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Cross-cultural validity of the Intuitive Eating Scale-2: Psychometric evaluation in a sample of the general French population

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The French version of the questionnaire is available through the corresponding author by e-mail.

Running head Validation of the French Intuitive Eating Scale-2

Word count: 8839 (title through references)

Number of tables: 3 / Number of figures: 0

Author list for indexing: Camilleri, Méjean, Bellisle, Andreeva, Sautron, Hercberg, Péneau

ABSTRACT

Intuitive eating is an adaptive dietary behavior that emphasizes eating in response to physiological hunger and satiety cues. The Intuitive Eating Scale-2 (IES-2) measures such attitudes and behaviors. The aim of the present study was to adapt the Intuitive Eating Scale-2 (IES-2) to the French context and to test its psychometric properties in 335 women and 297 men participating in the NutriNet-Santé study. We evaluated the construct validity of the IES-2 by testing hypotheses with regard to its factor structure, relationships with scores of the revised 21-item Three Factor Eating Questionnaire and the Center for Epidemiologic Studies Depression scale, and differences between "a priori" relevant subgroups. First, the exploratory factor analysis revealed three main dimensions: Eating for Physical Rather than Emotional Reasons, Reliance on Hunger and Satiety Cues, and Unconditional Permission to Eat. Second-order confirmatory factor analysis upheld the 3-factor solution influenced by a broader intuitive eating dimension. IES-2 total score was negatively related to cognitive restraint ($r=-0.31$, $P<0.0001$), emotional eating ($r=-0.58$, $P<0.0001$), uncontrolled eating ($r=-0.40$, $P<0.0001$), and depressive symptoms ($r=-0.20$, $P<0.0001$), and positively related to positive affect ($r=0.17$, $P<0.001$). IES-2 subscales showed similar correlations. Women had lower scores than did men for the IES-2 total scale (3.3 in women vs. 3.5 in men, $P<0.0001$), Eating for Physical Rather than Emotional Reasons, and Unconditional Permission to Eat subscales. Current or former dieters had lower scores on the IES-2 total scale and on all subscales than did those who had never dieted (all $P<0.01$). Finally, results showed satisfactory reliability for the IES-2 total scores (internal consistency = 0.85 and test-retest reliability=0.79 over a mean 8-week period) and for its subscales. Thus, the French IES-2 can be considered a useful instrument for assessing adult intuitive eating behaviors in empirical and epidemiological studies in the general population.

Keywords: Intuitive eating; Dietary behavior; Hunger; Satiety; Psychometric properties; Construct validity

INTRODUCTION

In a social context where thinness is perceived as an ideal, weight-loss programs based on energy restriction are becoming more and more common (French Agency for Food, Environmental and Occupational Health & Safety, 2010). Despite the relative short-term efficiency of such programs, the long-term benefits are questionable, as the majority of individuals eventually regain the weight they had lost (Jeffery et al., 2000; Mann et al., 2007). In addition, individuals following energy-restricted diets are more likely to display maladaptive eating behaviors such as emotional eating (Konttinen, Haukkala, Sarlio-Lähteenkorva, Silventoinen, & Jousilahti, 2009; Peneau, Menard, Mejean, Bellisle, & Hercberg, 2013), and to develop eating disorders (Patton, Selzer, Coffey, Carlin, & Wolfe, 1999).

As a result, "non-dieting" strategies based on adaptive behaviors that promote a healthier food-mind-body connection have emerged. One such adaptive behavior is intuitive eating characterized by eating in response to physiological hunger and satiety cues rather than external and/or emotional cues, as well as low preoccupation with food (Tribole & Resch, 2003; Tylka, 2006). Implementation of intuitive eating strategies via intervention studies has been shown to positively impact psychological health outcomes, such as self-esteem, body image, to reduce depressive symptoms (Bacon, Stern, Van Loan, & Keim, 2005; Hawley et al., 2008; Provencher et al., 2009), and to improve physical health indicators including blood pressure and cholesterol levels (Bacon et al., 2005). Intuitive eating programs have also achieved long-term weight maintenance in overweight or obese women (Bacon et al., 2005; Hawley et al., 2008; Provencher et al., 2009). In cross-sectional studies, intuitive eating has been associated with improved psychological health measures such as self-esteem or reduced negative affect (Tylka, 2006; Tylka & Kroon Van Diest, 2013; Tylka & Wilcox, 2006), and with reduced eating disorder symptomatology (Denny, Loth, Eisenberg, & Neumark-Sztainer,

2013; Madden, Leong, Gray, & Horwath, 2012; Tylka, 2006; Tylka & Kroon Van Diest, 2013) as well as lower body mass index (BMI) (Denny et al., 2013; Hawks, Merill, & Madanat, 2004; Madden et al., 2012; Tylka, 2006; Tylka & Kroon Van Diest, 2013; Webb & Hardin, 2012), lower triglyceride levels and cardiovascular risk (Hawks, Madanat, & Harris, 2005). There is also some evidence that intuitive eating is associated with a healthier diet, especially vegetable intake and time taken to eat a meal (Madden et al., 2012). An intuitive eating program has also helped participants improve their dietary intake as measured by a dietary quality score (Hawley et al., 2008). Although intuitive eating has shown promising results, almost all intervention studies thus far have targeted overweight/obese women and most of the cross-sectional studies have been limited to small samples and female university students.

To our knowledge, two instruments have been developed to measure intuitive eating. The first one was developed by Hawks et al. (2004) and consisted of 27 items assessing four dimensions of the behavior: 1/intrinsic eating, 2/extrinsic eating, 3/anti-dieting, and 4/self-care. Shortly afterwards, Tylka's original 21-item Intuitive Eating Scale (IES) (Tylka, 2006) was published, identifying three central features of this behavior: 1/unconditional permission to eat, 2/eating for physical rather than emotional reasons, and 3/reliance on hunger and satiety cues. Tylka's initial IES was validated in a sample of college women and was later used in a cross-sectional study involving a large sample of women aged 40-50 years (Madden et al., 2012). Although the original version demonstrated good psychometric properties, Tylka and Kroon Van Diest (2013) developed a revised version, the 23-item Intuitive Eating Scale-2 (IES-2) which included a fourth dimension called Body Food-Choice Congruence and comprised more positively-worded items. The IES-2 proved to be valid and reliable in both male and female college students in the U.S. (Tylka & Kroon Van Diest, 2013).

