

**Not all personal definitions of healthy eating are linked to orthorexic behaviors among French college women. A cluster analysis study.**

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### Abstract

**Purpose:** This study represents a first attempt to explore the typology of French female young adults based on personal definitions of healthy eating and to examine inter-group differences regarding their tendencies towards Orthorexia Nervosa (ON), eating disorder (ED) and obsessive-compulsive (OC) behaviors. **Method:** 362 female adults ( $M_{age} = 23.43$ ,  $SD = 3.82$ ) completed a 40-item questionnaire assessing personal definitions of healthy eating, the Eating Habits Questionnaire, the Eating-Disorders Inventory-3 and the Obsessive-Compulsive Inventory-Revised. **Results:** Exploratory factor analysis yielded 6 factors for healthy eating definitions: "Health benefits", "Politico-ecological", "Restriction", "Pleasure", "Socio-cultural" and "Dietary avoidance". Cluster analysis based on these factors identified 3 distinct groups: "Self & Environment aware" (SEA), "Restrictive-Avoidant" (RA) and "Sociable-Pleasure seeking" (SP). The SEA cluster emphasized the "Health benefits", "Politico-ecological" and "Dietary avoidance" factors while defining healthy eating. The RA cluster highlighted the "Restriction" and "Dietary avoidance" factors while the SP cluster mainly emphasized the "Pleasure" and "Socio-cultural" factors. Compared to all other clusters, the SEA cluster displayed greater scores in ON behaviors. The RA cluster displayed greater scores in ED behaviors compared to SP cluster. No significant difference was found between clusters regarding OC behaviors. **Conclusion:** Findings from this study suggest that ON behaviors can vary depending on personal definitions of healthy eating. They further indicate that the definitions of healthy eating related to ON behaviors are largely different from those related to ED and OC behaviors. This study offers considerable support for the possibility of ON being a distinct condition from ED and OC behaviors.

**Keywords:** Healthy eating, Orthorexic behaviors, Eating disorders, Obsessive-compulsive disorder

## 1. Introduction

Orthorexia Nervosa (ON) is a potentially pathological eating behavior characterized by an excessive preoccupation with healthy eating leading to strict dietary rules and restrictions (Bratman, 1997; Dunn & Bratman, 2016). More precisely, individuals with ON behavior are preoccupied with potential health-promoting benefits of foods, to avoid certain foods considered as unhealthy (e.g., containing saturated fat, preservatives and food-additives) in order to improve health (Valente et al., 2019) and/or in fear of developing an illness (Barthels et al., 2015; Moroze et al., 2015; Dunn & Bratman, 2016). They also spend considerable amounts of time reading about and/or preparing specific types of foods (Moroze et al., 2015). Over time, this eating pattern may lead to self-punishments (e.g., when personal rules are violated), avoidance of entire categories of food (Valente et al., 2019) and result in social isolation, impaired quality of life (Koven & Abry, 2015), malnutrition (Moroze et al., 2015) or medical complications (Park et al., 2011).

Nevertheless, existing data on the prevalence of ON (ranged between less than 1% to 57.6%) (Dunn et al., 2017; Ramacciotti et al., 2011) and its possible risk factors such as age (Fidan et al., 2010; Herranz Valera et al., 2014), sex (Herranz Valera et al., 2014; Ramacciotti et al., 2011), educational level (Aksoydan & Camci, 2009; Ramacciotti et al., 2011) and body mass index (BMI) (Fidan et al., 2010; Oberle et al., 2017) remain controversial.

Moreover, although the connection with the concept of “healthy eating” appears to be an important characteristic of ON behavior (Bratman, 2017; Dunn & Bratman, 2016), this concept is thought to be interpreted in different ways depending on one’s environment, personal, social and cultural experiences (Bisogni et al., 2012). Previous research (Bisogni et al., 2012; James, 2004; Ristovski-Slijepcevic et al., 2008) suggested that people explained healthy eating in terms of nutrients food components (e.g., gluten, additives), food production methods (e.g., natural, organic) as well as psychological well-being, physical (e.g., weight management) and social outcomes (e.g., connecting with family and friends). Another study conducted with French Canadian population, suggested that, in individuals’ perceptions, the concept of healthy eating and of eating pleasure were highly compatible (Landry et al., 2018). Other studies suggested that healthy eating was associated with spiritual well-being and religion (Rawlins et al., 2013; Rowe, 2010) as well as moral and ethical values (e.g., consuming products obtained through methods that are respectful of animal rights) (Ristovski-Slijepcevic et al., 2008). Accordingly, a study conducted in four different European countries (Van Loo et al., 2017) suggested that the concepts of “healthy eating”, “a plant-based diet” and “a sustainable diet” (i.e., environmental sustainability) were perceived

very similarly by individuals. Yet, to our knowledge, no study to date has investigated what healthy eating meant for individuals with orthorexic behaviors. Thus, the possibility of ON being a condition that can vary depending on personal definitions of healthy eating remains unexplored.

