RESEARCH ARTICLE

Temperament Subtypes in Treatment Seeking Obese Individuals: A Latent Profile Analysis

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Abstract

Objective: This study aimed to investigate temperament subtypes in obese patients.
Methods: Ninety-three bariatric surgery candidates and 63 obese inpatients from a psychotherapy unit answered the Behavioral Inhibition System/Behavioral Activation System Scale (BIS/BAS), the Effortful Control subscale of the Adult Temperament Questionnaire-Short Form (ATQ-EC), and questionnaires for eating disorder, depressive and attention deficit hyperactivity disorder (ADHD) symptoms and completed neurocognitive testing for executive functions. Binge eating disorder and impulse control disorders were diagnosed using interviews.
Results: A latent profile analysis using BIS/BAS and ATQ-EC scores revealed a 'resilient/high functioning' cluster ($n = 88$) showing high ATQ-EC and low BIS/BAS scores and an 'emotionally dysregulated/undercontrolled' cluster ($n = 68$) with low ATQ-EC and high BIS/BAS scores. Patients from the 'emotionally dysregulated/undercontrolled' cluster showed more eating disorder, depressive and ADHD symptoms, and poorer performance in the labyrinth task.
Conclusion: The findings support the assumptions regarding the heterogeneity of obesity and the association between temperament subtypes and psychopathology. Copyright © 2014 John Wiley & Sons, Ltd and Eating Disorders Association.

Keywords
binge eating disorder; obesity; temperament; latent profile analysis

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Introduction

Obesity (body mass index, BMI $\geq 30\,kg/m^2$) is recognised as a major public health concern, which is associated with higher risks for chronic somatic (Kopelman, 2000) and mental comorbidity (e.g. Mühlhans, Horbach, & de Zwaan, 2009; Ul-Haq, Mackay, Fenwick, & Pell, 2013). Binge eating disorder (BED) is known to be prevalent in individuals with obesity (de Zwaan, 2001), affecting up to 30% in weight loss treatment samples (e.g. Jones-Corneille et al., 2012). Previous research has shown that individuals with obesity and comorbid BED suffer from more eating disorder symptoms and higher levels of general psychopathology, including depression (e.g. Mühlhans et al., 2009; Nazar et al., 2014; Villarejo et al., 2014). Moreover, obese individuals with BED exhibit more food-related impulsivity (e.g. Schag, Schönleber, Teufel, Zipfel, & Giel, 2013) as well as food-unrelated impulsivity (Müller et al., 2014) than those without BED. Previous research indicated increased prevalence rates of impulse control disorders in obese patients with BED (Schmidt, Körber, de Zwaan, & Müller, 2012) and an association between binge eating and attention deficit hyperactivity disorder (ADHD; Nazar et al., 2014). Some authors view BED even as a specific phenotype of obesity (Dalton, Blundell, & Finlayson, 2013; Schag, Schönleber, et al., 2013; Schag, Teufel, et al., 2013).

Different phenotypes of obesity could be explained by different temperament features (Claes, Vandereycken, Vandeputte, & Braet, 2013; Jansen, Havermans, Nederkoorn, & Roefs, 2008; Jokela et al., 2013). Temperament refers to individual differences in behaviour tendencies that are biologically based. According to Gray's biopsychological theory of personality (Gray, 1987), reactive temperament represents bottom-up regulation and has been conceptualised by the following neurobiological systems: the Behavioral Inhibition System (BIS) and the Behavioral Activation System (BAS). As the BIS is believed to regulate aversive motives, the BAS is proposed to regulate appetitive motives. The BIS inhibits ongoing behaviour that may result in negative, punishing or non-rewarding consequences and has been linked to anxiety and depression (Carver & White, 1994). The BAS is sensitive to rewarding consequences of behaviour, promotes approach tendencies and is proposed to underlie impulsive behaviours (Bijttebier, Beck, Claes, & Vandereycken, 2009). Effortful control is recognised as the regulative aspect of temperament, which is responsible for the top-down regulation of avoidance (BIS) and approach (BAS) tendencies (Rothbart, Ahadi, & Evans, 2000). According to the psychobiological model of temperament of Rothbart, Derryberry, and Posner (1994), effortful control refers to individual differences in the ability to voluntarily focus or shift attention, to plan, to detect errors and to activate or inhibit impulses to act. It is, therefore, related to executive functioning (Bridgett, Oddi,

Laake, Murdock, & Bachmann, 2013) and may be linked to conscientiousness and less to psychopathology (Rothbart, Ellis, Rosario Rueda, & Posner, 2004).