French and U.S. populations differ in attitudes to food (Rozin, Fischler, Imada, Sarubin, & Wrzesniewski, 1999; Rozin, Remick, & Fischler, 2011) and in the prevalence of overweight (World Health Organization, 2011). It would thus be of particular interest to assess whether intuitive eating encompasses similar principles in both countries and whether the positive associations with nutritional status and dietary behaviors observed in New Zealand (Madden et al., 2012) and U.S. college student samples (Denny et al., 2013; Smith & Hawks, 2006; Tylka & Kroon Van Diest, 2013) is confirmed in France. To our knowledge, no French version of the IES-2 questionnaire exists. To accurately measure intuitive eating in a large French-speaking population, the questionnaire must be cross-culturally adapted with further evaluation of the validity of the translated instrument (Beaton, Bombardier, Guillemin, & Ferraz, 2000).

The purpose of the present study was therefore to adapt the IES-2 to the French context and test its psychometric properties in a large sample derived from the general population. Specifically, we aimed at evaluating the construct validity of the translated instrument, i.e., studying its factor structure, testing its correlation with other scales assessing maladaptive eating behaviors and psychological well-being, and comparing scores between subgroups with "a priori" differences in intuitive eating behaviors. We also examined the instrument's internal consistency and test-retest reliability.

METHODS

Instrument assessing intuitive eating

Questionnaire items

The 23-item Intuitive Eating Scale-2 (IES-2; Tylka & Kroon Van Diest, 2013) includes 4 dimensions: 1/ Eating for Physical Rather than Emotional Reasons (referred to as Eating for Physical Reasons in the manuscript, 8 items), e.g., "I find other ways to cope with stress and anxiety than by eating," 2/ Unconditional Permission to Eat (6 items), e.g., "I do NOT follow

eating rules or dieting plans that dictate what, when, and/or how much to eat," 3/ Reliance on Hunger and Satiety Cues (6 items) e.g., "I trust my body to tell me when to eat", and 4/ Body-Food Choice Congruence (3 items), e.g., "I mostly eat foods that give my body energy and stamina." Items are rated on a 5-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree) with each point on the scale represented by a word anchor. Individual item scores were summed in each of the four subscales, which were then summed up into a total intuitive eating score. Next, the resulting scores were divided by the number of items in each subscale or in the total IES-2 scale, leading to a possible range from 1 to 5. Higher scores indicated greater levels of intuitive eating or its dimensions. The original version of IES-2 has been validated in male and female college students in the U.S. with evidence of internal consistency reliability (α between 0.81 and 0.93), 3-week test-retest reliability, and construct validity (Tylka & Kroon Van Diest, 2013).

French adaptation protocol

The IES-2 was cross-culturally adapted from English into French following the guidelines proposed by Beaton et al. (2000). Forward translations were independently performed by two bilingual translators informed about the concepts underlying the questionnaire and one bilingual translator naïve to the concepts being measured; all three were native French speakers and specialized in nutrition. A synthesis of the three translations was created. Then, two bilingual, native English translators, unfamiliar with the original English version, back-translated the French items. All translations were reviewed by the expert committee composed of all translators to develop the pre-final version of the questionnaire. Dr. Tracy Tylka, the researcher who developed the original IES-2 scale (Tylka & Kroon Van Diest, 2013), provided her agreement and also feedback and advice during the scale adaptation process. Next, the questionnaire was pre-tested in a sample of 36 individuals including fellow researchers, colleagues, family members and friends in order to evaluate

item comprehension. These individuals were asked to express in a few words what they thought was meant by each item or to give a concrete example of a particular situation. Overall, all items were well understood except for item 9 ("I have forbidden foods that I don't allow myself to eat"), for which we added the following clarification: "This affirmation does not concern foods that are forbidden for religious or philosophical convictions."

Population and procedures

The present sample was derived from the NutriNet-Santé study, which is a large ongoing web-based prospective observational cohort launched in France in May 2009, with a scheduled follow-up of 10 years. It aims to investigate the relationship between nutrition and chronic disease risk, as well as the determinants of dietary behavior and nutritional status. The study was implemented in the general French population (internet-using adult volunteers, age ≥18 years). The rationale, design and methodology of the study have been fully described elsewhere (Hercberg et al., 2010). For the present analysis, 1000 participants were randomly selected among the 119,834 participants of the NutriNet-Santé study at the time of the analysis preparation. This subsample was representative of the French population in terms of age, sex and educational level (French National Institute of Statistics and of Economic Studies, 2009). The IES-2 questionnaire was administered via the NutriNet-Santé study web site (https://www.etude-nutrinet-sante.fr). This study was conducted in accordance with the Declaration of Helsinki, and all procedures were approved by the Institutional Review Board of the French Institute for Health and Medical Research (IRB Inserm n° 0000388FWA00005831) and the Commission Nationale de l'Informatique et des Libertés (CNIL n° 908450 and n° 909216). All participants provided electronic informed consent. The NutriNet-Santé cohort study is registered in EudraCT (n°2013-000929-31).

Data collection

The IES-2 questionnaire was administered twice, with a mean interval between the two administrations of 56 days (SD=12). The introduction of the questionnaire mentioned that questions were about eating behaviors and personal factors.

In addition to completing the IES-2, participants were also asked to complete a process evaluation form comprising 3 items (e.g., the questionnaire was difficult, clear or long) to assess the feasibility of the questionnaire. The responses were rated on a 5-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree) with each point on the scale represented by a word anchor.