Moreover, previously mentioned divergent findings regarding socio-demographic correlates of ON behavior, which may be explained by characteristics of selected populations and the use of different measurement tools, further complicate the conceptualization and classification of ON among other mental disorders (Barthels et al., 2015). In fact, ON has been proposed as a type of eating disorder (ED) diagnosis, given its similarities with other ED diagnoses, such as as over-concern about food, negative body image attitudes (Barnes & Caltabiano, 2017; Cena et al., 2019), drive for thinness and body dissatisfaction (Barthels et al., 2020). Yet, several reasons were advanced to consider ON as a distinct condition from currently classified EDs, such as lack of significant correlations between ON and body dissatisfaction (Segura-Garcia et al., 2012) or weight loss attempts (Mcinerney-Ernst, 2012). Several authors (Dunn & Bratman, 2016; Brytek-Matera et al., 2017) also highlighted important differences between ON and ED behaviors: individuals with ON are focused on food quality and its impact on general health, whereas EDs are known to be characterized by a focus on food quantity, preoccupations with weight and body shape.

In addition to similarity between EDs and ON, there is evidence that ON also shares features with obsessive-compulsive disorder (OCD), such as ruminations about food quality, the concerns over contamination and the rituals around food preparation (Mathieu, 2005). However, the OCD symptoms that individuals with orthorexic behaviors are assumed to have, are related to healthy eating and food, while OCD is known to be characterized by a large range of symptoms (Cena et al., 2019). And there is little and contradictory empirical evidence for this presumed connection between ON and OCD (Barthels et al., 2015). Moreover, a recent typological study (Yakın et al., 2020) demonstrated the naturally occurring distinct groups of individuals with ON, ED and OCD behaviors, respectively. In this study no significant relationship was found between ON and OCD behaviors. Additionally, the group of individuals with ON was found to have positive body image attitudes compared to group with ED behaviors. Together, these findings supported the possibility of ON being a distinct condition from ED and OCD.

These controversial findings on the shared etiology between ON, ED and OCD indicate that the question of whether ON is a variant of these existing disorders or a separate disorder has not been resolved. This further complicates the development and recognition of a

proper diagnostic criteria, assessment instruments and thus our understanding of exact etiology, clinical features, treatment, and prevention of ON behavior which is suggested to have important consequences on one's health (Koven & Abry, 2015; Moroze et al., 2015).

Thus, exploring whether there is a link between different personal definitions of healthy eating and tendencies towards ON, ED and OC behaviors could deepen our understanding of not only very particular characteristic of ON but also its controversial relationship with ED and OCD and thus give an important insight on potential prevention and treatment strategies.

Starting from these considerations, the primary aim of this study was to explore the typology of French college women from a large non-clinical sample based on personal definitions of healthy eating. The second aim was to compare these individuals' tendencies towards ON, ED and OC behaviors as well as some of their key socio-demographic characteristics depending on their personal definitions of healthy eating. We employed the typological approach and cluster analysis as they allow to detect and differentiate subgroups of individuals with similar characteristics (Vogt & Nagel, 1992). Its use thus may be helpful to better capture the behavioral patterns of people who have similar perceptions of healthy eating. Moreover, there is no validated diagnostic criteria for ON which would enable us to study clinical populations with this condition. Yet, studying non-clinical populations allows to investigate the occurrence of several symptoms without complications of an established illness (Sun et al., 2018). Based on previous studies reporting higher orthorexic tendency for young women (Dell'Osso et al., 2018; Parra-Fernandez et al., 2018), a non-clinical population of young adult women was preferred in this study. Following other research on eating behaviors (Corsino et al., 2013), we chose to define young adulthood as ranging between 18 and 35 years old.

## **2. Method**

### *2.1 Participants and procedure*

The data were collected through an online questionnaire that was shared on Facebook, an effective and frequently used recruitment source in psychosocial research (Thornton et al., 2016). We shared the questionnaire in groups specifically dedicated to students from different French universities. This questionnaire also provided information regarding the aims of the study and the anonymity of the collected responses. All participants agreed to give their free and informed consent prior to completing the study.

