross-sectional study assessed a group of patients
7 before bariatric surgery (n=163), and a group of bariatric patients 12 months or more
8 after surgery (n=131). Face-to-face assessment: Eating Disorders Examination for
9 binge-eating episodes; Rep(eat) for grazing. LOC was measured by 5 questions
10 answered in a 5-point Likert scale. Self-report measures: disordered eating, grazing,
11 negative urgency, depression, anxiety, and stress. **Results:** OBEs were reported by
12 26(8.8%), SBE by 29(9.8 %), CG by 35(11.9%), and NCG by 36(12.2%) of patients.
13 The different PEBs differed significantly in the severity of LOC ($F(3,120)= 25.81$,
14 $p<.001$). Patients reporting OBEs scored higher and patients with NCG scored lower in
15 most measures than patients with other PEBs. Patients with any PEBs scored higher in
16 all self-report measures than those not reporting any PEBs, with statistical significance
17 reached for uncontrolled eating ($F(4,288)= 20.21$, $p<.001$), emotional eating ($F(4,288)=$
18 23.10 , $p<.001$), repetitive eating $F(4,288)= 18.34$, $p<.001$), and compulsive grazing
19 ($F(4,288)= 27.14$, $p<.001$). LOC was found to be a full mediator between PEBs and
20 psychopathology. **Discussion:** There is no evidence that the different PEBs differ in the
21 psychopathology severity, independently of the experience of LOC eating during the
22 eating episodes. We show evidence for the conceptualization of different PEB,
23 including grazing, on a continuous scale of LOC and psychopathology.

24 **Keywords** – loss of control eating; binge-eating episodes; grazing; eating-
25 related psychopathology; bariatric surgery

1 **INTRODUCTION**

2 Binge eating is considered a central marker in the diagnosis of bulimia nervosa
3 or binge-eating disorder. The DSM-5 (American Psychiatric Association, 2013) defines
4 binge-eating episodes based on two criteria: 1) the experience of loss of control (LOC)
5 over eating during the episodes, a sense that one cannot resist eating or stop eating once
6 started; and, 2) the ingestion of an extremely large amount of food. However, a growing
7 body of research has put into question the importance of the amount of food consumed
8 during the episode, arguing that the experience of LOC is uniquely and more strongly
9 related with psychopathology than the amount ingested, being the core feature in the
10 definition of binge eating (Fitzsimmons-Craft et al., 2014; Goldschmidt, 2017; Mond,
11 Latner, Hay, Owen, & Rodgers, 2010). LOC eating has been associated with poor
12 quality of life, problematic weight control behaviors, low self-esteem, disinhibition
13 while eating, emotional dysregulation, depressive symptoms and general distress in
14 non-clinical population (Goldschmidt et al., 2015; Jenkins, Conley, Hoste, Meyer, &
15 Blissett, 2012), and in patients with eating disorders or obesity (Blomquist et al., 2014;
16 Colles, Dixon, & O'Brien, 2008b; Fitzpatrick et al., 2014). Furthermore, the experience
17 of LOC seems to be more resistant to treatment than the amount of food eaten. For
18 instance, although LOC eating with large amounts of food seem to decrease
19 significantly in the initial stages of treatment (Niego, Pratt, & Stewart Agras, 1997), or
20 as a result of self-monitoring (Hildebrandt & Latner, 2006), the experience of LOC
21 eating with modest amounts remains high (Hildebrandt & Latner, 2006) and changes
22 more slowly during treatment (Niego et al., 1997). LOC eating in pediatric ages
23 frequently seems to persist into early adolescence being associated with the onset of
24 binge-eating disorder (Tanofsky-Kraff et al., 2011) and is a unique prospective predictor
25 of overweight/obesity and depressive syndromes (Sonneville et al., 2013).

1 Grounded on this accumulating evidence highlighting the clinical importance of
2 LOC eating regardless of the amount ingested, a rising number of studies have used a
3 terminology proposed by Fairburn, Cooper & O'Connor (2014) who distinguish
4 objective binge-eating episodes (OBE – experience of LOC while eating objectively
5 large amounts of food) from subjective binge-eating episodes (SBE – experience of
6 LOC while eating an amount of food that is not large but is experienced as excessive by
7 the respondent). The current state of the art suggests that among patients with an eating
8 disorder, SBEs are associated with significant clinical impairment similar to OBEs
9 (Brownstone et al., 2013; Mond et al., 2010; Palavras, Morgan, Borges, Claudino, &
10 Hay, 2013). Evidence shows that the size of binge-eating episodes does not differentiate
11 the degree of eating disorder psychopathology, dietary restraint, disinhibition, hunger,
12 mental health or general psychopathology (Brownstone et al., 2013; Keel, Mayer, & JH,
13 2000; Latner, Hildebrandt, Rosewall, Chisholm, & Hayashi, 2007; Mond et al., 2010),
14 leading to the proposal that both SBE and OBE should be considered in the diagnoses of
15 bulimic disorders (Goldschmidt, 2017).

16 In addition to being a hallmark feature for eating disorders, it is estimated that
17 binge-eating episodes are reported by about 50% of the general population that do not
18 meet criteria for an eating disorder (Machado, Machado, Gonçalves, & Hoek, 2007),
19 and in up to 40% of the bariatric surgery candidates with severe obesity (Colles et al.,
20 2008b), being associated with increased caloric intake and higher BMI (Masheb et al.,
21 2015; Meany, Conceição, & Mitchell, 2014; Mustelin, Bulik, Kaprio, & Keski-
22 Rahkonen, 2017). Binge-eating episodes, regardless of the amount of food ingested,
23 have also been associated with greater eating disorder and general psychopathology, as
24 well as poorer quality of life in diverse obese groups, and with poor weight loss
25 outcomes in patients after bariatric surgery (Blomquist et al., 2014; Meany et al., 2014;

1 White, Kalarchian, Masheb, Marcus, Marsha, & Grilo, 2010). The amount of food
2 eaten, however, seems to be associated with the severity of LOC experienced (Mitchell
3 et al., 2012) and considered more of a risk factor for poor weight management
4 (Goldschmidt, 2017). Put together, these data highlight the importance of assessing the
5 experience of LOC independently of the quantity consumed and its conceptualization as
6 a marker of psychopathology.