Socio-demographic and behavioral characteristics including sex, age, educational level (primary education, i.e., less than high school diploma, secondary education or university-level), self-reported height and weight, and weight-loss dieting practices (never, former or current dieters) were collected at enrollment and each year thereafter. BMI (kg/m^2) was calculated as the ratio of weight to squared height.

Eating behaviors were assessed 14 months after enrollment using the French version (de Lauzon et al., 2004) of the revised 21-item Three Factor Eating Questionnaire (TFEQ-R21) (Tholin, Rasmussen, Tynelius, & Karlsson, 2005). The questionnaire covered 3 aspects of eating behavior: cognitive restraint (6 items), emotional eating (6 items) and uncontrolled eating (9 items). These items were rated on a 4-point scale ranging from “definitely true” to “definitely false.” Individual item responses were scored from 1 to 4 and were summed into scale scores of cognitive restraint, emotional eating, and uncontrolled eating. The raw scores were transformed to a 0 - 100 scale [((raw score – lowest possible raw score) / possible raw score range)*100], with higher scores on the respective scales indicating greater cognitive restraint, emotional eating, and uncontrolled eating. Evidence of internal consistency (α between 0.83 and 0.87), convergent and discriminant validity were obtained in a general population living in Northern France (de Lauzon et al., 2004).

Finally, depressive symptoms were measured 26 months after enrollment with the French version of the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977) which consists of 20 items describing 4 factors: depressive affect, somatic symptoms, interpersonal relationships and positive affect. These items were rated on a 4-point scale from "never or rarely" to "most or all of the time." Individual item responses were scored from 0 to 3 and were summed. CES-D scores range from 0 to 60, with a lower score corresponding to fewer depressive symptoms. Previous analyses of data from the French Gazel cohort have shown good internal consistency (α=0.89) (Wahrendorf, Ribet, Zins, & Siegrist, 2008). Support of construct validity in French clinical and non-clinical adults has also been reported (Morin et al., 2011). The CES-D can be scored as a single depression-happiness continuum (Joseph & Wood, 2010; Wood, Taylor, & Joseph, 2010). We also considered separately the positive affect subscale comprising four positively-rated items because it has been regarded as interchangeable with the concept of happiness (Fowler & Christakis, 2008; Mroczek & Kolarz, 1998).

Psychometric properties analysis

Construct validity

In a first step, Confirmatory Factor Analysis (CFA) was performed in the whole sample as we were interested in testing the initial factor structure of the original scale. As that model did not provide a good fit to the data, we performed an Exploratory Factor Analysis (EFA) on a subsample to understand the underlying structure of our set of measured items. The model thus derived was then tested via CFA conducted in a different subsample to confirm the factor structure as recommended (Brown, 2006; Kline, 2011). For that purpose, the initial sample was split randomly into two datasets, each including 316 participants. The two subsample sizes exceeded recommendations of a 5:1 participant-to-item ratio for factor

221 analysis (Hatcher, 1994). We compared participants' characteristics across the two datasets
222 using Student's *t* test and chi-square tests, as appropriate.

223 Before proceeding with EFA in the first subsample (n=316), we examined the
224 adequacy of the items' common variance for factor analysis using the Kaiser-Meyer-Olkin
225 (KMO) test of sampling adequacy (Tabachnick & Fidell, 2007). As the items were
226 represented by ordinal variables, we used the Unweighted Least Squares (ULS) estimation
227 method based on polychoric correlations (Flora, Labrish, & Chalmers, 2012). As the factors
228 were expected to be correlated, an oblique rotation (direct oblimin) was applied (Tabachnick
229 & Fidell, 2007). The number of factors to be extracted was based on the interpretability
230 criterion (Hatcher, 1994) and on the scree plot (Catell, 1966), the proportion of variance
231 explained by a factor (at least 5-10%) (Hatcher, 1994), and the MAP test (Velicer, 1976). In
232 interpreting the rotated factor pattern, items with a factor loading of 0.40 or greater were
233 considered to represent a given factor. If an item presented similar, non-negligible loading (>
234 0.30) on both a primary factor and a secondary factor, it was removed from further analysis
235 (Hatcher, 1994; Tabachnick & Fidell, 2007).

236 A hierarchical measurement model was tested using CFA in the second subsample
237 (n=316). Each item was specified to load only on its first-order factor and these factors were
238 specified to load on a second-order intuitive eating factor. We estimated correlated errors
239 between similarly worded IES-2 items as they were expected to share method variance (Tylka
240 & Kroon Van Diest, 2013). The ULS estimation method and the covariance matrix computed
241 from polychoric correlations as input were used (Yang-Wallentin, Jöreskog, & Luo, 2010).
242 We examined the following goodness-of-fit indices to assess model fit: the Adjusted
243 Goodness of Fit Index (AGFI), the Parsimony Goodness of Fit (PGFI), and the Standardized
244 Root-Mean Square Residual (SRMR). Specifically, values around 0.95 or higher for AGFI,
245 and values around 0.08 or lower for SRMR indicate reasonably good fit of the model to the

data (Hu & Bentler, 1999). While there is no recommended threshold for PGFI, it is possible to have an acceptable model with a PGFI in the vicinity of 0.50 as it measures both goodness of fit and parsimony of the model (Mulaik et al., 1989). Thus, a value larger than 0.60 was considered as favorable in our study. Residuals and their distribution were also examined as advised (Hatcher, 1994). Normal distribution without large residuals is evidence of good model fit.

To understand the observed differences in the psychometric properties between our instrument and the original scale, subgroup EFA analyses were performed based on the total sample. First, analyses were stratified by sex, and then by age group (18-36, 37-59, 60-87 y), overweight status (<25 kg/m², ≥ 25 kg/m²) and educational level (primary or secondary, university). Subgroup sample sizes exceeded the recommended 5:1 participant-to-item ratio (Hatcher, 1994).

