

Eating Disorders Inventory: Assessment of its Construct Validity in a Nonclinical French Sample of Adolescents

Christophe Maïano · Alexandre J. S. Morin ·
Johana Monthuy-Blanc · Jean-Marie Garbarino ·
Yannick Stephan

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Abstract Recent studies have questioned the appropriateness of the original Eating Disorders Inventory (EDI) in nonclinical samples of adolescents. The main objective of the present series of studies is to systematically test the construct validity of the EDI (i.e. content, factorial, convergent, discriminant and discriminative) in a nonclinical sample of French adolescents. A total sample of 1,323

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C. Maïano (✉)
UMR 6233 “Institute of Movement Sciences,
Etienne-Jules Marey”, CNRS-University of Aix-Marseille II,
163 Avenue de Luminy, CP 910,
13288 Marseille Cedex 9, France
e-mail: christophe.maiano@univmed.fr

A. J. S. Morin
FLSH, Department of Psychology, University of Sherbrooke,
Sherbrooke, QC, Canada

J. Monthuy-Blanc
EA 4206 “Addictive, Performance and Health Behaviors”,
University of Montpellier I,
Montpellier, France

J.-M. Garbarino
Laboratory “Human motricity, Education, Health”,
University of Nice Sophia-Antipolis,
Nice, France

Y. Stephan
EA 3742 “Sport and Social Environment”,
University Joseph Fourier,
Grenoble, France

adolescents was involved in these five studies. The factorial validity and the measurement invariance of the EDI were verified through confirmatory factorial analyses. Correlation and student t-tests were also used to test the convergent and discriminative validity of the EDI. Results from the first study confirmed the unsuitability of the French original EDI for young adolescents. Items were re-worded and an adaptation for adolescents was developed (EDI-A). The following four studies provided support for the factorial validity, measurement invariance, reliability, convergent validity and discriminant validity for a short form (i.e. 24 items) of the EDI-A. The present results thus provide preliminary evidence regarding the construct validity of the 24-item EDI-A for French nonclinical adolescents. Recommendations for future uses and research activities with this instrument in French speaking adolescents are outlined.

Keywords Adolescents · Nonclinical ·
Eating disorders inventory · Confirmatory factor analysis ·
French · Measurement invariance

Given their prevalence, severity and multiple consequences, anorexia nervosa, bulimia nervosa and binge eating disorders represent a significant public health problem for western societies (Fairburn and Harisson 2003). Consequently, clinicians and researchers are increasingly interested in the measure of Eating Disorders (ED) symptoms and related characteristics (associated behaviors, attitudes and personality characteristics) in children and adolescents and rely on these measures to identify those who might benefit from early interventions because they: (i) are at risk of developing ED on the basis of their attitudes and behaviors, or (ii) currently present subclinical symptoms of ED

(Schoemaker et al. 1994; Smolak and Levine 1994). Indeed, the roots of clinical ED (anorexia nervosa, bulimia nervosa, and binge ED) often emerge in the preadolescent period (Golden et al. 2003) and body shape dissatisfaction and dieting appear to already represent widespread attitudes and behaviors in middle school (O'Dea and Abraham 1996). Early evaluation of ED symptoms and associated characteristics during childhood and adolescence thus represent an important part of efficient public health intervention because recovery rates are higher for patients treated in the early stages (Lock et al. 2001).