7 More recently, research has suggested that LOC eating may be associated with
8 other problematic eating behaviors (PEBs) besides binge eating (Conceição, Utzinger,
9 & Pisetsky, 2015). Studies with patients undergoing bariatric surgery for weight loss
10 brought into light grazing behavior, generally characterized as the ingestion of food in
11 an unplanned and repetitive manner, not in response to hunger/satiety sensations.
12 Grazing behavior has been consistently associated with poor weight loss (Colles, Dixon,
13 & O'Brien, 2008a; Conceição et al., 2017; Robinson et al., 2014) and weight regain
14 (Kofman, Lent, & Swencionis, 2010; Pizato, Botelho, Gonçalves, Dutra, & Carvalho,
15 2017), following bariatric surgery. Despite mixed findings (Conceição et al., 2014),
16 growing evidence supports its association with LOC eating (Goodpaster et al., 2016),
17 increased eating disordered psychopathology, psychological distress, impulsivity under
18 negative emotions, uncontrolled eating and emotional eating (Conceição et al., 2017),
19 lower dietary restraint and higher dietary disinhibition (Colles et al., 2008a) in both
20 bariatric and community samples. The non-planned nature of this eating behavior and
21 its compulsive component suggest that there is little control exerted over eating and that
22 some degree of lack of control is associated (Conceição et al., 2014). With different
23 definitions being used in the literature, Conceição and colleagues (2014) made an
24 attempt organize the varied criteria used across studies, and proposed a consensus
25 definition considering two types of grazing: non-compulsive grazing, characterized by a

1 distracted and mindless repetitive eating; and a compulsive grazing, characterized by
2 not being able to resist going back to eat repeatedly. A grazing-type behavior has been
3 reported by 33% of patients after bariatric surgery (Goodpaster et al., 2016), 57.6% of
4 patients with bulimia, 34.3% with anorexia and 44% with binge-eating disorder
5 (Conceição et al., 2013).

6 Based on this evidence, Conceição et al. (2015) proposed that these different
7 PEBs – OBEs, SBEs, compulsive and non-compulsive grazing – should be
8 conceptualized in relation to different degrees of LOC eating, with OBE and non-
9 compulsive grazing being associated with the highest and lowest severity of LOC
10 eating, respectively. Yet, support for the conceptualization of these different PEBs on a
11 continuum of LOC eating and psychopathology is still limited (Goldschmidt et al.,
12 2016). Moreover, there is little evidence for the two subtypes of grazing or for a
13 conceptualization of grazing in the spectrum of disordered eating.

14 This study compares these different PEBs in relation to the severity of LOC
15 eating and psychopathology. We also investigate the role of LOC eating as a mediator
16 between PEBs and psychopathology. With this study, we aim to provide evidence that
17 the different PEBs are associated with different severity of LOC eating and that,
18 regardless of the PEB, the experience of LOC eating during the episode is the core
19 feature explaining the associated psychopathology. Additionally, we wish to provide
20 further evidence for the concept of grazing in the spectrum of disordered eating
21 psychopathology.

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1 **METHODS**

2 *Procedure and sample*

3 A total of 309 bariatric surgery patients were invited for this study, but 15 denied
4 participation claiming no interest (n=5), or no time for the assessment (n=10). This
5 cross-sectional study assessed a convenience sample of 163 bariatric surgery candidates
6 and 131 postoperative bariatric patients (12 months or more following surgery; M=
7 26.32; SD=10.18; min=12; Max=58). Between November 2015 and April 2017 patients
8 were invited to the study after their appointment with a professional of the bariatric
9 surgery's multidisciplinary team in two main hospital centers in the North of Portugal.
10 Eligible patients included those cleared out for bariatric surgery by the multidisciplinary
11 team. Bariatric candidates with any major active psychiatric disorder (including binge-
12 eating disorder), evaluated by the psychiatrist of the bariatric team, would not receive
13 approval for surgery. Specific exclusion criteria for this study included: current
14 pregnancy or breastfeeding; not being able to understand/read Portuguese; not being
15 autonomous in eating choices. Patients accepting participation in this study were
16 interviewed by a trained psychologist, and responded to a set of self-report measures.

17 Patients were informed about the confidentiality of the data collected and that
18 the information discussed would not influence the treatment provided. An informed
19 consent form was signed by those accepting participating in our study. This study was
20 approved by the institutional review boards of the university and hospital institutions
21 involved and conforms to the recognized standards of the Declaration of Helsinki.

22 Face-to-face psychological assessment: Interviews were conducted by three
23 psychologists trained in the assessment measures used. All diagnoses were discussed for
24 consensus. Socio-demographic and anthropometric information was retrieved. Weight

1 and height were measured during the medical appointment. The diagnostic items of the
2 *Eating Disorders Examination, 17th Ed*, (Fairburn, Christopher G Cooper & O'Connor,
3 2014) were used to identify OBEs and SBE, as defined in the introduction section. The
4 *Rep(eat)* interview (Conceição et al., 2014, Appendix B) was used to identify grazing in
5 its compulsive and non-compulsive subtypes, as defined in the introduction section.
6 Both the EDE and the Rep(eat) are investigator-based interviews where the interviewer
7 decides on the presence/absence of episodes after a series of compulsory and subsidiary
8 probe questions. For the purpose of this study, the interview focused on the preceding
9 four weeks.