The eligibility criteria included age between 18 and 35 years (i.e., young adults), female gender and studying in a French university. Individuals who did not give informed

consent and those who were < 18 or > 35 years of age, those who were not studying in a French university and those who did not answer at least 90% of the questions, were excluded from the study. After this step, a small number of missing data (< 5% of total data of the participants for studied variables) were identified and were subsequently replaced with the item mean. Participants were all women ( $N = 362$ ), their mean age was 23.43 ( $SD = 3.82$ ) and their average BMI was 21.67 ( $SD = 3.86$ ). The study followed the World Medical Association Declaration of Helsinki. The study protocol was approved by the local ethics committee (Comité d'Éthique de la Recherche of Toulouse University).

## 2.2 Measures

First, participants completed a set of demographic questions (age, sex, educational level) and then the following questionnaires.

**2.2.1. Definitions of healthy eating.** In order to explore the definitions of healthy eating among French college women, we created a questionnaire containing 40 items thought to be representative of health-oriented diets. As there was no pre-established measure of healthy eating definitions, most of the statements of this questionnaire were inspired from the items of the Food Choice Questionnaire (Stephoe et al., 1995) a measure of motives related to dietary choices (i.e., health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity and ethical concern) and other complementary statements were derived from previous research concerning perceptions of health and healthy eating (i.e., religious beliefs, cultural values and traditions, family's eating habits, political concerns) (Bisogni et al., 2012; Ristovski-Slijepcevic et al., 2008; Van Loo et al., 2017). During this step, the cultural differences and the translation accuracy were carefully taken into account by bilingual authors, as one word or an expression could have different significations in English and in French languages. Participants were asked to define healthy eating (e.g., "For me healthy eating is..."). Items were rated on a 5-point Likert scale, ranging from "1 = strongly disagree" to "5 = strongly agree". This questionnaire was administered in French language and the English versions of the selected items can be found in Table 1.

**2.2.2. Orthorexic behaviors.** The French version of the Eating Habits Questionnaire (EHQ) (Yakin, Raynal & Chabrol, 2020) was used to measure orthorexic behaviors. This 21-item scale has a 3-factor structure with Knowledge, Problems and Feelings subscales. The first subscale includes 5 items on knowledge about healthy eating (e.g., "I prepare food in the most healthful way"), the second includes 12 items on problems associated with healthy eating (e.g., "My diet affects the type of employment I would take"), and the third subscale includes 4 items on positive feelings about healthy eating (e.g., "I feel great when I eat

healthy"). Items are rated on a 4-point scale from 1 = "false, not at all true" to 4 = "very true". The French version of this scale was found to have good internal consistency with subscale Cronbach's alphas ranged between .82 and .89 (Yakın et al., 2020). Overall, the EHQ was found to be a reliable and valid measure of ON symptomatology (Oberle et al., 2017; Gleaves et al., 2013).

*2.2.3. Disordered Eating Behaviors.* Disordered eating behaviors were assessed using the French versions (Turgeon et al., 2015) of the Drive for thinness and the Bulimia subscales of the Eating Disorders Inventory-3rd Edition (EDI-3). The Drive for thinness subscale assesses preoccupation with thinness, dieting and fear of gaining weight (e.g., "I am very afraid of gaining weight"), and the Bulimia subscale evaluates the frequency of disturbed eating behaviors (e.g., "I eat moderately in front of others and stuff myself when they are gone"). Both subscales contain 7 items which are scored on a 6-point Likert scale, recoded as 0, 0, 1, 2, 3 and 4 (Nyman-Carlsson et al., 2015). The Drive for thinness and the Bulimia subscales were found to have satisfactory internal consistency with Cronbach's  $\alpha = .90$  and  $.68$ , respectively (Turgeon et al., 2015).

*2.2.4. Obsessive-compulsive behaviors.* Obsessive-compulsive behaviors were measured using the French version (Zermatten et al., 2006) of the Obsessive-Compulsive Inventory Revised (OCI-R). This scale contains 18 items (e.g., "I check things more often than necessary") scored from 0 = "Not at all" to 4 = "Extremely". A high score is an indicator of elevated obsessive-compulsive behaviors. This scale revealed satisfactory internal consistency with Cronbach's  $\alpha$  coefficients ranging from 0.63 to 0.86 (Zermatten et al., 2006).

*2.2.5 Body mass index.* Participants were requested to provide their height and weight. BMI was calculated as  $\text{kg/m}^2$ .

### *2.3 Statistical analysis*

Statistical analyses were conducted with STATISTICA 10. First, an exploratory factor analysis (EFA) (Maximum likelihood as extraction method) was performed on 40 items assessing definitions of healthy eating. A normalized Varimax rotation was employed as previous research argued that orthogonal factor rotation could be preferred over oblique rotation in exploratory stages of analysis (Kim & Mueller, 1978; Brown, 2009). This analysis identified the number of factors underlying this set of 40 items. The number of retained factors was determined on the basis of the scree test (Cattell, 1966). Cronbach's alpha reliability analyses were conducted to assess the internal consistency of each factor and of

other study variables. Pearson zero-order correlations were performed on the full sample to examine the association between these factors and other study variables.