Among the various instruments used to evaluate ED symptoms and their associated characteristics, the Eating Disorders Inventory (EDI; Garner et al. 1983) has gained considerable popularity with both clinicians and researchers (Espelage et al. 2003). One of the main advantages of this instrument relative to other instruments is that it assesses, in addition to ED symptoms per se, an important array of behavioral and psychological characteristics (personality and attitudes) known to be associated with these disorders. This instrument was originally validated in a mixed sample (i.e. normal and clinical: anorexia nervosa, bulimia nervosa, binge ED and obesity) of North American adults ($n=1164$). It is comprised of 64 items and assesses eight dimensions: (i) Body Dissatisfaction (BD; dissatisfaction with the “maturational” areas of the body: thighs, hips, buttocks...); (ii) Bulimia (BU; tendency towards episodes of uncontrollable overeating and self-induced vomiting); (iii) Drive for Thinness (DT; excessive preoccupation with weight and dieting, and intense pursuit of thinness); (iv) Ineffectiveness (IN; feelings of general inadequacy, insecurity, and not being in control of one's life); (v) Perfectionism (PF; excessive and unrealistic standards for one's behavior and achievements); (vi) Interpersonal Distrust (ID; tendency to avoid intimate, open communication and relationships with others); (vii) Interoceptive Awareness (IA; confusion and apprehension about emotional experience, and difficulty in identifying emotions and bodily sensations); and (viii) Maturity Fears (MF; Yearnings for childhood, and reluctance to assume adult responsibilities). The three first scales (BD, BU and DT) measure behavioral symptoms of ED and the other five (IN, IA, ID, PF, MF) refer to psychological characteristics commonly associated with ED (Muro-Sans et al. 2006; Tachikawa et al. 2004).

In their initial study, Garner et al. (1983) confirmed, on adult samples, the convergent validity of the full scale and subscales of the EDI with measures of self-esteem ($r=-.76$ and $r=-.57$ with the IN and ID subscales), body dissatisfaction ($r=.51$ with the BD subscale), anxiety ($r=.45$ with the IN subscale) and ED ($r=.51$ between the Eating Attitudes Test and the DT subscale). Other studies confirmed those results within additional samples of adults (Berland et al. 1986; Raciti and Norcross 1997). This

instrument was later updated by the original author (Garner 1991a; EDI-2) with the inclusion of 27 additional items measuring additional personality characteristics commonly associated with ED and forming three new scales: (ix) Asceticism (pursuing virtue via self-denial or restraint); (x) Impulse regulation (impulsivity and hostility); and (xi) Social insecurity (social self-doubts and unhappiness). No changes to the original eight scales were made. Although the psychometric properties of the new scales appeared satisfactory (Garner 1991a), they are very seldom used in recent studies (Espelage et al. 2003). For this reason and to ensure comparability and consistency with results from other studies, the present studies focused only on the EDI original eight scales.

The factor structure of the EDI has been extensively cross-validated in English (Eberenz and Gleaves 1994; Espelage et al. 2003; Welch et al. 1990) and non-English (Criquillion-Doublet et al. 1993; Guimera and Torrubia 1987; Norring and Sohlberg 1988; Shimura et al. 2003; van Strien and Ouwens 2003; Thiel and Paul 1988) clinical and mixed adult and adolescent samples. The results from these studies clearly replicated the factor structure of the EDI in clinical samples of adult and adolescent. However, the results were less consistent in nonclinical samples. Table 1 shows the summary of a literature review, conducted in different databases (i.e. Current contents, Francis, Medline, Psychology and Behavioral Science Collection, PsycINFO), on the results from nonclinical studies of the EDI. Half (five out of ten) of the studies conducted on adults or on mixed adolescent and adult samples failed to replicate the original eight-factor structure of the EDI and yielded highly heterogeneous solutions (see Table 1). These results suggest solutions ranging from one (Bennett and Stevens 1997) to six dimensions (Klemchuk et al. 1990), and including from 26 (Joiner and Heatherton 1998; Limbert 2004) to 64 items (Klemchuk et al. 1990). The findings from the studies in which the factor structure of the EDI was exclusively tested in nonclinical adolescent populations are illustrated in Table 1 and also failed to replicate the original eight factor structure with the three different versions of the EDI (EDI, EDI-2 and EDI-2 for Children¹—EDI-C: Garner 1991b). The obtained solutions ranged from three (Phelps and Wilczenski 1993) to eight dimensions (Franko et al. 2004) and included between 52 (Schoemaker et al. 1994) and 91 items (Muro-Sans et al. 2006). Standing alone, these results cast serious doubt on the appropriateness of this instrument as a screening tool

¹ It is a version of the EDI-2 questionnaire that has been developed especially for children and adolescents. In this adaptation the wording of the EDI-2 was modified to be consistent with youth's lower levels of vocabulary.