We further evaluated the construct validity of the instrument via the correlation of IES-2 and its subscales with cognitive restraint, emotional eating, uncontrolled eating, depressive symptoms, and positive feelings. Because several of these scores were not normally distributed, Spearman's correlation coefficients were used. We also compared subgroups of the population presenting "a priori" differences in intuitive eating behaviors by sex, dieting history, and weight status. Student's *t* tests were used to compare sex differences, and differences according to dieting history were assessed by ANOVA and *post hoc* multiple comparisons with a Bonferroni correction.

Reliability

Internal consistency was estimated with the ordinal alpha coefficient (Gadermann, Guhn, & Zumbo, 2012), which is more accurate in estimating alphas for measurements involving ordinal variables (Gadermann et al., 2012). Although it is calculated using polychoric correlations, it is conceptually equivalent to Cronbach's alpha and has a similar

interpretation, i.e. a value higher than 0.70 is considered adequate (Kline, 2011). Polychoric correlations between the items and their respective subscale corrected for overlap (i.e., the modified subscale after removal of the studied item) were also computed. The aim of this analysis was to verify that items were substantially correlated with their assigned subscale ($r \geq 0.40$, corrected for overlap).

Test-retest reliability was assessed by calculating the intra-class correlation coefficients (ICC) for the IES-2 scores (Shrout & Fleiss, 1979). This ICC was estimated from a one-way random effect ANOVA model with the participant as the random effect (Fermanian, 2005; Shrout & Fleiss, 1979). Its confidence limits were also computed.

All tests of significance were two-sided, and a *P* value <0.05 was considered significant. All statistical analyses were performed using SAS software (version 9.3, SAS Institute Inc.).

RESULTS

Participants

Among the original 1000 randomly-drawn participants, 665 completed the IES-2 questionnaire. A total of 33 participants were excluded due to current dieting either for medical reasons or due to pregnancy. Participants who were dieting in order to lose weight remained in the analysis. The analyses were therefore performed on data from 632 participants (297 men and 335 women). The study sample comprised 53% women and 7% dieters, 50% former dieters, and 44% without any history of dieting. Mean age was 48.5 years (SD=14.4), mean BMI was 25.1 kg/m² (SD=4.8), and 25.8% had university-level education, while 14.9% had secondary-level education, and 59.3% had primary-level education. Sex, age, educational level, and BMI were not significantly different between the two EFA and CFA randomly divided subsamples, each including 316 participants (all $p>0.05$). Finally, a total of 489 participants completed the questionnaire twice, with a mean test-retest interval of

296 56 days (SD=12, range: 26-94 days). This subsample was very similar to the whole sample in
297 terms of sex (52% women), age (mean=50.0 years, SD=13.8), BMI (mean=25.3kg/m², SD=4.8) and educational level (24.5% had a university level, 14.3% a secondary level, and
299 61.2% a primary education level).

300 Process evaluation

301 A total of 24% of the participants thought the IES-2 questionnaire was difficult
302 (considering participants who answered agree or strongly agree), and 12% found it too long.
303 Finally, 64% of the participants thought it was clear.

304 Construct validity

305 First, CFA was performed on the whole sample to test the original IES-2 structure.
306 The goodness-of-fit indices were as follows: SRMR=0.09, AGFI=0.93 and PGFI=0.78. We
307 observed a correlation estimate greater than 1 for item 19 corresponding to a variance
308 estimate less than 0, also known as a "Heywood case." This was likely due to insufficient
309 number of items loading strongly on the Body-Food Choice Congruence factor which was
310 originally composed of only three items. Therefore, the original model did not provide a good
311 fit to the data. As the KMO statistic was 0.83, the data had adequate common variance
312 allowing an EFA. An expected four-factor structure was imposed on the data from the first
313 random subsample (n=316). However, the scree test suggested that only three factors should
314 be retained and this was confirmed with the MAP test. The fourth factor was not interpretable.
315 In EFA conducted with the three-factor solution, items 18 ("Most of the time I desire to eat
316 nutritious foods") and 20 ("I mostly eat foods that give my body energy and stamina") from
317 the original Body-Food Choice Congruence factor had low loadings (i.e. < 0.40) on any of the
318 three factors, while items 3 ("If I am craving a certain food, I allow myself to have it"), 16 ("I
319 allow myself to eat what food I desire at the moment") from the original Unconditional
320 Permission to Eat factor, and 19 ("I mostly eat foods that make my body perform efficiently")

from the original Body-Food Choice Congruence factor had cross-loadings >0.30 on two factors, Reliance on Hunger and Satiety Cues and Unconditional Permission to Eat. Thus, from the original 23 items, 18 items were retained. Results of the EFA conducted with the remaining 18 items are shown in Table 1. The first factor (Eating for Physical Reasons) consisted of 8 items which accounted for 59.4% of the total variance. The second factor (Reliance on Hunger and Satiety Cues) comprised 6 items which accounted for 25.4% of the total variance. The third factor (Unconditional Permission to Eat) included 4 items which accounted for 15.2% of the total variance. All primary factor loadings exceeded 0.50 and were lower than 0.30 for the other factors. According to the inter-factor correlation matrix, inter-correlations were 0.32 between Eating for Physical Reasons and Reliance on Hunger and Satiety Cues, 0.17 between Eating for Physical Reasons and Unconditional Permission to Eat, and 0.08 between Reliance on Hunger and Satiety Cues and Unconditional Permission to Eat.