In the second step, based on the factors from the EFA, a hierarchical cluster analysis was conducted (Ward's method with squared Euclidean distance) on the whole sample. Hierarchical clustering was preferred as it inherently allows to combine cases into clusters that share similar characteristics and differ significantly from other clusters (Bahr et al., 2011; Yim & Ramdeen, 2015). This analysis identified homogeneous groupings of participants based on factor scores converted to z-scores. We used the dendrogram and the agglomeration schedule to identify the number of clusters. In the third step, K-means clustering was used to assign individuals to one of the identified clusters. Cluster group differences regarding ON, ED, OC behaviors as well as age, educational level and BMI were tested using one-way ANOVA for each variable. Tukey post hoc tests were conducted to determine which clusters were statistically different on each scale.

### **3. Results**

#### *3.1. Exploratory factor analysis for the meaning of healthy eating*

The EFA conducted on the initial 40 items resulted in 32 items and a six-factor solution for the definitions of healthy eating: "Health benefits", "Politico-ecological", "Socio-cultural", "Restriction", "Pleasure", "Dietary avoidance". The "Health benefits" factor reflected physical and psychological outcomes of healthy eating (e.g., items covering the improvement of physical and intellectual performance, prevention of physical and mental illness); The "Politico-ecological" factor reflected the environmental outcomes of a diet perceived as healthy (sustainability, ethics, environment, local production, animal rights); The "Socio-cultural" factor reflected social outcomes such as one's religious beliefs, family's eating habits and cultural values. The "Restriction", "Pleasure" and "Dietary avoidance" factors suggested that healthy eating can be indeed defined in terms of dietary restriction, pleasure of food or avoidance of several products (e.g., due to dietary intolerances), respectively. It is important to note that, while the "Restriction" factor reflected eating restraint in order to control the calorie, saturated fat, sugar and salt intake, which is more related to weight and shape control, "Dietary avoidance" reflected avoiding consuming gluten-lactose and animal products, which may be more related to dietary intolerances and ethical choices. We removed eight items with factor loadings and inter-item correlations below .3 (Boateng et al., 2018; Murray et al., 2019) . Factor loadings, eigenvalues and variance accounting for by these six factors can be found in Table 1.

#### *3.2. Descriptive statistics and correlation analysis*



Means, standard deviations and Cronbach's alpha for all variables are reported in Table 2. Correlations between study variables can be found in Table 3.

### 3.3. Cluster analysis

Based both on the dendrogram and on the aggregation schedule, a three-cluster solution was identified. The agglomeration schedule showed a sudden increase in linkage distance when three clusters were merged to two clusters (from 121.79 to 158.18). This indicated that the passage from three to two clusters would have more impact on the heterogeneity of the clusters than previous stages of the analysis. Therefore, the three-cluster solution was the most appropriate (Fig. 1). A discriminant analysis showed clear differences between clusters (Wilks' lambda = .095,  $p < 0.0001$ ) with 95% of cases correctly classified.

The first group ( $n = 178$  [49%]) was characterized with a mean score on "Health benefits", "Politico-ecological" and "Dietary avoidance" factors that was above the sample mean by one standard deviation ( $SD$ ) (shown in Fig. 1; Table 4). Thus, this group was called "Self & Environment-aware" cluster ( $SEA$ ). The second group ( $n = 70$  [19%]) demonstrated mean scores on "Restriction" and "Dietary avoidance" factors that was above the sample mean by one  $SD$  value and mean scores on "Pleasure", "Socio-cultural", "Health benefits" and "Politico-ecological" factors below the sample means by at least half  $SD$  value. This group was thus labeled "Restrictive-Avoidant" cluster ( $RA$ ). A third group ( $n = 114$  [32%]) had mean scores on "Pleasure" and "Socio-cultural" factors above the sample by at least half  $SD$  value, while mean scores for "Health benefits", "Politico-ecological", "Restriction" and "Dietary avoidance" were slightly below the sample means. It was thus termed "Sociable - Pleasure seeking" cluster ( $SP$ ).

### 3.4. Analysis of variance

Using one-way analysis of variance and Tukey's HSD posthoc tests (shown in Table 4), we compared the three clusters based on ON, ED and OC behaviors, age, educational level and BMI. Results revealed that compared to all other clusters, the  $SEA$  cluster displayed greater scores in ON behaviors. The  $RA$  cluster scored higher in ED behaviors compared to  $SP$  cluster. The effect sizes for these differences ranged between  $\eta^2 = .02$  and  $.41$ . No significant difference was found between clusters regarding the presence of OC behaviors, age, educational level or BMI (all  $p > .05$ , all  $\eta^2 < .01$ ).