Table 1 Studies on the factorial structure of EDI's forms in a nonclinical sample

| References | EDI version | Country | Female | Male | Total | Sample | Factorial analysis (Reliability/intercorrelation) | Mean/SD age (Range) | Supports the original factors | Adequate items-scale correspondence | Number of factors | Number of items |
|------------------------------|-------------|---------|--------|------|-------|------------|--|-------------------------------------|-------------------------------|-------------------------------------|-------------------|--------------------|
| Lee et al. (1997) | 1 | CN | 606 | 566 | 1,172 | Adult | PCA** with OR (.70-.92 [‡] ; .62-.89 [†] /.09-.73 [#]) | 20.16-20.17/1.13-1.34 (18-28/18-26) | Yes | Yes | 8 ^a | 61 ^d |
| Wicks et al. (2004) | 1 | NZ | 266 | - | 266 | Adult | CFA* with parceling (.77-.94/.14-.86) | 19.90/NR (18-28) | Yes | Yes | 8 ^a | 64 ^d |
| Raciti and Norecross (1987) | 1 | US | 238 | - | 238 | Adol/Adult | PCA* with VR (.79-.93/.03-.79) | 18.00/0.78 (NR) | Yes | Yes | 8 ^a | 45 ^d |
| Machado et al. (2001) | 1 | SP | 274 | 67 | 341 | Adol/Adult | PCA** with OR (.69-.93/.003-.45) | 20.3-21.1/3.95-8.47 (15-62/15-51) | Yes | Yes | 8 ^a | 62 ^d |
| van Strien and Ouwens (2003) | 2 | NL | 492 | - | 492 | Adult | EFA** with MLE and VR (.75-.94/NR) | 22.80/4.35 (NR) | Yes | Yes | 8 ^a | 49 ^d |
| Bennett and Stevens (1997) | 1 | GB | 310 | - | 310 | Adol/Adult | PCA* with VR (NR) | 24.40/ NR (16-65) | No | No | 1/6 ^a | 35/34 ^d |
| Joiner and Heatherton (1998) | 1 | US | 1,162 | - | 1,162 | Adult | PCA* with OR/VR (NR/.02-.68) | 20.01/1.70 (NR) | No | Yes | 5 ^b | 26 ^d |
| Klemchuk et al. (1990) | 1 | US | 1,506 | - | 1,506 | Adult | PCA* with OR/VR (NR/NR) | 18.3-20.6/0.7-1.0 (17-31) | No | No | 6 ^a | 64 ^d |
| Limbirt (2004) | 1 | GB | 647 | - | 647 | Adol/Adult | PCA* with VR (.55-.83/NR) | 23.30/7.10 (16-60) | No | Yes | 5 ^b | 26 ^d |
| Welch et al. (1988) | 1 | NZ | 587 | - | 587 | Adult | FACTOREP* (.70-.94/NR) | 20-26/NR (NR) | No | No | 3 ^a | 44 ^d |
| Franko et al. (2004) | 1-C | US | 2,379 | - | 2,379 | Adol | PCA* with OR (.46-.93 [◊] ; .15-.87; NR) | NR/NR (11-12) | No | No | 8 | NR |
| Eklund et al. (2005) | 2-C | FI | 481 | 417 | 898 | Ch/Adol | EFA** with MLE and OR/VR (.63-.91/.51-.97) | NR/NR (9-16) | No | No | 5 ^c | 64 ^c |
| Muro-Sans et al. (2006) | 2 | SP | 563 | 574 | 1,137 | Adol | EFA with PAF with OR (.63-.90/NR) | NR/NR (10-16) | No | No | 5 ^c | 91 ^e |
| Phelps and Wilczenski (1993) | 2 | US | 122 | - | 122 | Adol | PCA* with VR (.51-.87/NR) | 16.95/1.35 (12-18) | No | No | 3 ^c | 55 ^e |
| Schoemaker et al. (1994) | 1 | NL | 735 | - | 735 | Adol | PCA** with VR (.51-.87/NR) | 15.60/1.50 (13-20) | No | No | 5 ^a | 52 ^d |
| van Strien and Ouwens (2003) | 2 | NL | 724 | - | 724 | Adol | EFA**/**, MLE with VR (.64-.93/NR) | 15.60/1.50 (12-18) | No | No | 7 ^a | NR ^d |