334 **Table 1**

335 Exploratory and confirmatory factor analyses of the French IES-2, NutriNet-Santé study,
336 France, 2013

Factor and item	Total Sample (n=632) Item-factor r[a]	EFA Sample 1 (n=316) Factor 1	Factor 2	Factor 3	CFA Sample 2 (n=316) First-order	Second-order
		Standardized factor loadings				
F1: Eating for Physical Rather Than Emotional Reasons (EPR)						0.74
2. I find myself eating when I'm feeling emotional (e.g., anxious, depressed, sad), even when I'm not physically hungry.	0.77	0.89	-0.09	-0.12	0.75	
5. I find myself eating when I am lonely, even when I'm not physically hungry.	0.74	0.78	0.01	0.03	0.72	
10. I use food to help me soothe my negative emotions.	0.82	0.91	-0.12	0.08	0.91	
11. I find myself eating when I am stressed out, even when I'm not physically hungry.	0.84	0.93	-0.10	0.02	0.84	
12. I am able to cope with my negative emotions (e.g., anxiety, sadness) without turning to food for comfort.	0.77	0.79	0.12	0.04	0.83	
13. When I am bored, I do NOT eat just for something to do.	0.56	0.54	0.10	0.00	0.59	
14. When I am lonely, I do NOT turn to food for comfort.	0.68	0.69	0.02	0.02	0.72	
15. I find other ways to cope with stress and anxiety than by eating.	0.67	0.60	0.22	0.00	0.79	
F2: Reliance on Hunger and Satiety Cues (RHSC)						0.35
6. I trust my body to tell me when to eat.	0.65	0.03	0.69	-0.05	0.68	
7. I trust my body to tell me what to eat.	0.55	-0.12	0.70	0.00	0.39	
8. I trust my body to tell me how much to eat.	0.69	0.06	0.78	-0.02	0.60	
21. I rely on my hunger signals to tell me when to eat.	0.61	0.00	0.63	-0.01	0.70	
22. I rely on my fullness (satiety) signals to tell me when to stop eating.	0.68	0.04	0.71	0.03	0.86	
23. I trust my body to tell me when to stop eating.	0.73	0.08	0.76	0.07	0.93	
F3: Unconditional Permission to Eat (UPE)						0.53
1. I try to avoid certain foods high in fat, carbohydrates, or calories.	0.49	-0.17	0.00	0.71	0.31	
4. I get mad at myself for eating something unhealthy.	0.44	0.16	0.03	0.53	0.80	
9. I have forbidden foods that I don't allow myself to eat.	0.47	0.02	-0.12	0.59	0.52	
17. I do NOT follow eating rules or dieting plans that dictate what, when, and/or how much to eat.	0.43	0.03	0.12	0.63	0.60	

337 EFA=Exploratory Factor Analysis; CFA=Confirmatory Factor Analysis

[a]Polychoric correlations between each studied item and its assigned subscale corrected for overlap (i.e., the subscale is modified by excluding the studied item).

The CFA conducted in the second subsample (n=316) tested whether the three-factor model would be confirmed in a different dataset and whether the three first-order factors would load on a higher-order intuitive eating factor (Table 1). The goodness-of-fit indices demonstrated that overall the model provided an adequate fit to the data: SRMR=0.07, AGFI=0.95, and PGFI=0.76. There were no large standardized residuals and the distribution was centered on zero and roughly symmetrical. Table 1 presents the standardized item-factor loadings as well as the loadings of the first-order factors on the second-order factor. All salient items of each factor had meaningful loadings (>0.50 except for two items with loadings >0.30) on their assigned factor, and the three first-order factors loaded substantially on a broader intuitive eating dimension.

Finally, the whole sample (n=632) was stratified first by sex, then by age group, overweight status and finally by educational level, and EFA analyses were performed in each subgroup. The original four-factor structure (Eating for Physical Reasons, Unconditional Permission to Eat, Reliance on Hunger and Satiety Cues and Body-Food Choice Congruence) was found to fit the data in the subsample of women, in the youngest age group, in non-overweight participants, and in those with a university-level education. In contrast, the four-factor structure did not correspond to the underlying structure of the data in the following subgroups: men, older age (37-59 and 60-87y), overweight (including obese) and participants with primary or secondary educational level. In these subgroups, we found the same challenges as in the EFA, i.e. the three items of the original Body-Food Choice Congruence factor, and items 3 and 16 of the Unconditional Permission to Eat factor had either no meaningful loading on a given factor or exhibited high cross-loadings.

Women had lower IES-2 scores compared with men while current and former dieters had lower IES-2 scores compared with participants with no dieting history (Table 2). IES-2

subscale scores presented the same patterns by sex and dieting history as the total scores, except for Reliance on Hunger and Satiety Cues scores which showed non-significant differences between men and women. The French IES-2 total score was negatively correlated with cognitive restraint, emotional and uncontrolled eating as measured by the TFEQ (Table 3, all $P<0.0001$). It was also negatively correlated with depressive symptoms ($P<0.0001$) and positively correlated with positive feelings ($P<0.001$) as measured by the CES-D. IES-2 subscale scores were similarly correlated with all eating behaviors and psychological measures (all $P<0.05$) except for non-significant correlations between Reliance on Hunger and Satiety Cues, positive feelings and depressive symptoms, as well as between the revised Unconditional Permission to Eat, positive feelings and uncontrolled eating.

Table 2

Descriptive statistics of the participants according to sex and weight-loss dieting history, NutriNet-Santé study, France, 2013

	N	IES-2	EPR	RHSC	UPE
Full sample	632	3.36 ± 0.62	3.62 ± 0.95	3.14 ± 0.83	3.16 ± 0.86
Sex					
Men	297	3.47 ± 0.60	3.84 ± 0.86	3.13 ± 0.86	3.24 ± 0.87
Women	335	3.26 ± 0.63	3.43 ± 0,98	3.15 ± 0.80	3.10 ± 0.86
P^a		<0.0001	<0.0001	0.70	0.03
Dieting to lose weight					
Never dieters	275	3.62 ± 0.53^A	3.98 ± 0.79^A	3.27 ± 0.84^A	3.40 ± 0.84^A
Former dieters	313	3.20 ± 0.61^B	3.38 ± 0.95^B	3.07 ± 0.80^B	3.03 ± 0.84^B
Current dieters	44	2.93 ± 0.65^C	3.11 ± 1.06^B	2.88 ± 0.82^B	2.64 ± 0.68^C
P^b		<0.0001	<0.0001	0.001	<.0001
Weight status	628				
Non-overweight	363	3.47 ± 0.59	3.78 ± 0.87	3.28 ± 0.81	3.15 ± 0.88
Overweight	269	3.21 ± 0.64	3.41 ± 1.01	2.95 ± 0.82	3.19 ± 0.84
P^a		<0.0001	<0.0001	<0.0001	0.59

Note: Values are means ± SD. Labelled means in a column without a common letter differ ($P<0.05$; Post-hoc tests with a Bonferroni correction). IES-2 = Intuitive Eating Scale-2; EPR

= Eating for Physical Rather Than Emotional Reasons; RHSC = Reliance on Hunger and Satiety Cues; UPE = Unconditional Permission to Eat.