## 4. Discussion

Previous research conducted on populations with different ethnical backgrounds suggested that people defined healthy eating in terms of physical and psychological outcomes (Bisogni et al., 2002; Vizireanu & Hruschka, 2018), environmental benefits (Ristovski-

Slijepcevic et al., 2008; Van Loo et al., 2017), spiritual well-being (Rawlins et al., 2013; Rowe, 2010), social outcomes (James, 2004), pleasure eating (Landry et al., 2018), dietary restriction (Vizireanu & Hruschka, 2018) and dietary elimination (e.g., due to intolerances) (Bisogni et al., 2012; Ristovski-Slijepcevic et al., 2008). In line with these findings, our exploratory factor analysis revealed six underlying dimensions to the meaning of healthy eating: the "Health benefits", "Politico-ecological", "Socio-cultural", "Pleasure", "Restriction" and "Dietary avoidance".

Moreover, cluster analysis based on these six factors used to identify the typology of French college women, extracted a three-cluster solution: a "Self & Environment-aware", a "Restrictive-Avoidant" and a "Sociable-Pleasure seeking" group. These clusters were similar regarding their age, educational level, BMI and the presence of OC behaviors. However, they displayed significant differences on their tendencies towards ON and ED behaviors.

First, in comparison to other clusters, the *SEA* cluster was characterized by greater interest in "Health benefits", "Politico-ecological" and "Dietary avoidance" factors and displayed in return greater scores in ON behaviors. This suggests that emphasizing these factors (e.g., improving physical/intellectual performance, preventing physical/mental illnesses, respecting the sustainability, the ecosystem and the rights of animals etc.) in personal definitions of healthy eating can be associated with a greater tendency towards ON behaviors.

Second, the *RA* cluster placed greater importance to "Restriction" and "Dietary avoidance" factors and the *SP* cluster was characterized by greater interest in "Pleasure" and "Socio-cultural" factors. Interestingly, the *RA* cluster displayed greater scores in ED behaviors compared to *SP* cluster. This implies that in personal definitions of healthy eating, emphasizing the "Restriction" and "Dietary avoidance" factors rather than "Pleasure" or "Socio-cultural" factors can be associated with a greater tendency towards ED behaviors. This finding is in line with previous research (Gustafsson & Sidenvall, 2002; Saltonstall, 1993) suggesting an overlap in perceptions of healthy eating and restrictive eating among women. These findings are further in accordance with another study (Lindeman & Stark, 2000) which suggested that dieters who did not emphasize the pleasure of eating had greater ED symptomatology compared to those who did.

However, we found no difference between the *SEA* cluster (characterized with greater tendency towards ON as indicated above) and the *RA* cluster regarding the presence of ED behaviors. This implies that, while greater interest in "Health benefits", "Politico-ecological" and "Dietary avoidance" can distinguish between ON and ED behaviors, emphasizing

“Restriction” and “Dietary avoidance” in personal definitions of healthy eating are not sufficient to distinguish these behaviors.

Finally, our clusters did not differ from each other regarding the presence of OC behaviors. This finding was not expected, as OC behaviors are known to be highly comorbid with ED behaviors (Milos et al., 2002) and there is an ongoing debate about the resemblances between OC and ON behaviors (Barthels et al., 2015; Mathieu, 2005). Yet, this finding suggests that, unlike those of ON and ED, OC behaviors do not vary depending on one’s personal definitions of healthy eating. This further suggests an important difference between these behaviors which are thought to be somehow linked to each other.

Together, these results have several implications. First, they suggest that healthy eating has diverse meanings among French college women. Second, they suggest that ON behaviors can vary depending on personal definitions of healthy eating which include not only physical health benefits but also dietary avoidance (e.g., due to intolerances), psychological and politico-ecological outcomes. Third, while OC behaviors were not found to be related to any definitions of healthy eating addressed in this study, our results suggest that definitions related to ON and ED behaviors are largely different from each others.

However, this study has several limitations. First, this study was conducted with a non-clinical sample of French college women who was recruited online. Thus, findings from this study cannot be generalizable beyond French population, to different age groups, to clinical or male populations or to general population. Further, as very little prior research has been conducted in the area under study, the use of an exploratory approach, combining two exploratory analyses, was reasonable. Yet, this exploratory (rather than hypothesis or theory-driven), descriptive and cross-sectional nature of this study limits our ability to explain the causal interactions between findings or whether the identified profiles are stable over time or whether individuals may switch from one group to the other. Future studies should also consider latent class or latent profile analyses as useful alternative techniques to explore, identify and distinguish between subgroups of individuals with similar characteristics. The use of confirmatory approaches and techniques could also be helpful to replicate and confirm the profiles explored in the current study.