EDI Eating disorders inventory; SD Standard deviation; CN China; NZ New Zealand; US United States; GB Great Britain; FI Finland; NL Nederland; SP Spain; CH Children; Adol Adolescent; PCA Principal component analysis; CFA Confirmatory factor analysis; EFA Exploratory factor analysis; MLE Maximum likelihood; PAF Principal axis factoring; OR Oblique rotation; VR Varimax rotation; NR Not reported

*transformed scores; **untransformed scores; ^a 8-factor were tested; ^b 5-factor were tested; ^c 11-factor were tested; ^d 64-item were tested; ^e 91-item were tested; [†] Male sample; [‡] Female sample; [#] total sample; [◊] White girls; [•] Black girls

for the identification of individuals who are likely to present or develop significant levels of ED in younger nonclinical populations. However, the many methodological limitations present in these studies suggest that more rigorous investigation is needed before any conclusions regarding the appropriateness of this instrument for younger populations can be reached.

First, with the exceptions of Franko et al.'s (2004) and Eklund et al.'s (2005) studies, which relied either on an adaptation of the EDI for children and adolescents (Franko et al. 2004) or on Garner's (1991b) EDI-C (Eklund et al. 2005), none of the other studies verified whether the items used in their EDI versions were appropriately formulated for a nonclinical sample of youths. Yet, the suitability of the adult versions of the EDI within younger populations has previously been questioned (Williams 1987). Recently, Franko et al. (2004) showed that, to be clearly understood by children and adolescents, 29 items from the original EDI needed to be slightly re-worded and 19 items significantly changed. Given these results, it is possible that the inconsistent results obtained in the various adolescents' samples relates to the concomitant lack of adaptation of the questionnaire to children and adolescents' vocabulary.

Second, the various versions of the EDI are quite lengthy (i.e. EDI: 64-item; EDI-2 and EDI-C: 64-item or 91-item) and take between 30 min to 45 min to complete (Petty et al. 2000). These characteristics are problematic for two reasons. First, according to Petty et al. (2000) long questionnaires may be problematic when they are used by youths with reading difficulties and short attention spans, as well as with clinical populations. Shorter questionnaires increase the probability that youths will maintain attention and provide valid answers to the instrument. Second, several authors suggest that the EDI can be used as a screening instrument with nonclinical samples (for a review see, Kashubeck-West et al. 2001). However, screening measures are usually brief (Anderson et al. 2004), which allows their incorporation in the multidimensional instruments that are often used in mass community screenings and in extensive developmental studies. The length of the current versions of the EDI would thus clearly impede its efficacy and versatility as a screening tool for community samples of children and adolescents. Today, numerous instruments already exist for the screening of ED in nonclinical children adolescents, such as the Eating Attitudes Test (EAT; Garner and Garfinkel 1979), the EAT-26 (Garner et al. 1982), the Bulimia Test-Revised (Thelen et al. 1991) and the Dutch Eating Behavior Questionnaire (van Strien et al. 1986). Nevertheless, whereas the EDI evaluates ED behavioral symptoms and a wide array of associated psychological characteristics, these other instruments assess a more restricted range of ED symptoms and associated characteristics and are often

limited to a specific form of ED such as anorexia nervosa or bulimia nervosa. However, numerous research (for a review see Cassin and von Ranson 2005) has recently stressed the importance of personality traits and attitudes in the onset, symptomatic expression, and maintenance of ED. The assessment of these psychological characteristics commonly associated with ED should thus be considered as a priority for ED early identification and prevention programs (e.g. Golden et al. 2003). For this reason, the EDI does present a clear advantage over competitive instruments and the development of a valid short form of this instrument adapted to younger populations would clearly represent an improvement for ED screening and for extensive developmental studies of young community samples. As recommended in the literature (for reviews, see Marsh 2007; Marsh et al. 2005), initial attempts to develop short versions should comprise a minimum of three indicators per latent factor (i.e. 24 items in the case of the EDI). This minimum is important for many reasons: (i) to ensure without added constraints the local identification of confirmatory factor models; (ii) to allow for the elimination of potentially problematic items while retaining multiple indicators per construct; (iii) to maintain the content coverage of each factor, and (iv) maintain internal consistency coefficient in a modest to acceptable range ($\alpha > 70$ and $\alpha > 80$).