10 To assess the *experience of loss of control* associated with the different PEBs,
11 when one of these behaviors was reported by the participant, the interviewer would
12 follow with five questions regarding the experience of LOC during each specific
13 episode. The questions were answered orally by the participant in a 5-point Likert scale
14 from 0 (not at all) to 4 (extremely). The interviewer prompted the questions asking:
15 “*During the times where you experience [...description of the episodes...], while you*
16 *were eating, to what extent did you:* i) ...feel a sense of LOC?; ii) ...feel that you could
17 not stop eating once you started?; iii)... did you feel that you overate?; iv)... did you
18 feel that you could not resist eating?; v)... did you feel driven or compelled to eat?
19 These five questions were retrieved from Ecological Momentary Assessment studies
20 [e.g. Goldschmidt et al. (2011)] that assessed the experience of LOC eating associated
21 with each binge-eating episode. Cronbach’s α for the sum of the 5 questions was $>.90$
22 for the different PEBs.

23

24 Self-report measures: The *Eating Disorders-15* (ED-15; Tatham et al., 2015) is a
25 15-item measure that assesses eating disorder psychopathology and compensatory

1 behaviors. It generates a total score and two subscales: weight and eating concern.
2 Cronbach's α for our sample was .89 for the total score. The Portuguese version of the
3 *Three Factors Eating Questionnaire-Revised 21* (TFEQ-R21; Cappelleri et al., 2009;
4 Moreira, Almeida, Sampaio, & Almeida, 1997) was used. This is a 21-items revision of
5 the Stunkard and Messick questionnaire (Stunkard & Messick, 1985) that generates
6 three subscales: uncontrolled eating; restraint eating and emotional eating. For the
7 mediation analyses, we have computed a total score (TFEQ_sum) corresponding to the
8 sum of the different subscales. Cronbach's α for our sample was .85 for the total score.
9 The Rep(eat)-Q (Conceição et al., 2017) is a 12-item measure validated in Portuguese
10 that assesses a grazing-type eating pattern. It generates two subscales: repetitive eating
11 and compulsive grazing, and a total score. Cronbach's α for our sample was .93 for the
12 total score. The negative urgency subscale of *the Urgency, Premeditation,*
13 *Perseverance, and Sensation Seeking scales* (UPPS-NU; Whiteside, Lynam, Miller, &
14 Reynolds, 2005) is a 12-item measure that assesses the tendency to act impulsively
15 under negative emotions. Cronbach's α for our sample was .91. The Portuguese version
16 of the *Depression, Anxiety and Stress Scales* (DASS; Lovibond & Lovibond, 1995;
17 Pais-Ribeiro, Honrado, & Leal, 2004), a 21-item measure, was used. For the mediation
18 analyses, we have computed a total score (DASS_sum) corresponding to the sum of the
19 different subscales (depression, anxiety, and stress). Cronbach's α for our sample was
20 .96 for the total score.

21 Statistics

22 One way ANOVA was used to compare eating behaviors in term of their scores
23 on LOC eating, and MANOVAs to compare patients presenting the different PEBs (IV)
24 on the psychological measures used (DV). The Sidak post hoc test for pairwise
25 comparison was used to test the difference between each possible pair of PEBs while

1 controlling for familywise error rate. We have further used Ryan-Einot-Gabriel-Welsch
2 (REGWF) post hoc test, a powerful step-down test that keeps familywise error at α .
3 REGWF generates homogeneous subsets where the means that saturate in each resulting
4 subset are not significantly different, highlighting the similarities within each subset.
5 When patients presented more than one PEB they were assigned to the group of the
6 PEB found to be associated with the highest severity of LOC eating in the previous
7 analysis. This set of analyses was conducted controlling for the co-variable “sex”. Since
8 the co-variable “pre-/post-surgery” was non-significant and showed the exact same
9 pattern of significances it was removed from the model. These analyses were conducted
10 with IBM SPSS 22 software. Variations in sample size are due to missing data.

11 Mediation analyses were used to investigate the variance in the relationship
12 between an independent variable (IV; PEB) and a dependent variable (DV;
13 psychopathology), that is better explained by a third variable (Mediator; LOC eating).

14 Acknowledging the cross-sectional nature of our sample, different authors
15 suggested that the mathematical methods underlying mediation analyses can be
16 employed with such data, particularly when there is a solid argument in the field
17 suggesting the causal relationships among the variables under study (see Hayes (2013),
18 pp.78-91). As discussed in the introduction section, we have sufficient evidence to
19 support such analysis. Notwithstanding, our results will be discussed in light of the
20 nature of our data.

21 In the models tested, the IV (a multicategorical variable) represents patients
22 presenting no PEBs, non-compulsive grazing, compulsive grazing, SBE or OBE. Three
23 models were tested for three different DV reflecting eating-related psychopathology
24 (TFEQ_sum and ED-15) and psychological distress (DASS_sum). The macro
25 PROCESS for SPSS was used with model 4, bootstrapping of 5.000, bias corrected as

1 the bootstrap confidence interval (CI) method, 95% CI, and Helmert coding method
2 (see Hayes (2013), pp.568). The contrasts tested with Helmet coding allow the
3 comparison of a group x to all groups ordinally higher on the categorical variable. In our
4 models, *path 1* represents the comparison between no PEB and any PEB; *path 2* non-
5 compulsive grazing vs compulsive grazing, SBE and OBE; *path 3* compulsive grazing
6 vs SBE and OBE; and, *path 4* SBE and OBE.

7

8 **RESULTS**

9 *Characterization of the Sample*

10 Out of the 294 participants of our study, 247 (84%) were women and 47 (16%)
11 men. Participants were aged between 19 and 67 (M=42.02, S.D=10.78), the majority
12 (63.9%) was married or living with a partner, had at least 9 years of education (63%)
13 and was employed (56.8%). OBEs were reported by 26(8.8%), SBE by 29(9.8%),
14 compulsive grazing by 35(11.9%), and non-compulsive grazing by 36(12.2%) of the
15 patients. **Table 1** presents the detailed sociodemographic information and the
16 distribution of PEB pre- and post-surgery.