[a] On the basis of the Student's *t* test.

[b] On the basis of ANOVA analysis.

Table 3

Correlation coefficients between total and subscale IES-2 scores, and the TFEQ-R21 and CES-D, NutriNet-Santé study, France, 2013

	N	IES-2	*P*	EPR	*P*	RHSC	*P*	UPE	*P*
IES-2	632	-							
EPR		0.83	<0.0001	-					
RHSC		0.62	<0.0001	0.23	<0.0001	-			
UPE		0.48	<0.0001	0.20	<0.0001	0.10	0.01		
TFEQ-R21	521								
Cognitive restraint		-0.31	<0.0001	-0.18	<0.0001	-0.10	0.02	-0.45	<0.0001
Emotional Eating		-0.58	<0.0001	-0.72	<0.0001	-0.12	0.006	-0.16	0.0002
Uncontrolled eating		-0.40	<0.0001	-0.52	<0.0001	-0.12	0.007	-0.04	0.34
CES-D	420								
Depressive symptoms		-0.20	<0.0001	-0.26	<0.0001	0.03	0.49	-0.10	0.03
Positive feelings		0.17	0.0007	0.19	<0.0001	0.01	0.85	0.08	0.08

Note: Values are Spearman correlation coefficients; CES-D = Center for Epidemiologic Studies Depression scale**;** IES-2 = Intuitive Eating Scale-2; EPR = Eating for Physical Rather Than Emotional Reasons; RHSC = Reliance on Hunger and Satiety Cues; UPE = Unconditional Permission to Eat; TFEQ-R21= the revised 21-item Three Factor Eating Questionnaire.

Reliability

Ordinal alpha values were 0.85 for the 18-item IES-2, 0.92 for Eating for Physical Reasons, 0.87 for Reliance on Hunger and Satiety Cues, and 0.70 for Unconditional Permission to Eat. These statistics were all at or above the recommended value of 0.70

indicating adequate internal consistency. For each subscale, corrected item-total polychoric correlations as calculated on the whole sample were all above 0.40 (Table 1).

In the sample of 489 participants who completed the questionnaire twice, ICC were 0.79 (95% CI: 0.75, 0.82), 0.81 (95% CI: 0.78, 0.84), 0.66 (95% CI: 0.61, 0.71) and 0.71 (95% CI: 0.66, 0.75) for IES-2 total score, Eating for Physical Reasons, Reliance on Hunger and Satiety Cues, and Unconditional Permission to Eat scores, respectively. These ICC indicated a high test-retest reliability for almost all scores except for Reliance on Hunger and Satiety Cues where test-retest reliability was moderate.

DISCUSSION

We first translated and then validated the French version of the IES-2 instrument in a large sample drawn from the general population. The IES-2 was originally developed by Tylka and Kroon Van Diest (2013) as a 23-item tool to measure four aspects of intuitive eating, namely Eating for Physical Rather than Emotional reasons, Unconditional Permission to Eat, Reliance on Hunger and Satiety Cues and Body-Food Choice Congruence. Results indicated good acceptability of the French IES-2. In the French version, which has 18 items, the Eating for Physical Reasons and Reliance on Hunger and Satiety Cues subscales were replicated while two items assigned to Unconditional Permission to Eat and all items constituting Body-Food Choice Congruence were not retained. The obtained three-factor structure was cross-validated in a separate dataset and demonstrated further evidence of construct validity via its associations with other measures of eating behaviors and psychological well-being as well as satisfactory reliability, including internal consistency and test-retest reliability.

The Eating for Physical Reasons and Reliance on Hunger and Satiety Cues factors of the IES-2 (Tylka & Kroon Van Diest, 2013) were consistently reproduced and found to be linked. Eating for Physical Reasons captures the individual's motives for eating (i.e., eating due to physical hunger rather than to cope with negative emotions, loneliness or boredom). In turn, Reliance on Hunger and Satiety Cues represents people's ability and trust to use physical hunger and satiety cues (Tylka & Kroon Van Diest, 2013). Thus, both of these components are expected to reflect adaptive properties of intuitive eating in a complementary but substantially different way. It has been shown that people who respond to physiological signals are less likely to engage in unhealthy eating behaviors than are those who do not respond to such signals (Denny et al., 2013). As expected, there were negative correlations between these subscales and the three types of unhealthy eating styles, i.e. restrained, emotional and uncontrolled eating (which includes environmental triggers). In addition, the highest observed correlation was between Eating for Physical Reasons and emotional eating. The Eating for Physical Reasons dimension measures the extent to which people use food to satisfy hunger rather than using food to alleviate emotional distress. In the present study, we found that current or former dieters had lower scores on Eating for Physical Reasons and Reliance on Hunger and Satiety Cues than did participants who had no history of dieting. It has been suggested that people have an innate ability to respond to body signals and thus be able to adequately regulate food intake (Birch, Johnson, Andresen, Peters, & Schulte, 1991). However, this ability can be overridden by environmental pressure or individual experiences, such as parental eating practices (Birch, Fisher, & Davison, 2003) or dieting (Herman & Polivy, 1984) that may habituate individuals to negate their body signals of hunger and satiety and, as a result, become less sensitive to internal cues but more responsive to various environmental factors.