Different phenotypes of obesity may have a different predictive value for psychiatric comorbidity. The identification of obesity subtypes with an increased risk for eating disorders and general psychopathology may help to predict treatment response, to optimise treatment strategies and/or to prevent further weight gain or weight regain after initial weight loss (Dalton et al., 2013).

To date, research concerning personality subtypes in obesity is scarce. Recently, Leombruni et al. (2014) investigated personality traits as measured with the Temperament and Character Inventory (Cloninger, Przybeck, Svrakic, & Wetzel, 1994) in 462 individuals with obesity and BED or with subthreshold BED who were seeking treatment for an eating disorder. They conducted a two-step cluster analysis followed by bootstrapping validation and found two clusters. The first cluster was characterised by higher *harm avoidance* and lower *self directedness* and exhibited more eating disorder symptoms, higher depression scores and lower quality of life. The study was limited by a sample of patients who were seeking treatment for an eating disorder and by the assessment of eating disorder and depressive symptoms. In another study, Claes et al. (2013) identified two clusters based on the Big Five personality traits in a sample of 102 morbidly obese female bariatric surgery candidates performing a k-means analysis. They determined a 'resilient/high functioning' subtype and a 'dysregulated/undercontrolled' subtype. As the first cluster showed a rather normal personality profile, the latter was characterised by high *neuroticism*, low *extraversion/agreeableness* and lower *conscientiousness*. Patients belonging to the 'dysregulated/undercontrolled' cluster exhibited more eating disorder symptoms (e.g. binge eating and emotional eating), more anxiety and depressive symptoms and more avoidance and depressive coping responses than those in the 'resilient/high functioning' cluster. This study, however, was limited by the inclusion of only women who were seeking surgical treatment for obesity and by the single use of self-report measures to validate the two subtypes. It is noteworthy that studies applying the Big Five model in eating disordered patients had found three instead of two personality clusters (Claes et al., 2006; Thompson-Brenner & Westen, 2005), in particular a 'resilient/high functioning' cluster, a 'dysregulated/undercontrolled' cluster and an additional 'constricted/overcontrolled' cluster that was characterised by high *neuroticism*, *high conscientiousness* and low *openness to experience* scores. The latter cluster could not be replicated in obese individuals seeking surgical treatment for obesity (Claes et al., 2013).

Bariatric surgery is recommended for individuals with obesity grade 3 (BMI $\geq 40\,kg/m^2$), or for those with obesity grade 2 (BMI: 35–39.9 kg/m^2) who suffer from chronic comorbid somatic disorders (e.g. diabetes, hypertension, cardiovascular disease, sleep apnea and dyslipidemia; Mechanick et al., 2009). Past research demonstrated an increased psychiatric comorbidity in prebariatric samples, in particular high depression rates, BED and other impulsive behaviours (Jones-Corneille et al., 2012; Müller, Mitchell, Sondag, & de Zwaan, 2013).

The present study aimed to expand previous findings by investigating obesity subtypes based on reactive and regulative temperament features in a sample of obese women and men including both bariatric surgery candidates and obese individuals who were not considering bariatric surgery. We decided to use a less traditional clustering methodology than Claes et al. (2013) and applied a latent profile analysis (Lazarsfeld & Henry, 1968). The clusters were validated by using different variables. First of all, eating disorder symptoms including BED, which is known to be common in obesity, were assessed. A depression measure was utilised given that depressive symptoms are prevalent in obesity. As impulsivity seems to be linked to both BED and obesity, several impulsivity measures were used to tap different facets of impulsivity (Sharma, Markon, & Clark, 2014). Moreover, behavioural tasks were administered to assess executive functioning that is related to effortful control.