Moreover, the use of EDI-3 Bulimia and Drive for Thinness subscales does not fully assess disordered eating behaviors and does not allow the diagnosis of eating disorders. It is also important to note that some authors suggested that the EHQ ignored several aspects of orthorexic behaviors, such as the negative emotionality (fear, shame, guilt, self-punishment) that individuals with orthorexic behaviors could experience when faced with unhealthy food

(Roncero et al., 2017). The Teruel Orthorexia Scale – TOS (Barrada & Roncero, 2018) is a recently proposed bidimensional measure of orthorexia, distinguishing between healthy orthorexia and pathological orthorexia. Using this scale and the FCQ (Stephoe et al., 1995), a recent study (Depa et al., 2019) demonstrated that the motives predicting food choices in pathological and healthy orthorexia were quite different. Perceptions of healthy eating, as it was investigated in the current study, are one of the determinants that can structure food choices (Raine, 2005). So, it would be interesting to use TOS in order to identify potential differences between individuals with healthy orthorexia and those with pathological orthorexia regarding their perceptions of healthy eating.

## **5. Conclusion**

To our knowledge, this is the first study to explore the typology of French college women from a large non-clinical sample based on definitions of healthy eating. This study also represents a first attempt to compare individuals' tendencies towards ON, ED and OC behaviors depending on their personal definitions of healthy eating. Our findings suggest that healthy eating has various meanings among French college women, which resulted in 6 different factors in this study. Our findings further provide evidence for the existence of a distinct group of individuals who emphasized the "Health benefits", "Politico-ecological" and "Dietary avoidance" factors while defining healthy eating and who in return had a greater tendency towards ON behaviors. These factors related to ON behaviors were found to be largely different from those related to ED behaviors. In addition, contrary to ON and ED behaviors, OC behaviors did not appear to be related to any definitions of healthy eating addressed in this study. These findings bring new information about ON behaviors which appear to vary depending on personal definitions of healthy eating. They further offer considerable support for the possibility of ON behaviors being distinct from ED and OC behaviors. In sum, these findings can be useful in clinical settings to identify different healthy eating perceptions and to screen for ON or ED behaviors. Future research should investigate gender, age and culture-related differences in personal definitions of healthy eating which may explain the variance of ON behaviors.

## **Ethics approval**

The study protocol was approved by the local ethics committee (Comité d'Éthique de la Recherche of Toulouse University)

## **Author contributions**

EY and HC designed the study and wrote the protocol. EY conducted literature searches, provided summaries of previous research studies and conducted the statistical analysis. EY wrote the first draft of the manuscript, HC and PR supervised the writing process. All authors contributed to and have approved the final manuscript.

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Table 1. Standardized factor loadings for the healthy eating definitions among French female young adults, 6-Factor Model ( $N = 362$ )

Items	Factor Loadings					
	Politico-ecological	Restriction	Health benefits	Socio-cultural	Pleasure	Dietary avoidance
28- A cooking method that preserves the nutritional values	0.30					
29- The choice and the <i>hygiene</i> of the <i>kitchen utensils</i>	0.36					
30- Eating organic	0.59					
31- Eating local	0.71					
32- Eating seasonal	0.63					
33- A diet based on products respecting the ecosystem	0.84					
34- A sustainable diet	0.87					
35- A diet that is respectful of animal rights	0.76					
36- A diet that does not cause animal suffering	0.73					
37- A diet in accordance with my political stance	0.51					
5- Eating in moderation		0.32				
14- A low calorie diet		0.57				
15- A low saturated fat diet		0.75				
16- A low refined sugar diet		0.68				
17- A low salt diet		0.66				

Table 1 (Continued)

Items	Factor Loadings					
	Politico-ecological	Restriction	Health benefits	Socio-cultural	Pleasure	Dietary avoidance
7- A beneficial diet for my body (muscles, skin...)			0.70			
8- A diet that is beneficial for my morale			0.58			
9- A diet that improves my physical performance			0.66			
10- A diet that that improves my intellectual performance			0.59			
11- A diet that can prevent physical illnesses (diabetes etc.)			0.61			
12- A diet that can prevent mental illnesses (depression...)			0.47			
4- Timing and the <i>amount of food eaten</i> to stay healthy			0.33			
23- A diet rich in nutrients and minerals			0.56			
24- A high fiber diet			0.54			
25- A high protein diet			0.37			
38- A diet in accordance with my religious beliefs				0.38		
39- A diet in accordance with the eating habits of my family				0.75		
40- A diet in accordance with cultural values of my country				0.77		
1- Eating with pleasure					0.80	
2- A diet that is pleasing to my senses (taste, smell...)					0.77	
18- A low-gluten or gluten-free diet						0.63
19- A low lactose or lactose-free diet						0.69
20- An animal products-free diet						0.52
Eigen value	8.90	3.20	2.41	1.71	1.49	1.30
% of total variance	22.20	0.80	6.02	4.29	3.73	3.27

Note. Selected factor loadings >.3.