17 *(Insert Table 1 about here)*

18 *Differences in LOC eating and psychopathology between the different PEBs*

19 The varied PEBs differed significantly in the severity of LOC experienced
20 during the eating episode, with non-compulsive grazing being associated with the
21 lowest and OBEs with the highest severity. OBEs were associated with significantly
22 higher severity of LOC eating than both grazing subtypes. (**Table 2**) REGWK
23 homogeneous subsets supported the assumption that no significant differences were

1 found in the LOC scores between OBE and SBE, or between SBE and compulsive
2 grazing.

3 Patients with any PEBs scored higher in all self-report measures than those not
4 reporting any PEBs, with statistical significance reached for uncontrolled eating,
5 emotional eating, repetitive eating and compulsive grazing subscales of the Rep(eat)-Q.
6 Patients reporting OBEs and non-compulsive grazing scored higher and lower in most
7 subscales, respectively, than other patients with PEBs (with the exception of eating
8 concern and repetitive eating). Nonetheless, OBE, SBE, and compulsive grazing
9 saturated in the same REGWF homogeneous subset for uncontrolled eating, emotional
10 eating, weight concern and negative urgency. As for the grazing measure (Rep(eat)-Q),
11 not only patients reporting compulsive and non-compulsive grazing but also patients
12 reporting OBE and SBE scored significantly higher than patients not reporting PEBs.
13 No significant differences were found for cognitive restraint.

14 In regard to depression, anxiety, and stress, although patients reporting OBE
15 were the only ones scoring significantly higher than patients without PEBs, it is
16 noticeable that patients with any PEB saturated together in a REGWF homogeneous
17 subset for depression, anxiety and stress, highlighting their similarities in the
18 psychological distress associated.

19 Finally, the same PEB frequently saturated in different REGWK subsets within
20 the same measure. For instances, in regards to uncontrolled eating, compulsive grazing
21 and SBE saturated in one subset together with non-compulsive grazing, and in another
22 subset with OBE, suggesting that they occupy a median position within the spectrum of
23 uncontrolled eating.

24 *(Insert table 2 about here)*

1 The mediating role of LOC eating in understanding psychopathology in PEBs

2 LOC was found to be a mediator between PEBs and psychopathology [**Figure**
3 **1a**): disordered eating (TFEQ_sum); **Figure 1b**): eating disorder psychopathology (ED-
4 15 total score); **Figure 1c**): psychological distress (DASS_sum)]. Overall, supporting
5 our data presented in **Table 2**, non-compulsive grazing, compulsive grazing, SBE, and
6 OBE are significantly associated with increasing severity of LOC eating (*a'* path values
7 all positive and significant). Independently of the PEB reported, participants
8 experiencing higher severity of LOC eating scored significantly higher in the
9 psychopathological measures tested (*b* path positive and significant). There is no
10 evidence that the different PEBs differ in the psychopathology severity, independently
11 of the experience of LOC eating during the eating episodes (*c'* paths and omnibus test –
12 relative direct effect – not significant). The presence of PEBs is associated with
13 psychopathology through the level of LOC eating experienced during such episodes
14 which, in turn, is associated with increased psychopathology (*ab* paths and omnibus test
15 – relative indirect effect – with all CIs above zero). Of note, although the omnibus test
16 of the relative total effect (*ab + c'*) was significant for the three models tested, there was
17 not a significant difference between patients reporting compulsive grazing or binge-
18 eating episodes in the total effect explaining psychopathology, suggesting a similarity in
19 these mechanisms of psychopathology between these PEBs.

20

21 **Discussion**

22 This study expands the current literature supporting the clinical significance of
23 LOC eating by considering other forms of problematic eating beyond SBE and OBE,
24 specifically grazing subtypes, and showing evidence for their association with LOC

1 eating and psychopathology. This was the first study to compare these different PEBs in
2 terms of the severity of the LOC experienced during the eating episode and the
3 associated psychopathology. Moreover, we provide evidence for the experience of
4 LOC eating as a unique indicator of disordered eating-related psychopathology in a
5 non-eating disordered sample.

6 LOC eating in association with different PEBs

7 Taking together the differences found in LOC eating scores across the different
8 PEBs and the results of the mediation models tested (Paths a'), we show evidence for a
9 conceptualization of non-compulsive grazing, compulsive grazing, SBE and OBE as
10 associated with increasing severity of LOC eating as proposed by Conceição et al.
11 (2015). With OBE and non-compulsive grazing associated with the highest and lowest
12 severity of LOC eating, respectively, our data also highlight the similarities in the
13 experience of LOC eating between SBE and compulsive grazing.

14 PEBs and psychopathology

15 Generally, patients reporting OBEs and non-compulsive grazing scored highest
16 and lowest, respectively, in the psychopathology measures. Moreover, patients reporting
17 OBEs, SBEs and compulsive grazing showed similar scores in uncontrolled eating,
18 emotional eating, weight concern and negative urgency (same homogeneous subsets).
19 These findings underscore their similarities in these aspects of disordered eating and in
20 the tendency to act impulsively under emotionally negative situations. Further evidence
21 for the similarities between compulsive grazing and binge-eating episodes was found in
22 the mediation analyses where we did not find a significant relative total effect of
23 compulsive grazing explaining psychopathology between both binge-eating episodes.
24 Taken together, these data suggest that compulsive grazing is associated with similar

1 severity of disordered eating psychopathology to binge-eating episodes (particularly
2 SBEs). Past research has stressed the similarities between SBE and OBE (Fitzsimmons-
3 Craft et al., 2014; Goldschmidt, 2017; Mond et al., 2010) and with this study, we bring
4 attention to compulsive grazing behavior as a clinically relevant eating behavior in the
5 spectrum of disorder eating.