Given previous research in obese individuals (Claes et al., 2013; Leombruni et al., 2014), our hypotheses were twofold. First, we expected to find two different temperament clusters, in particular a rather 'resilient' cluster and an 'emotionally dysregulated' cluster. Second, we hypothesised that the clusters will be characterised by different levels of eating disorder symptoms, depression, impulsivity (i.e. ADHD and impulse control disorders) and executive functioning with more maladaptive symptoms in the 'emotionally dysregulated' group.

Method

Participants

Data for the present study were obtained at three clinical centres in Germany between April 2011 and May 2012 (Kiunke et al., 2013). Inclusion criteria were BMI $> 30\,kg/m^2$, age ≥ 18 years and sufficient German language skills. Exclusion criteria were neurological disorders, psychosis, dementia, current substance abuse, developmental or learning disorders, sensory impairments and intellectual disability.

The total sample consisted of 156 obese individuals (72% women) with a mean age of 39.91 years (SD = 11.42, Range 18–65). Most participants ($n = 123$, 79%) suffered from obesity grade 3, 26 patients (17%) from obesity grade 2 (BMI: 35–39.9 kg/m^2) and 7 individuals (4%) had obesity grade 1 (BMI: 30–34.9 kg/m^2).

Ninety-three patients (59.6%) considered bariatric surgery and were seen for a routine preoperative psychosomatic evaluation at the University Hospital Erlangen ($n = 64$) or the Hannover Medical School ($n = 29$). The remaining 63 participants (40.4%) were obese inpatients from a psychosomatic unit (Schoen Clinic Bad Bramstedt). Written informed consent was obtained from all participants according to procedures approved by the Institutional Ethics Committees of the three study sites.

Assessment

All patients were interviewed face-to-face, filled-out self-ratings and completed computerised cognitive tests. The assessments were conducted by three trained assessors (two psychologists and one psychiatrist) who were experienced in working with somatically ill as well as with psychiatric patients. During the whole study period, they were under continuous supervision by the first author.

Interviews

The BED module of the Eating Disorder Examination (EDE; Hilbert & Tuschen-Caffier, 2006a) was used to diagnose BED

according to the research criteria in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; APA, 2000). BED was defined as having objective binge eating episodes on at least 2 days per week during the past 6 months.

Impulse control disorders (ICDs) were diagnosed by the German translation of the ICD-module of the research version of the Structured Clinical Interview for DSM-IV (SCID-ICD; First, Spitzer, Gibbon, & Williams, 2002). The interview includes sections for intermittent explosive disorder, pyromania, kleptomania, pathological gambling, trichotillomania, dermatillomania, compulsive buying, nonparaphilic compulsive sexual behaviour and pathological internet use. In addition, nine questions concerning exercise dependence were asked (e.g. 'Do you spend most of your free time exercising?' 'Have you ever exercised despite physical problems?' 'Have you exercised to relieve uncomfortable feelings such as feeling helpless, guilty, anxious, irritable, tense, or depressed?').

The assessors were trained in a standardised way beginning with observations of life interviews followed by a series of interviews, which were reviewed by the first author. During the whole study period, all assessors were under continuous supervision by the first and the last author.

Questionnaires

Temperamental reactivity was assessed by means of the BIS and BAS scale (Strobel, Beauducel, Debener, & Brocke, 2001). The BIS subscale (seven items, Cronbach's α in the present sample 0.81) measures the dispositional sensitivity to punishment, whereas the BAS subscale (13 items, $\alpha = 0.76$) assesses the dispositional approach tendency towards potentially rewarding outcomes. The BAS scale consists of the three subscales 'drive', 'fun seeking' and 'reward responsiveness'. Only the total (13 items) BAS scale and not these three subscales has been used in the analysis because the three subscales have a very low to low reliability (e.g. subscale 'fun seeking' $\alpha = 0.37$).

Regulative temperament was measured by means of the 19-item Effortful Control scale of the Adult Temperament Questionnaire-Short Form (ATQ-EC; $\alpha = 0.74$; Wiltink, Vogelsang, & Beutel, 2006); this ATQ-EC scale consists of the three subscales 'activation control', 'attentional control' and 'inhibitory control'. We utilised the ATQ-EC total score for analysis given the not acceptable reliability of the subscales (e.g. subscale 'inhibitory control' $\alpha = 0.33$).