Table 2. Descriptive statistics and reliabilities for all variables

	Sample <i>N</i> = 921 <i>M</i> ( <i>SD</i> )	Range	$\alpha$	<i>MIC</i>
Health benefits	39.98 (7.12)	11-50	0.84	0.35
Politico-ecological	34.87 (7.98)	9-45	0.88	0.47
Restriction	17.53 (4.46)	5-25	0.75	0.38
Pleasure	8.15 (2.04)	2-10	0.83	0.71
Socio-cultural	6.87 (3.04)	3-15	0.67	0.41
Dietary avoidance	8.10 (3.38)	3-15	0.75	0.50
ON behaviors	43.55 (9.55)	21-69	0.87	0.24
ED behaviors	35.72 (13.07)	14-78	0.88	0.35
OC behaviors	17.18 (11.89)	0-54	0.88	0.30
BMI	22.02 (3.94)	16.00-59.02	n.a	n.a
Educational level	3.82 (1.59)	1-7	n.a	n.a
Age	23.43 (4.33)	18-35	n.a	n.a

*Note.* *MIC* = mean interitem correlation; n.a = not applicable. ON, ED and OC behaviors are measured with the EHQ, EDI-3 and OCI-R, respectively.

Table 3. Correlations between six factors for healthy eating definitions and ON, ED, OC behaviors

	1	2	3	4	5	6	7	8	9
1- Health benefits	-								
2- Politico-ecological	0.48**	-							
3- Restriction	0.30**	0.15*	-						
4- Pleasure	0.31**	0.32**	-0.01	-					
5- Socio-cultural	0.00	0.15*	0.05	0.06	-				
6- Dietary avoidance	0.15*	0.25**	0.24**	-0.01	-0.02	-			
7- ON behaviors	0.25**	0.24**	0.14*	0.17**	-0.03	0.33**	-		
8- ED behaviors	-0.03	-0.03	0.23**	-0.15*	0.00	0.00	0.26**	-	
9- OC behaviors	-0.01	0.03	0.02	-0.10*	0.05	0.03	0.14*	0.32**	-