6 Finally, patients reporting any PEBs scored significantly higher than those not
7 reporting any PEB for uncontrolled eating, emotional eating, repetitive eating and
8 compulsive grazing. Moreover, although the different eating behaviors loaded together
9 in homogeneous subsets for most of the subscales assessed, highlighting their
10 similarities, they also saturated simultaneously in multiple subsets of increasing
11 psychopathology. Additionally, the mediation models show that, compared to patients
12 not reporting PEBs, the presence of any PEB is associated with significantly higher
13 scores in the psychological measures tested. Taken together, these findings support the
14 argument for the conceptualization of these different PEBs in the spectrum of
15 disordered eating psychopathology and psychological distress, as suggested in previous
16 research (Conceição et al., 2017, 2015). Of note, in line with findings from other studies
17 (Fitzsimmons-Craft et al., 2014), cognitive restraint does not differentiate patients
18 reporting the different PEB. As this is a sample undergoing treatment for obesity, it is
19 not surprising that all these patients would have similar concerns about watching their
20 eating.

21 Grazing behavior and psychopathology

22 The fact that patients presenting any PEB scored significantly higher than
23 patients without PEBs in the repetitive eating and compulsive grazing subscales,
24 suggests that grazing-type eating behaviors are associated with any PEB. The Rep(eat)-
25 Q assesses a repetitive eating pattern and compulsive grazing-type eating behaviors

1 (associated with LOC eating). The repetitive eating score was lowest for those not
2 reporting PEB and for SBE (characterized by eating small amounts of food in one
3 sitting with the sense of LOC). The compulsive grazing subscale reflects the sense of
4 LOC eating associated with the eating behavior (ex: "I cannot resist eating in between
5 meals"). Thus it is not surprising that patients reporting OBE and compulsive grazing
6 score the highest in this subscale. Our results also contribute to the clarification of the
7 mixed literature regarding grazing-type eating behaviors and psychopathology. The fact
8 that studies used a variety of definitions to identify grazing-type behaviors (Conceição
9 et al., 2014), diverting particularly in its association with LOC eating, complicated the
10 literature. The majority of studies that did not find an association with psychopathology
11 generally used definitions that would exclude the sense of LOC eating associated with
12 grazing-like behaviors (Masheb, Roberto, & White, 2013; Reas, Wisting, Kapstad, &
13 Lask, 2012), while those which found an association generally did not exclude a sense
14 of LOC in their definition (Busetto et al., 2005; Poole et al., 2005; Robinson et al.,
15 2014). Goodpaster et al. (2016) showed that LOC eating in association with grazing is
16 particularly linked to anxiety disorders, binge-eating disorder and internalizing
17 dysfunction compared to grazing without LOC. We showed that compulsive grazing is
18 associated with higher severity of LOC eating and psychopathology than non-
19 compulsive grazing, which is further evidence that LOC eating plays a central role in
20 explaining psychopathology in PEBs. Future research should explore the role of the
21 grazing subtypes in the context of eating disorders and of obesity treatment.

22 LOC eating as an indicator of psychopathology

23 Past research has shown that the presence of LOC eating while eating is
24 associated with increased psychopathology in patients with eating disorders
25 (Fitzsimmons-Craft et al., 2014; Mond et al., 2010), obesity (Colles et al., 2008b), or in

1 community samples (Latner et al., 2007). We hypothesized that, regardless of the
2 amount eaten or the behavioral presentation of the problematic eating episodes, the
3 severity of LOC eating experienced would explain eating disorder psychopathology and
4 psychological distress. The mediation models tested found support for the severity of
5 LOC eating as a mediator in the relationship between eating behaviors and disordered
6 eating (TFEQ-R21), eating disorder psychopathology (EDE-Q), and psychological
7 distress (DASS). In fact, we found no evidence that the different PEBs differ in the
8 psychopathology severity, independently of the severity of LOC eating. Accordingly,
9 other authors have suggested that the amount of food ingested should be considered a
10 descriptive indicator of the degree of LOC eating (Wolfe, Baker, Smith, & Kelly-
11 Weeder, 2009), and a marker of risk for excess weight gain and obesity (Goldschmidt,
12 2017). For instance, Mitchell et al. (2012) found that the severity of LOC during OBEs
13 varies in a sample of patients with bulimia nervosa and that greater LOC is associated
14 with a larger amount of kilocalories consumed as well as a greater likelihood of
15 vomiting after an eating episode. These findings bring further support for the argument
16 that assessing LOC eating in a continuous manner rather than dichotomously would
17 allow the identification of a variety of clinically relevant disordered eating behaviors
18 (Conceição et al., 2014; Goldschmidt et al., 2016; Latner, Mond, Kelly, Haynes, & Hay,
19 2014; Mitchell et al., 2012). Additionally, assessing LOC eating instead of the behavior
20 itself seems to better explain severity of psychopathology. In this context, two measures
21 have been developed to capture de multi-dimension of LOC eating: Loss of Control
22 over Eating Scale (LOCES; Latner et al., 2014), and the Eating Loss of Control Scale
23 (ELOCS; Blomquist et al., 2014). In accordance to our data, it has been suggested that
24 investigating higher order (latent) constructs, instead of specific behaviors/disorders,
25 allows a better understanding of the variability observed in psychopathology or

1 treatment outcomes (Marek, Ben-Porath, & Heinberg, 2016). The same authors
2 suggested that LOC eating, which may be reflected in different behavioral forms
3 depending on its severity, is a manifestation of the higher order construct
4 disinhibition/disconstraint. Thus research focusing on higher order dimensions of
5 psychopathology instead of on the specific behavioral manifestation may yield a more
6 consistent explanation for psychopathology.

7 We should stress that our population includes patients reporting PEBs but not
8 meeting full criteria for an eating disorder diagnosis. Our results should not be
9 generalized to other populations and future research should attempt to replicate these
10 findings in other samples (eating disorders, obese non-bariatric, and non-clinical
11 community). We would expect that the difference in terms of LOC eating between these
12 episodes would be more marked in a sample of individuals with bulimic disorders.
13 However, we would not expect much differentiation in terms of psychopathology, nor a
14 full mediation effect of LOC, considering the bias of the disorder itself which is
15 maintained and modulated by a series of mechanisms (such as compensatory behaviors,
16 low BMI, clinical perfectionism, weight-based self-esteem, etc..) that contribute to the
17 psychological state of the individual. In fact, the lack of differences in binge-eating
18 severity, compensatory behaviors, self-esteem, depressive symptoms, or in disordered
19 eating psychopathology reported by previous studies comparing patients with bulimia
20 with OBE vs SBE (Fitzsimmons-Craft et al., 2014; Palavras et al., 2013) may be due to
21 the core psychopathology of the eating disorder. The fact that this study compares
22 eating behaviors reported by individuals that do not meet criteria for an eating disorder
23 allow us to investigate the unique contribution of LOC eating and of the eating
24 behaviors to psychopathology.