Unconditional Permission to Eat reflects one‘s willingness to eat when hungry without specifically categorizing foods as acceptable or non-acceptable. The Unconditional Permission to Eat factor was partially reproduced in the present study. Items 3 (“If I am craving a certain food, I allow myself to have it”) and 16 (”I allow myself to eat what food I desire at the moment”) were omitted because of high cross-loadings. The remaining items characterize well the preoccupation with food or diet rules, but the internal consistency of the Unconditional Permission to Eat subscale was at the acceptability threshold in our study. Consequently, the meaning of the Unconditional Permission to Eat factor in the French version of the instrument may be somewhat different from the original one. As expected, the Unconditional Permission to Eat score and cognitive restraint were negatively correlated, and current dieters had highly significantly lower Unconditional Permission to Eat scores than did former dieters and even lower scores than those who had never dieted. These results suggest that the Unconditional Permission to Eat factor reflects a low tendency to have forbidden foods or self-imposed restrictions on eating behaviors. It has further been suggested that restrained eaters might develop an appetite urge or craving to eat in response to visual or olfactory food cues (Fedoroff, Polivy, & Herman, 1997) which could result in increased eating. In addition, the Unconditional Permission to Eat scores were not correlated with uncontrolled eating and there were no significant differences of Unconditional Permission to Eat scores between non-overweight and overweight participants, which could suggest that people who give themselves unconditional permission to eat do not overindulge in food. In the literature, strong negative correlations between Unconditional Permission to Eat and the dieting and the bulimia/food preoccupation subscales of the Eating Attitude Test-26 assessing levels of eating disorder symptomatology have been reported (Tylka & Wilcox, 2006).

Body-Food Choice Congruence assesses one’s tendency to make food choices according to the body’s needs. This factor was not included in the original IES (Tylka, 2006)

and represents the main difference between the two versions of IES (Tylka, 2006; Tylka & Kroon Van Diest, 2013). It was inversely related to Unconditional Permission to Eat in the original psychometric validation study of IES-2 (Tylka & Kroon Van Diest, 2013). This inverse relationship was explained by the fact that individuals who eat intuitively are expected to balance between these two attitudes toward foods. If a person has a desire for a certain unhealthy food, he/she has it without guilt, but in the absence of a craving he/she will choose the food that will give the body health and strength (Tribole & Resch, 2003). Body-Food Choice Congruence had only three items in the IES-2 and further examination of its psychometric properties was suggested (Tylka & Kroon Van Diest, 2013). In our dataset, most original Body-Food Choice Congruence items were negatively correlated with the Unconditional Permission to Eat items. However, when a four-factor structure was imposed, Body-Food Choice Congruence items did not load strongly on the fourth factor. When a three-factor structure was modeled, two out of three Body-Food Choice Congruence items had cross-loadings but had stronger, negative loadings on the Unconditional Permission to Eat factor. It seemed therefore that the Unconditional Permission to Eat and Body-Food Choice Congruence factors could not coexist in our scale. Body-Food Choice Congruence items might not have been clearly understood in our sample. As mentioned previously, people who eat intuitively are expected to switch between two attitudes according to the situation: when having a craving they will adopt the Unconditional Permission to Eat attitude, whereas without any cravings they will adopt the Body-Food Choice Congruence attitude. Body-Food Choice Congruence and Unconditional Permission to Eat items are mostly formulated as to measure behavior in general, which might have led to some confusion (particularly since 2 items of Unconditional Permission to Eat that measure behavior in a specific situation were omitted in our version of the IES-2, i.e., “If I am craving a certain food, I allow myself to have it” and “I allow myself to eat what food I desire at the moment”). The Body-Food

494 Choice Congruence factor might be an important aspect of the intuitive eating behavior even
495 in the French population, but it would need further development to be taken into account.

496 To understand the observed differences in the psychometric properties between the
497 French version of the scale and the original scale, subgroup EFA analyses were performed.
498 The original 4-factor structure was replicated only in women, younger, non-overweight and
499 more educated people and not in the other subgroups. In the other subgroups (men, older age,
500 overweight, and participants with primary or secondary education), the same recurrent
501 problems concerning items 18, 19 and 20 from the original Body-Food Choice Congruence,
502 and items 3 and 16 from the original Unconditional Permission to Eat were found. The initial
503 psychometric work of Tylka and Kroon Van Diest (2013) used a sample of undergraduate
504 psychology students. Participants had a mean age of 20 years and were more educated than
505 the general population. The inability to replicate the original 4-factor structure of the IES-2 in
506 our study could be partly attributed to the differences in sample composition. Performing
507 analysis in specific subgroups can give an insight into the stability and the generality of the
508 questionnaire. Caution is needed when generalizing results obtained in undergraduate student
509 samples to the general population (Caudwell et al., 2011) as a questionnaire developed in the
510 former group may not be suitable to another group of the population. The original IES of
511 Tylka (2006) has also been adapted for adolescents, resulting in 17 items and a four-factor
512 structure (Dockendorff, Petrie, Greenleaf, & Martin, 2012).

513 In addition, cross-cultural differences are common and might partly explain the
514 observed discrepancies between questionnaires. For example, when comparing French
515 individuals with their counterparts from the U.S., Japan and Belgium regarding attitudes,
516 Rozin et al. (1999) found that the French were the most food-pleasure-oriented and the least
517 food-health-oriented. This observation could partly explain why some items from the original
518 scale were excluded in the French scale. For example, items 3 and 16 might be related to

519 pleasure in our French sample and lack discriminative capacity (50.7 and 48.9 % of
520 participants, respectively, answered “agree” to these items). In addition, the items presented
521 cross-loadings on several factors.