Disturbed attitudes and behaviours related to eating, body shape and weight were assessed by means of the Eating Disorder Examination-Questionnaire (EDE-Q; Hilbert & Tuschen-Caffier, 2006b). The EDE-Q consists of the four subscales: 'restraint' (five items, $\alpha = 0.70$), 'eating concern' (five items, $\alpha = 0.77$), 'shape concern' (eight items, $\alpha = 0.78$) and 'weight concern' (five items, $\alpha = 0.69$).

Depression was assessed using the total score of the 9-item Patient Health Questionnaire depression scale (PHQ-9; Löwe, Spitzer, Zipfel, & Herzog, 2002). The PHQ-9 scored each of the nine DSM-IV criteria for depression ($\alpha = 0.88$).

Participants rated their ADHD symptoms in childhood retrospectively, using the short version of the Wender Utah Rating Scale (WURS-k; Rösler, Retz-Junginger, Retz, & Stieglitz, 2008), which includes 25 items ($\alpha = 0.78$). In accordance to Rösler et al. (2004), a score larger than the cut-off score of 30 indicates a diagnosis of childhood ADHD.

Adult ADHD symptoms were assessed with the 22-item ADHD Self-Rating scale (ADHD-SR; Rösler et al., 2004), which includes the DSM-IV items of inattention, hyperactivity and impulsivity ($\alpha = 0.90$). Rösler et al. (2004) recommend using a cut-off of ≥15 to classify individuals with adult ADHD. In the present study, only participants who fulfilled both the WURS-k and the ADHD-SR criteria were diagnosed as probable cases of adult ADHD.

Adult ADHD symptoms were also assessed by using the 42-item Connors Adult ADHD Rating Scale (CAARS; Christiansen et al., 2012) with the four factors 'inattention/memory problems' (12 items, $\alpha = 0.83$), 'hyperactivity/restlessness' (12 items, $\alpha = 0.79$), 'impulsivity/emotional lability' (12 items, $\alpha = 0.86$) and 'problems with self-concept' (6 items, $\alpha = 0.85$).

Neuropsychological tasks

Three tasks were used to assess executive functioning, particularly decision-making, selective attention, response inhibition, planning and error utilisation.

An adapted computerised version of the Iowa Gambling task (IGT; Bechara, Damasio, Damasio, & Lee, 1999) was used to measure decision-making under uncertainty. Participants were asked to choose among four card desks (A, B, C and D) over a task of 100 trials. They were allocated with an amount of money and were instructed to win as much money as possible until they are told to stop. Some card decks (A and B) yielded high monetary gains or losses and an overall loss over the course of the task. Therefore, they were considered as 'disadvantageous' decks. Sustained choosing of decks C and D was more 'advantageous' as they yielded lower monetary gains or lower losses. Performance on the IGT was measured by net scores that were computed as the total number of cards chosen from the advantageous decks minus the number of cards chosen from the disadvantageous decks ($[C + D] - [A + B]$), with lower net scores indicating poorer performance.

Selective attention and response inhibition were assessed with a computerised adaptation of the Stroop Color Word Test (Golden, 1978). In this study, the answers were given not verbally but by pressing the corresponding button on the touch screen. In the interference condition, the participants had quickly to identify the colour of the ink in which the words were printed and to inhibit the word reading response. The number of correctly named colours was used as dependent variable.

The Labyrinth Test assesses spatial memory, planning and error utilisation. In this computerised adaptation of the Austin Maze (Bowden & Smith, 1994), participants had to find a hidden path through a spatial maze. The total number of errors during this task was used as dependent variable.

Data analysis

To find groups of participants that have different temperament profiles, a latent profile analysis (LPA; Lazarsfeld & Henry, 1968) was performed using the centred (across participants) total scores of the BIS and BAS subscales and the ATQ-EC scale. To determine the number of groups that are present in the data, LPA with two to four clusters were performed, and the appropriate number of clusters was identified by inspecting the Bayesian Information Criterion (BIC). In addition, the Akaike Information Criterion

(AIC), adjusted BIC and entropy-values were reported. Assignment of cluster membership was based on Bayesian probabilities.