1 Another limitation is that, although we have a large sample size of individuals
2 undergoing bariatric surgery, only a small percentage reported PEBs, which results in a
3 low sample size to detect statistically significant differences between groups for such a
4 large amount of pairwise comparisons tested. The major strengths of this study include
5 the use of validated interviews to assess the different PEBs, the fact that we study a
6 sample without an eating disorder diagnosis and that we included both men and women.

7 With this study, we show that LOC eating is an indicator of disordered eating-
8 related psychopathology. Regardless of the PEB presented, it is the severity of LOC
9 eating that better explains associated psychopathology in patients with obesity under
10 bariatric surgery treatment. This study also found evidence for grazing, in its
11 compulsive and non-compulsive subtypes, as PEBs in the spectrum of disordered eating
12 and related psychopathology. Of note, the similarities between SBE and compulsive
13 grazing, either in the associated severity of LOC eating and in psychological measures,
14 highlight the clinical relevance of compulsive grazing in this sample. Non-compulsive
15 grazing, on its end, generally showed lower scores in all the measures assessed.
16 Together, our findings support the conceptualization of the different PEB, including
17 grazing, on a continuous scale of LOC and psychopathology.

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1 Tables

Table 1- Characterization of the sample: socio-demographic and weigh-related variables.

	Pre-surgery (n=163) <i>n(%); M(S.D.)</i>	Post-surgery (n=131) <i>n(%); M(S.D.)</i>
<i>Sociodemographic/clinical information</i>		
Sex (male/female)	32(19.6)/131(80.4)	15(11.5)/116(88.5)
Age	41.03(11.39)	42.26 (9.87)
Marital status		
Single	39(23.9)	23(17.6)
Live with partner	100(61.3)	88(67.2)
Separated	19(11.7)	14(10.7)
Widowed	5(3.1)	6(4.6)
Education level		
Basic(4 years) or less	34(20.9)	25(19.1)
5-8 years	20(12.3)	30(22.9)
9-12 years	82(50.3)	59(45.0)
Graduate level	27(16.6)	17(13.0)
Employment situation		
Student	5(3.1)	4(3.1)
Unemployed	63(38.7)	34(26.0)
Employed	82(50.3)	81(61.8)
Retired	13(8.0)	7(5.3)

Table 1(cont.) - Characterization of the sample: socio-demographic and weigh-related variables.

	Pre-surgery (n=163) <i>n(%); M(S.D.)</i>	Post-surgery (n=131) <i>n(%); M(S.D.)</i>
<i>Sociodemographic/clinical information</i>		
Type of surgery		
Gastric band	-	3(2.3)
Gastric bypass	-	80(61.1)
Gastric sleeve	-	48(36.6)
<i>Weight-related variables</i>		
BMI_current	42.82(5.66)	29.80(5.95)
Months since surgery	-	26.32(10.18)
PTWL	-	32.10(11.76)
BMI change	-	14.37(6.23)
PEBMIL	-	76.37(26.37)
WR	-	5.28(12.40)
<i>Number of patients presenting problematic eating behaviors</i>		
OBE	18(11)	8(6.1)
SBE	13(8)	18(13.7)
Compulsive grazing	19(11.7)	18(13.7)
Non-compulsive grazing	22(13.5)	18(13.7)

Legend: BMI – Body Mass Index; PTWL – Percentage of Total Weight Lost;

PEBMIL – Percentage of Excess BMI Lost; WR – Weight Regain; OBE – Objective

Binge-eating episodes; SBE – Subjective Binge-eating episodes.