522 In the CFA, the three first-order factors loaded substantially on a broader intuitive
523 eating dimension, supporting the use of the IES-2 total score. As expected, differences were
524 found according to sex. Women had lower scores on IES-2, Eating for Physical Reasons, and
525 Unconditional Permission to Eat than did men. Women are generally more likely to be
526 dissatisfied with their bodies and hence to follow restrictive dieting (French Agency for Food,
527 Environmental and Occupational Health & Safety, 2010), independent of physiological
528 signals. The literature also indicates greater emotional eating in women compared with men
529 (Peneau et al., 2013). However, we found no significant differences between men and women
530 for Reliance on Hunger and Satiety Cues. In the original work (Tylka & Kroon Van Diest,
531 2013), men had greater Reliance on Hunger and Satiety Cues scores than did women in two
532 out of the three studies performed. Denny et al. (2013) found that more young adult men than
533 young adult women reported trusting their bodies to tell them how much to eat but there were
534 no differences in their reports of stopping to eat when full. This issue remains unclear and
535 deserves additional investigation. Current dieters had highly significantly lower total IES-2
536 scores than did former dieters and even lower scores than did those who had never dieted, as
537 hypothesized (Tylka & Kroon Van Diest, 2013; Tribole & Resch, 2003). Likewise, the
538 intuitive eating score also varied across weight status categories, as previously observed
539 (Tylka & Kroon Van Diest, 2013). Moreover, IES-2 total scores were negatively related to
540 cognitive restraint, emotional eating, and uncontrolled eating, as measured by the TFEQ-R21
541 in accordance with the definition of intuitive eating, as previously discussed. In addition, IES-
542 2 was negatively correlated with depressive symptoms and positively correlated with positive
543 feelings. In contrast to dieting, intuitive eating is considered beneficial to psychological

health, and has been found to be related to several indices of well-being (Tylka & Kroon Van Diest, 2013). The resulting shortened French IES-2 scale still captured the same general meaning of the construct as the original IES-2. Moreover, the scale had good internal consistency and good test-retest reliability over an 8-week period. The instrument was well accepted in our population-based sample. Most participants found the IES-2 questionnaire to be easy to complete, short and clear.

The present validation study presents several strengths. First, it included a large general-population-derived sample with both men and women, and wide age range and educational levels. It allowed cross-validating the model across two independent datasets, as recommended (Brown, 2006; Kline, 2011), and examining differences by sex, age and educational level. Moreover, we used a random sample selected in order to be representative of the French population (French National Institute of Statistics and of Economic Studies, 2009). However, from the original randomly-drawn 1000 participants, 63% were included in the present analysis and therefore the final sample may not be fully representative. Whereas the distribution by sex and age remained close to that observed in the French population, the distribution by educational level diverged noticeably mainly due to a lower response rate of participants with low formal education. Next, we used polychoric correlations which are suitable for studying associations among ordered categorical variables (based on Likert scales), thus allowing a more accurate estimation of the parameters (Flora et al., 2012; Holgado-Tello, Chacon-Moscoso, Barbero-Garcia, & Vila-Abad, 2010). Likewise, we calculated an ordinal version of the alpha coefficient (Gadermann et al., 2012) and selected the ULS estimation method recommended for the analyses of polychoric correlations (de los Angeles Morata & Holgado-Tello, 2013; Flora et al., 2012). Finally, the use of a web-based version of the questionnaire is known to positively impact data quality since missing,

inconsistent or abnormal data can be minimized by adding alerts to users (Touvier et al., 2010).

During the translation and cultural adaptation process, we aimed to produce content equivalency between the original and adapted versions. However, the validation study revealed some challenges regarding the understanding of several questions from the Unconditional Permission to Eat and Body-Food Choice Congruence factors, which could be due to cultural differences in addition to the major differences in sample composition. Therefore, comparisons of intuitive eating behaviors across both cultures, French and American, are liable to be imperfect when considering the total IES-2 and the Unconditional Permission to Eat scores. Some limitations in the study design should also be mentioned. Caution is needed when generalizing our results since the NutriNet-Santé is a long-term web-based cohort and participants are recruited on a voluntary basis, implying that they are likely to be health-conscious and interested in nutritional issues. We used self-reported anthropometric data, which that may have led to misclassification. However, the validity of the web-based self-reported height and weight from the NutriNet-Santé study was recently demonstrated via comparisons with standardized clinical measurements on a subsample (n=2513) of the cohort (Lassale et al., 2013).

CONCLUSION

In the present study, we adapted the IES-2 to the French language and population. The scale thus included three dimensions: Eating for Physical Rather than Emotional Reasons, Reliance on Hunger and Satiety Cues and Unconditional Permission to Eat. Overall, the French version of the instrument demonstrated good psychometric properties. Moreover, this study extended previous knowledge by relying on a population-based sample. Thus, the French IES-2 may be of benefit as a short and understandable tool in general and clinical population studies to accurately assess the overall tendency to eat intuitively and the change

in such behavior over time in French-speaking samples. Future studies using large samples of the general population are needed to explore the relationship between intuitive eating, BMI, and dietary intake as well as individual characteristics associated with intuitive eating to better understand the underlying mechanism by which individual factors and eating behaviors interact and intervene in weight control.

ACKNOWLEDGMENTS

We thank all scientists, dietitians, technicians, and assistants who help carry out the NutriNet-Santé study. We especially thank Gwenael Monot, Younes Esseddik, Yasmina Chelghoum, Mohand Ait Oufella, Paul Flanzy, and Thi Hong Van Duong (computer scientists); Veronique Gourlet, Charlie Menard, Fabien Szabo, Nathalie Arnault, Laurent Bourhis, and Stephen Besseau (statisticians); and Florence Charpentier and Charlotte Voegtlin (dietitians). We are grateful to the volunteers of the NutriNet-Santé study. This study is being supported by the following institutions: the Ministère de la Santé, the Institut de Veille Sanitaire, the Institut National de la Prévention et de l'Education pour la Santé, the Fondation pour la Recherche Médicale, the Institut National de la Santé et de la Recherche Médicale, the Institut National de la Recherche Agronomique, the Conservatoire National des Arts et Métiers, and the Université Paris 13.

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