After the number of clusters being determined, each participant was assigned to a cluster using the subject-specific (Bayesian) probabilities of belonging to a certain class (i.e. each participant was assigned to the cluster for which his or her probability was the largest). Next, univariate and multivariate analyses of variance (ANOVA) and χ^2-tests were used to compare the clusters with regard to sociodemographic characteristics, BMI and psychological variables. The significance level was set at $\alpha = 0.05$. The LPA was performed using Mplus version 7.11 (Muthen & Muthen, Los Angeles, California, USA) and the ANOVAs using IBM SPSS Statistics version 21 (IBM Corp., Chicago, Illinois, USA).

Results

Latent profile analysis of the dimensional assessment of regulative and reactive temperament

Table 1 summarises the fit indices for the two to four cluster solutions. According to the BIC, a model with two clusters should be preferred. However, the AIC, the adjusted BIC and the entropy value rather preferred a model with four clusters. As the differences in AIC and adjusted BIC values between the two and four cluster models were small, the choice for a two-cluster model was preferred as a two-cluster solution is much more parsimonious than a four cluster solution. The model with three clusters was preferred by none of the AIC-like measures. Moreover, simulation studies in the context of a mixture of factor analysers, which is based on the same principles as LPA, showed that AIC has a tendency to select a too complex model (i.e. too many clusters), whereas BIC does not suffer from his tendency (Bulteel, Wilderjans, Tuerlinckx, & Ceulemans, 2013).

When examining the scale means, it appeared that both clusters showed significantly different means on the BIS, the BAS and the ATQ-EC (Figure 1). In particular, Cluster 1, which contained 88 subjects, was characterised by higher ATQ-EC ($M_1 = 4.63$, $SD_1 = 0.65$ and $M_2 = 3.78$, $SD_2 = 0.58$; $F(1, 154) = 70.67$; $p < 0.0001$), lower BIS ($M_1 = 2.64$, $SD_1 = 0.30$ and $M_2 = 3.20$, $SD_2 = 0.18$; $F(1, 154) = 182.70$; $p < 0.0001$) and BAS ($M_1 = 2.86$, $SD_1 = 0.35$ and $M_2 = 3.06$, $SD_2 = 0.40$; $F(1, 154) = 11.17$; $p < 0.001$) scores than cluster 2, which contained 68 participants (Table 1), with the difference being larger for the ATQ-EC and BIS scale and smaller for the BAS scale. Cluster 1 was labelled as 'resilient/high functioning', and cluster 2 as 'emotionally dysregulated/undercontrolled'.

Table 1 Fit indices for the different cluster solutions based on the latent profile analysis

	2 clusters	3 clusters	4 clusters
Cluster distribution (*N*)	88–68	5–85-66	38–20–73–25
Fit indices			
AIC	618.606	623.982	612.819*
BIC	658.254*	684.979	695.165
Adjusted BIC	617.105	621.673	609.702*
Entropy	.594	.729	.736*

AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.
*Preferred model

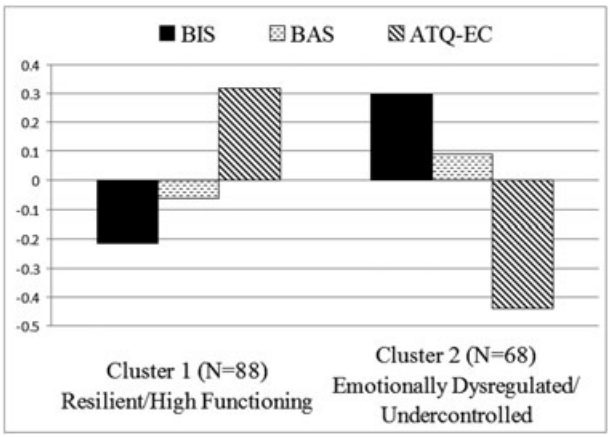

Figure 1 Two personality subtypes characterised by their centred ATQ-Effortful Control subscale (ATQ-EC) and Behavioral Inhibition Scale/Behavioral Activation Scale (BIS/BAS) patterns for clusters 1 and 2

Descriptive characteristics of the two clusters

Table 2 presents the sociodemographic characteristics and BMIs for the two groups. The clusters did not differ with regard to age, gender distribution, education and BMI. The only difference pertains to marital status with the 'resilient/high functioning' cluster containing more singles and widowed persons but less married and divorced participants than the 'emotionally dysregulated/undercontrolled' cluster.