Table 2 – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	OBE <i>M</i> (<i>SD</i>)	SBE <i>M</i> (<i>SD</i>)	Compulsive Grazing <i>M</i> (<i>SD</i>)	Non-Compulsive Grazing <i>M</i> (<i>SD</i>)	<i>None</i> <i>M</i> (<i>SD</i>)	<i>F</i> <i>statistic</i>	<i>Pairwise comparison</i> (<i>Sidak test</i>)	<i>Homogeneous subsets</i> (<i>REGWF</i>)
<i>Sample size</i>	<i>N=26</i>	<i>N=29</i>	<i>N=35</i>	<i>N=36</i>				
LOC total score	16.27 (3.14)	13.90 (3.82)	13.49 (3.06)	8.03 (4.97)	-	25.81**	All PEB>NCG; OBE>CG/NCG	S1: NCG S2:CG/SBE S3:SBE/OBE
<i>Sample size</i>	<i>N=27</i>	<i>N=28</i>	<i>N=25</i>	<i>N=28</i>	<i>N=186</i>			
TFEQ-R21						7.94**		
Uncontrolled eating	2.58 (.66)	2.20 (.71)	2.20 (.79)	2.03 (.58)	1.63 (.57)	20.21**	All PEB>none; OBE>NCG	S1:None S2:NCG/SBE/CG S3:SBE/CG/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	OBE <i>M</i> (<i>SD</i>)	SBE <i>M</i> (<i>SD</i>)	Compulsive Grazing <i>M</i> (<i>SD</i>)	Non-Compulsive Grazing <i>M</i> (<i>SD</i>)	<i>None</i> <i>M</i> (<i>SD</i>)	<i>F</i> <i>statistic</i>	<i>Pairwise comparison</i> <i>(Sidak test)</i>	<i>Homogeneous subsets</i> <i>(REGWF)</i>
<i>Sample size</i>	<i>N=27</i>	<i>N=28</i>	<i>N=25</i>	<i>N=28</i>	<i>N=186</i>			
TFEQ-R21 [†]						7.94**		
Cognitive restriction [‡]	2.78 (.58)	2.98 (.51)	2.91 (.65)	2.95 (.52)	3.02 (.58)	1.11	-	-
Emotional eating [‡]	2.83 (.66)	2.39 (.98)	2.53 (.86)	2.13 (.78)	1.66 (.70)	23.10**	All PEB>none; OBE>NCG	S1:none S2:NCG/SBE/CG S3:SBE/CG/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	OBE <i>M</i> (<i>SD</i>)	SBE <i>M</i> (<i>SD</i>)	Compulsive Grazing <i>M</i> (<i>SD</i>)	Non-Compulsive Grazing <i>M</i> (<i>SD</i>)	<i>None</i> <i>M</i> (<i>SD</i>)	<i>F</i> <i>statistic</i>	<i>Pairwise comparison</i> (<i>Sidak test</i>)	<i>Homogeneous subsets</i> (<i>REGWF</i>)
<i>Sample size</i>	<i>N=27</i>	<i>N=28</i>	<i>N=25</i>	<i>N=28</i>	<i>N=186</i>			
ED-15 [†]						4.45**		
Weight concern [‡]	3.28 (1.77)	2.75 (1.57)	2.65 (2.13)	1.85 (1.94)	1.81 (1.78)	5.91**	OBE >NCG/none	S1:none/NCG/CG/ S2:NCG/CG/SBE S3:CG/SBE/OBE
Eating concern [‡]	2.69 (1.14)	3.12 (1.32)	2.61 (1.33)	2.37 (1.58)	1.99 (1.44)	5.76**	SBE>none	S1:none/NCG/CG S2:NCG/CG/OBE/SBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	OBE <i>M</i> (<i>SD</i>)	SBE <i>M</i> (<i>SD</i>)	Compulsive Grazing <i>M</i> (<i>SD</i>)	Non-Compulsive Grazing <i>M</i> (<i>SD</i>)	<i>None</i> <i>M</i> (<i>SD</i>)	<i>F</i> <i>statistic</i>	<i>Pairwise comparison</i> (<i>Sidak test</i>)	<i>Homogeneous subsets</i> (<i>REGWF</i>)
<i>Sample size</i>	<i>N=27</i>	<i>N=28</i>	<i>N=25</i>	<i>N=28</i>	<i>N=186</i>			
Rep(eat)-Q [†]						13.15 ^{**}		
Repetitive eating [‡]	2.04 (1.43)	1.65 (1.57)	1.83 (1.45)	1.71 (1.44)	.66 (.84)	18.34 ^{**}	All PEB>none	S1:none S2:SBE/NCG/CG/OBE
Compulsive grazing [‡]	2.62 (1.58)	2.17 (1.67)	2.25 (1.64)	1.73 (1.57)	.69 (.94)	27.14 ^{**}	All PEB>none	S1:none S2:NCG/SBE/CG/OBE
DASS [†]						2.87 ^{**}		
Depression [‡]	7.04 (6.02)	6.29 (5.62)	5.72 (5.92)	4.14 (4.21)	4.12 (5.08)	2.93 [*]	OBE>none	S1:none/NCG/CG/SBE S2:NCG/CG/SBE/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	OBE <i>M</i> (<i>SD</i>)	SBE <i>M</i> (<i>SD</i>)	Compulsive Grazing <i>M</i> (<i>SD</i>)	Non-Compulsive Grazing <i>M</i> (<i>SD</i>)	<i>None</i> <i>M</i> (<i>SD</i>)	<i>F</i> <i>statistic</i>	<i>Pairwise comparison</i> <i>(Sidak test)</i>	<i>Homogeneous subsets</i> <i>(REGWF)</i>
<i>Sample size</i>	<i>N=27</i>	<i>N=28</i>	<i>N=25</i>	<i>N=28</i>	<i>N=186</i>			
DASS [†]						2.87**		
Anxiety [‡]	7.15 (6.35)	5.61 (4.94)	6.04 (5.63)	5.04 (4.87)	4.11 (4.48)	3.21*	OBE>none	S1:none/NCG/SBE/CG S2:NCG/SBE/CG/OBE
Stress [‡]	9.63 (5.53)	8.43 (4.87)	9.16 (5.41)	6.79 (4.65)	5.69 (4.91)	6.78**	OBE/SBE /CG >none	S1:none/NCG S2:NCG/SBE/CG/OBE
UPPS – negative urgency	2.99 (0.53)	2.66 (0.57)	2.72 (0.60)	2.42 (0.73)	2.29 (0.63)	10.28***	OBE/SBE/CG> none; OBE>NCG	S1:none/NCG S2:NCG/SBE/CG S3:SBE/CG/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Legend: OBE – Objective Binge-eating Episodes; SBE – Subjective Binge-eating Episodes; LOC – Loss of Control Eating; none – 4
no problematic eating behavior presented; TFEQ-R21 – Three Factor Eating Questionnaire; ED-15 – Eating Disorder-15; Rep(eat)-Q
– Repetitive Eating Questionnaire; DASS – Depression, Anxiety a Stress Scales; UPPS - Urgency, Premeditation, Perseverance, and
Sensation Seeking scales; †Multivariate statistics (Wilks' Lambda); ‡ Univariate test; * $p < .05$; ** $p < .001$; 7
8