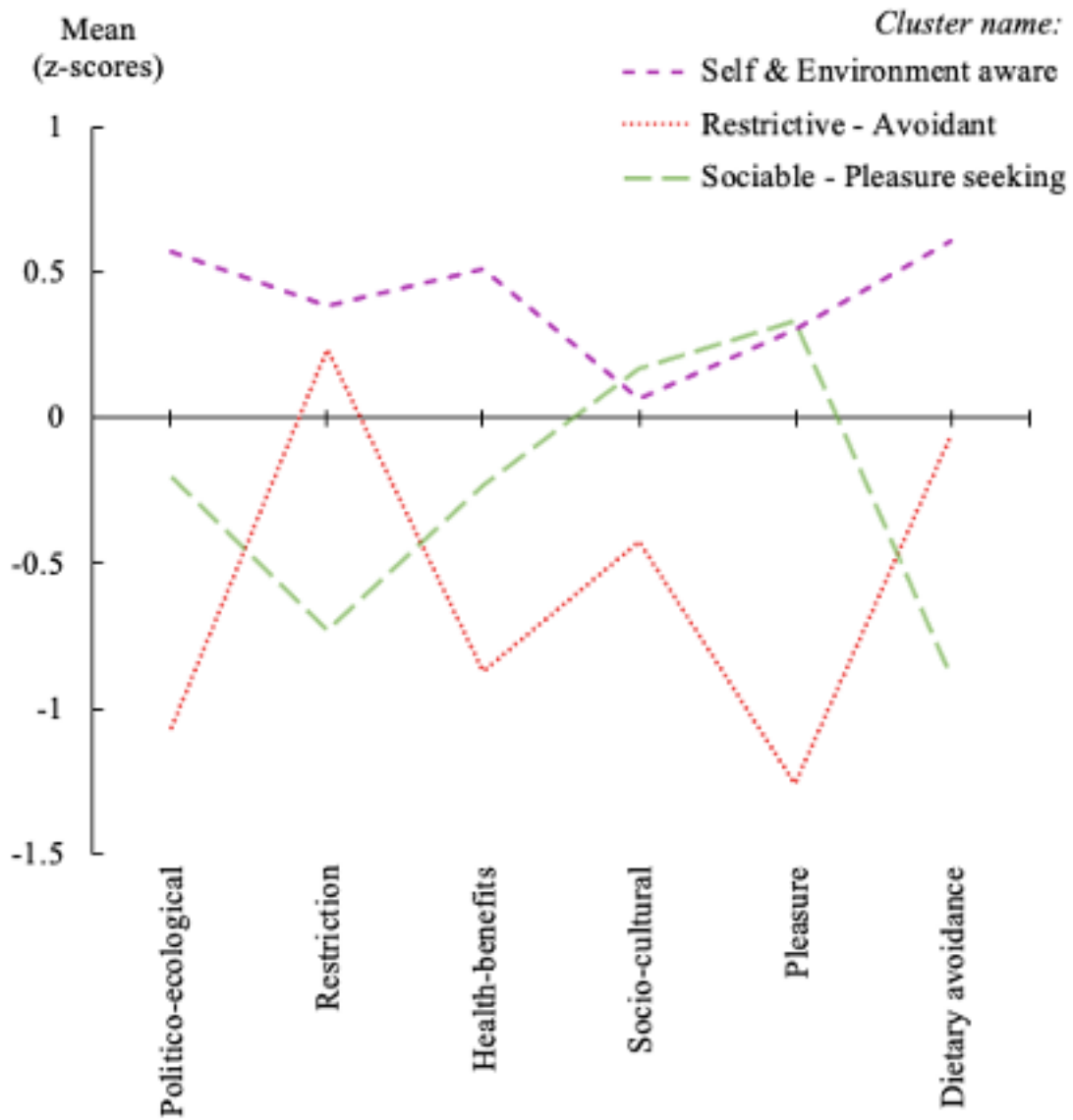
Note. \*\* $p < 0.001$ , \* $p < 0.05$ . ON, ED and OC behaviors are measured with the EHQ, EDI-3 and OCI-R, respectively.

Table 4. Typology of individuals based on six factors for definitions of healthy eating. Cluster comparison using ANOVA and post-hoc

	Cluster <i>M</i> ( <i>SD</i> )			<i>F</i>	$\eta^2$	Significant comparisons
	Self & Environment-aware <i>n</i> = 178 (49%)	Restrictive-Avoidant <i>n</i> = 70 (19%)	Sociable-Pleasure seeking <i>n</i> = 114 (32%)			
Health benefits	43.50 (4.57)	33.97 (9.21)	38.19 (5.70)	69.07**	0.27	SEA > SP > RA
Politico-ecological	39.31 (4.24)	25.72 (8.84)	33.54 (6.55)	127.76**	0.41	SEA > SP > RA
Restriction	19.27 (3.28)	18.92 (4.55)	13.95 (3.90)	75.61 **	0.29	RA > SP
Pleasure	8.77 (1.46)	5.61 (1.30)	8.75 (1.30)	107.10**	0.37	SEA, SP > RA
Socio-cultural	7.10 (3.15)	5.60 (2.62)	7.29 (2.92)	8.06**	0.04	SEA, SP > RA
Dietary avoidance	10.10 (2.68)	7.80 (3.15)	5.15 (2.01)	127.07**	0.41	SEA > RA > SP
ON behaviors	47.37 (8.16)	39.05 (10.32)	40.36 (8.73)	33.38**	0.15	SEA > RA > SP
ED behaviors	35.96 (12.47)	39.37 (15.36)	33.11 (11.94)	5.14*	0.02	RA > SP
OC behaviors	17.63 (11.90)	17.77 (12.91)	16.11 (11.24)	0.67	< 0.01	-
Age	23.07 (4.13)	23.77 (4.61)	23.12 (3.98)	1.10	< 0.01	-
Educational level	3.78 (1.53)	3.82 (1.66)	3.85 (1.61)	0.05	< 0.01	-
BMI	21.20 (4.21)	21.22 (3.42)	22.17 (4.16)	0.20	< 0.01	-

*Note.* *df* (residual) = 359 and *df* (clusters) = 2 for all comparisons.; SEA = "Self & Environment-aware" cluster; RA = "Restrictive-Avoidant" cluster; SP = "Sociable-Pleasure seeking" cluster. ON, ED and OC behaviors are measured with the EHQ, EDI-3 and OCI-R, respectively.

\*\**p* = < 0.001, \**p* = < 0.05



**Fig. 1.** K-means clustering: Graph of means for three-cluster solution based on six definitions of healthy eating