Table 2 Sociodemographic characteristics and BMI for cluster 1 and cluster 2

	Cluster 1 'resilient/high functioning' $N = 88$	Cluster 2 'emotionally dysregulated/ undercontrolled' $N = 68$	
	Mean (*SD*)	Mean (*SD*)	$F(1, 154)$
Age (years)	39.17 (12.18)	40.85 (10.40)	0.83
BMI	47.00 (8.00)	47.39 (9.09)	0.08
	N (%)	*N* (%)	χ^2
Obesity grade			
Grade I	3 (3.4)	4 (5.9)	0.55
Grade II	15 (17.0)	11 (16.2)	
Grade III	70 (79.5)	53 (77.9)	
Gender			
Female	59 (67.0)	54 (79.4)	2.94
Male	29 (33.0)	14 (20.6)	
School years			
≤9	26 (29.5)	27 (39.7)	1.97
10–11	42 (47.7)	26 (38.2)	
≥12	20 (22.7)	15 (22.1)	
Marital status			
Single	43 (48.9)	25 (36.8)	8.60*
Married	32 (36.4)	30 (44.1)	
Divorced	8 (9.1)	13 (19.1)	
Widowed	5 (5.7)	0 (0)	

*$p < 0.05$.

Comparison of the LPA clusters on eating disorder symptoms and depressive symptoms

On the basis of clinical interviews, BED was more prevalent in the 'emotionally dysregulated/undercontrolled' cluster than in the 'resilient/high functioning' cluster (55.9% vs 27.3%, $\chi^2_{(1)} = 13.11$, $p < 0.001$). There were also significant differences in terms of eating disorder psychopathology as measured with the EDE-Q subscales (Wilks' Lamda = 0.87, $F(4, 139) = 5.11$, $p < 0.001$). As can be seen in Table 3, the 'emotionally dysregulated/undercontrolled' cluster scored significantly higher on the *eating concern*, *shape concern* and *weight concern* subscales but not on the *restraint* subscale.

With respect to depression, the 'emotionally dysregulated/undercontrolled' cluster reported higher PHQ-9 scores than the 'resilient/high functioning' cluster ($M_{DYS} = 11.50$, $SD_{DYS} = 5.84$ and $M_{RES} = 8.46$, $SD_{RES} = 5.85$; $F(1, 128) = 8.62$; $p = 0.004$).

Comparison of the LPA clusters on impulsive behaviours (ICDs and ADHD)

In the total sample, 13 patients (8.3%) suffered from any current ICD, most commonly from dermatillomania (2.6%) and compulsive buying (2.6%). Twenty-nine patients (18.6%) fulfilled the diagnostic criteria for any lifetime ICD, again, most frequently lifetime dermatillomania (5.1%) and compulsive buying (4.5%). The comparison of the 'resilient/high functioning' and the 'emotionally dysregulated/undercontrolled' clusters did not reveal differences in the prevalence of any current ICD (8.0% vs 8.8%, $\chi^2_{(1)} = 0.04$, $p = 0.85$) or any lifetime ICD (15.9% vs 22.1%, $\chi^2_{(1)} = 0.96$, $p = 0.33$).

Table 4 summarises the results concerning childhood and adult ADHD symptoms. Patients in the 'emotionally dysregulated/undercontrolled' cluster reported on average significantly more childhood and adult ADHD symptoms than those in the 'resilient/high functioning' cluster. On the basis of the WURS-k cut-off, 10.1% of the 'resilient/high functioning' cluster and 23.3% of the 'emotionally dysregulated/undercontrolled' cluster reported about childhood ADHD ($\chi^2_{(1)} = 4.46$, $p = 0.035$). With regard to adult ADHD, 6% of the 'resilient/high functioning' cluster and 23% of the 'emotionally dysregulated/undercontrolled' cluster scored above the WURS-k as well as above the ADHD-SR cut-offs and were categorised as probable cases of adult ADHD ($\chi^2_{(1)} = 8.35$, $p = 0.004$). Both groups differed significantly on the CAARS total score and on the *inattention/memory*, *impulsivity* and *negative self-concept* CAARS subscales (Table 4).