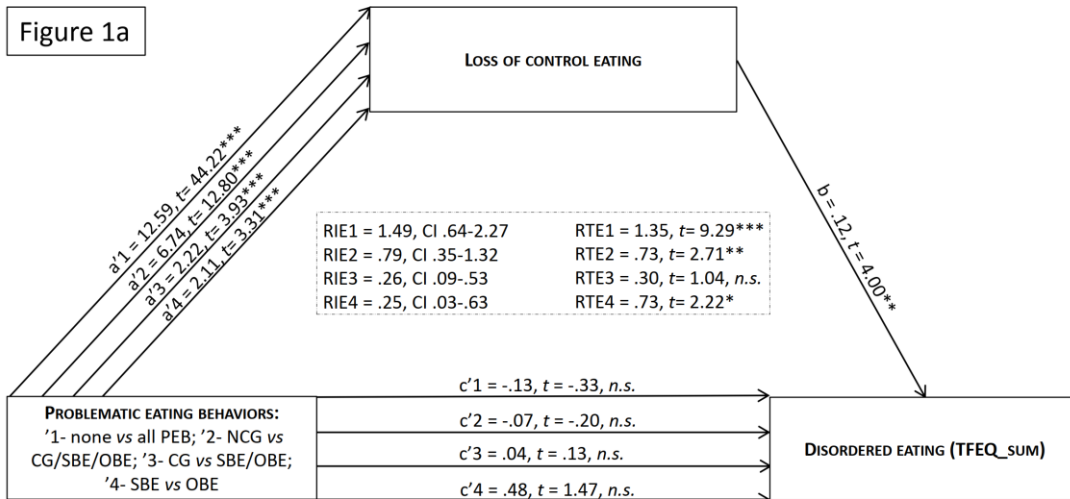
1 **Figure legends**

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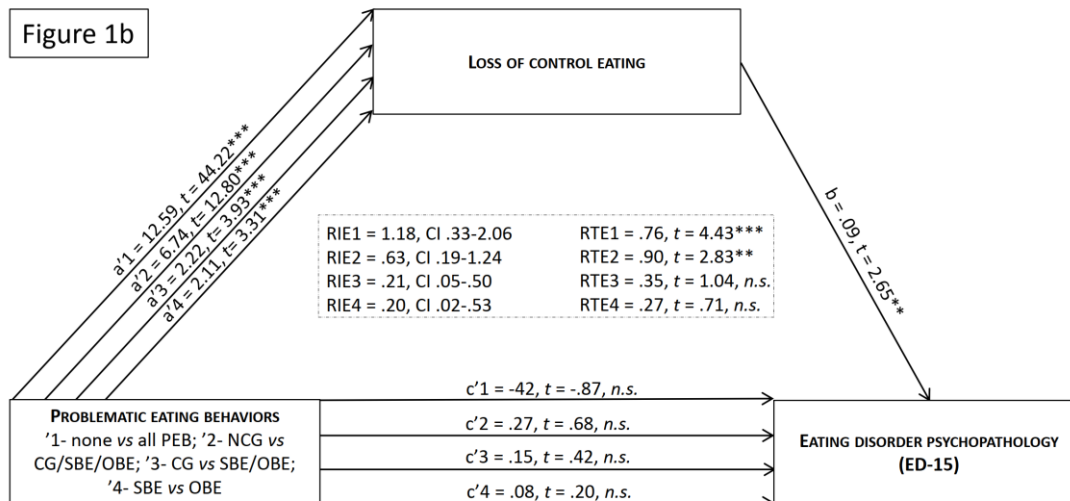
3 **Figure 1** – The mediation role of loss of control (LOC) eating in the relation between
4 problematic eating behaviors and a) disordered eating; b) eating disorder
5 psychopathology; and, c) psychological distress. Mediation model with Helmert coding
6 method.

7 *Legend Figure 1:* OBE – Objective Binge-eating episodes; SBE – Subjective Binge-
8 eating episodes; LOC – Loss of Control Eating; none – no problematic eating behavior
9 presented; TFEQ_sum – sum of the Three Factor Eating Questionnaire subscales; ED-
10 15 – Eating Disorder-15 total score; DASS_sum – sum of the Depression, Anxiety a
11 Stress Scales. RIE – Relative Indirect Effect; RTE – Relative Total Effect. LOC eating
12 is a full mediator in the relationship between problematic eating behavior and measures
13 of psychopathology. Non-compulsive and compulsive grazing, subjective and objective
14 binge eating are significantly associated with increasing severity of LOC eating. Greater
15 LOC eating is significantly associated with greater scores in the psychopathological
16 measures used. The indirect effect (through LOC eating) of PEBs on psychopathology is
17 significant. There is no evidence that PEBs are associated with psychopathology
18 independently of their association with LOC eating.

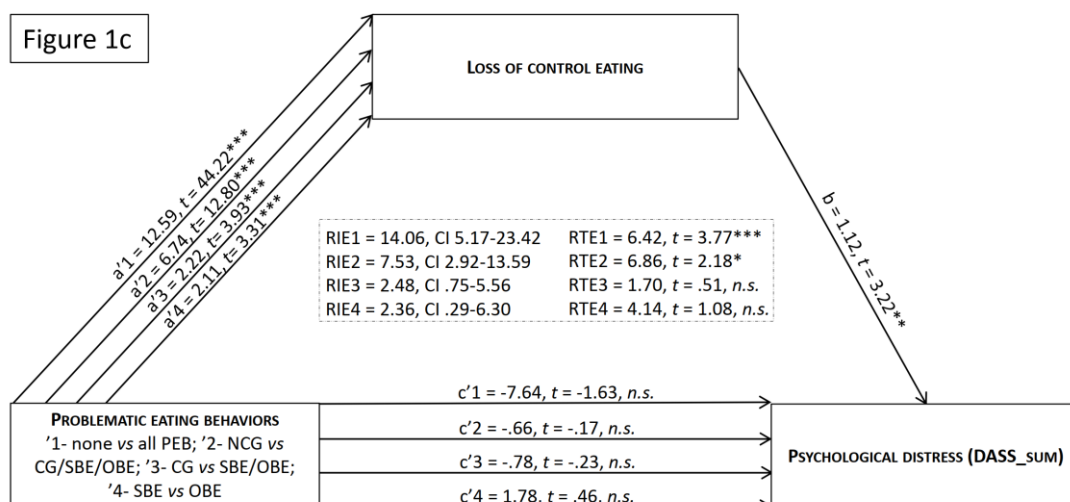
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