Comparison of the LPA clusters on executive functions

Taken together, the results of neurocognitive testing indicate a lack of cluster differences in the IGT and the Stroop test but

Table 3 Eating disorder symptoms in cluster 1 and cluster 2

	Cluster 1 'resilient/high functioning' $N = 81$*	Cluster 2 'emotionally dysregulated/undercontrolled' $N = 60$*	ANOVA		
	Mean (*SD*)	Mean (*SD*)	$F(1, 139)$	*p*-value	η^2
EDE-Q total	2.68 (1.02)	3.32 (0.87)	15.35	<0.001	0.10
Restraint eating	1.89 (1.37)	2.29 (1.34)	3.11	0.080	0.02
Eating concern	1.48 (1.35)	2.42 (1.38)	16.49	<0.001	0.11
Weight concern	3.46 (1.22)	4.01 (1.05)	7.81	0.006	0.05
Shape concern	3.89 (1.29)	4.55 (0.99)	10.78	0.001	0.07

EDE-Q = Eating Disorder Questionnaire;
*For 15 participants, no EDE-Q score was available.

Table 4 ADHD symptoms in cluster 1 and cluster 2

	Cluster 1 'resilient/high functioning' $N = 79$*	Cluster 2 'emotionally dysregulated/undercontrolled' $N = 60$*	ANOVA		
	Mean (*SD*)	Mean (*SD*)	$F(1,137)$	*p*-value	η^2
Childhood ADHD symptoms					
WURS-k total score	14.44 (12.27)	20.87 (12.35)	9.29	0.003	.06
Adult ADHD symptoms					
ADHD-SR	11.23 (7.36)	17.83 (9.91)	20.33	<0.0001	.13
CAARS total score	0.80 (0.36)	1.11 (0.41)	22.71	<0.0001	.14
CAARS-Inattention/Memory	0.73 (0.40)	1.11 (0.54)	21.70	<0.0001	.14
CAARS-Hyperactivity	0.62 (0.41)	0.75 (0.41)	3.51	0.063	.02
CAARS-Impulsivity	0.81 (0.49)	1.11 (0.51)	12.83	<0.0001	.09
CAARS-Negative Self-concept	1.25 (0.76)	1.83 (0.71)	20.60	<0.0001	.13

ADHD = attention deficit hyperactivity disorder; WURS-k = Wender Utah Rating Scale, short version; ADHD-SR = ADHD Self-Rating Scale; CAARS = Connors Adult ADHD Rating Scale.
*For 17 participants, no ADHD score was available.

suggest a better performance in the Labyrinth Test for the 'resilient/high functioning' cluster than for the 'emotionally dysregulated/undercontrolled' cluster. In particular, the difference between the clusters in mean IGT netscores was not significant ($M_{RES} = -5.53$, $SD_{RES} = 14.31$ and $M_{DYS} = -6.65$, $SD_{DYS} = 14.32$; $F(1, 150) = 0.15$; $p = 0.70$). Also, the number of correctly named colours in the interference condition of the Stroop test did not differ ($M_{RES} = 19.72$, $SD_{RES} = 0.68$ and $M_{DYS} = 19.66$, $SD_{DYS} = 1.19$; $F(1, 150) = 0.13$; $p = 0.72$). The total number of errors during the Labyrinth test, however, was larger in the 'emotionally dysregulated/undercontrolled' cluster ($M_{RES} = 38.80$, $SD_{RES} = 25.94$ and $M_{DYS} = 52.05$, $SD_{DYS} = 39.53$; $F(1, 150) = 6.14$; $p = 0.014$).

Considering that eating pathology could have been responsible for some of the differences between clusters, we repeated all analyses with BED as a covariate. The only difference between clusters that lost significance after including BED was depression as measured with the PHQ-9.

Discussion

The results of the LPA based on ATQ-EC and BIS/BAS scores indicated two separate temperament subtypes. The first cluster was characterised by high effortful control scores and low avoidance and approach tendencies, whereas the second cluster showed low effortful control and higher avoidance and approach tendencies. This two-cluster solution is in line with our first hypothesis and with previous research that also found two personality subtypes in obese samples (Claes et al., 2013; Leombruni et al., 2014). In accordance with the study of Claes et al. (2013), cluster 1 can be labelled as 'resilient/high functioning', and cluster 2 as 'emotionally dysregulated/undercontrolled'.

The comparison of the two clusters in terms of disordered eating, depressive symptoms and impulsive behaviours confirmed our second hypothesis. The 'emotionally dysregulated/undercontrolled' group exhibited more psychopathology, particularly more eating disorder symptoms, a higher prevalence of BED, a higher rate of probable cases of adult ADHD and more severe depression scores than the 'resilient/high functioning' group.

We had also assumed that the 'emotionally dysregulated/undercontrolled' subtype would show a higher occurrence of ICDs. Surprisingly, the two clusters did not differ with regard to the frequency of current or lifetime ICDs. Although the prevalence rates of lifetime ICDs suggest a trend towards more ICDs in the 'emotionally dysregulated/undercontrolled' cluster, this difference did not become statistically significant. It is noteworthy that the prevalence of ICDs in the studied sample was surprisingly low compared with an earlier study. Schmidt et al. (2012) reported a lifetime prevalence rate of any ICD in bariatric surgery candidates ($n = 100$) of 27%, whereas only 19% of the present sample was diagnosed with a lifetime ICD. As both studies used the same methodology (i.e. SCID-ICD interview), the difference might be explained by different sample characteristics. The study of Schmidt et al. (2012) was conducted on bariatric surgery candidates from one study centre. For the present study, prebariatric outpatients as well as inpatients who did not seek surgery were enrolled at three different sites.

With respect to executive functioning, we had expected poorer performance in neurocognitive tasks in the 'emotionally dysregulated' group. The results indicate that the Labyrinth test was the only task that differentiated the 'resilient/high functioning' group from the 'emotionally dysregulated/undercontrolled' group. The lack of group differences in the IGT can be explained by the high standard deviations in both groups (Dunn, Dalgleish, & Lawrence, 2006). The missing difference in the Stroop test, however, remains unclear. This task is proposed to measure the ability to suppress unwanted, automatic responses such as reading a word and should be correlated with effortful control. On the other hand, the result is in line with previous research that found only low correlations between self-reported ratings and behavioural measures of self-control (Claes, Mitchell, & Vandereycken, 2012; Robinson & Clore, 2002).

Several limitations of this study should be considered. First of all, the present sample of obese patients may not be very characteristic of obese patients in general. Another shortcoming pertains to the lack of information with regard to the number of potential participants that declined to participate. Therefore, the applicability of our findings is restricted to the present sample of obese treatment seeking patients who were either bariatric surgery candidates or inpatients. Future studies should investigate non-treatment seeking individuals covering the whole range of obesity from grades 1 to 3. Also, the assessment of additional psychological variables to validate temperament subtypes would be of interest including for instance food craving, emotion regulation, perception of teasing, substance abuse and suicidality.

Taken together, our findings support the assumptions regarding the heterogeneity of obesity (Dalton et al., 2013; Schag, Schönleber et al., 2013) and the association between temperament subtypes and psychopathology. The present findings suggest that obese individuals belonging to the 'emotionally dysregulated/undercontrolled' temperament subtype are more likely to develop impulsive behaviours such as a BED or ADHD and to suffer from depressive symptoms. Future research should address the possible predictive value of the two temperament clusters with respect to obesity risk, obesity persistence and treatment response. Some patients who underwent bariatric surgery show non-normative eating behaviour or subsequently develop or increase maladaptive excessive behaviours (e.g. alcohol use and exercise dependence) other than overeating or loss-of-control eating (Müller et al., 2013). Longitudinal studies of patients who lose substantial weight through conservative weight loss programmes or bariatric surgery may be helpful to understand the mechanisms underlying the association between temperament features and poor treatment outcome or unwanted post surgery side effects.

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