Third, all of the aforementioned studies examined the dimensionality of the EDI through exploratory factor or principal components analysis. Despite the relative accuracy of exploratory methods, Confirmatory Factor Analysis (CFA) appears to represent a more rigorous and complete approach to the verification of the construct validity of psychometric tools (Byrne 2005). The advantage of CFAs is that it allows for the *a priori* specification of a factor structure consistent with a model-based hypothesis-testing framework, as opposed to the post-hoc labeling of extracted factors that is the norm in exploratory analysis. Since CFA gives the researcher the ability to verify the adequacy of the hypothetical factor structure (or of alternative hypothetical structures) against observations, to directly model measurement errors, it is considered as the gold-standard method for the evaluation of the construct validity of psychometric inventories (Bagozzi and Kimmel 1995; Byrne 2005).

Fourth, in contrast to studies conducted on adult samples none of the validation studies realized in nonclinical samples of adolescents did verify: (i) the convergent validity of the EDI with instruments measuring similar (i.e. disturbed eating attitudes) and related concepts (e.g. self-esteem, anxiety and body image; see Garner et al. 1983), (ii) the capacity of the EDI to correctly discriminate clinical versus nonclinical levels of ED, and (iii) the replicability of the obtained factor structure in a cross validation sample. Indeed, most of the studies conducted on

children and adolescent samples limited themselves to the evaluation of the factor validity of the EDI within a single sample. Finally, two-thirds of these studies relied on samples composed exclusively of girls. It is thus currently unknown whether the factor structure of the EDI is appropriate for boys. Although ED is much more prevalent among girls, boys may also suffer from ED at an increasing rate (Eliot and Baker 2001; O’Dea and Abraham 1996). This observation justifies the need for gender-based comparative studies. However, such studies rely on measurement scales that are psychometrically equivalent (i.e. that measure the same thing) on boys and girls. The verification of the gender-based measurement invariance of EDI would thus be a prerequisite step to such studies (Vandenberg and Lance 2000) and would be particularly important given the fact that ED are known to take different forms and to emerge from different risk factors in boys and girls (Fairburn and Harisson 2003).

In this context, the objectives of the present series of studies were to: (i) test the suitability of the French version of the EDI in a nonclinical adolescent’s sample; (ii) examine the factor validity of the EDI in multiple nonclinical adolescent samples through CFA; (iii) develop a *short* form of the EDI comprised of 24 items (i.e. with three items per factor) and easy to complete with minimal effort for youths (Petty et al. 2000); and (iv) more extensively verify the convergent and discriminant validity of the EDI.

Study 1

The objective of the first study was to test the suitability of the French version of the EDI in a nonclinical sample of adolescents.

Method

*Sample*² Two samples (A and B) of 20 adolescents³ (ten boys and ten girls), aged between 11 years and 12 years old, were recruited from two middle and high schools from Northern and southern France. The descriptive statistics of these samples are presented in Table 2. This age bracket

² All participants gave written informed consent, and the research protocol was approved by the local Ethical Committee.

³ All participants met the following inclusion criteria: (i) they had no self-reported history of eating disorders and obesity and were neither underweight, overweight or obese at the time of the study (according to body mass index cut-off scores for males and females adolescents provided by Cole et al. 2000, 2007); (ii) they had to be schooled in regular classes and thus presented no intellectual, motor or sensory disability (according to the French education policies); (iii) they had never repeated a school year according to their self-reports.

Table 2 Statistics descriptive for all samples

| Study and sample | Age | | BMI† | |
|---------------------------|-------|------|-------|------|
| | M | SD | M | SD |
| Study 1 | | | | |
| Total | 11.40 | 0.50 | 19.98 | 1.46 |
| Subsample A | | | | |
| Total | 11.47 | 0.51 | 20.05 | 1.49 |
| Boys | 11.50 | 0.53 | 20.09 | 1.33 |
| Girls | 11.44 | 0.53 | 20.01 | 1.72 |
| Subsample B | | | | |
| Total | 11.37 | 0.50 | 19.92 | 1.46 |
| Boys | 11.40 | 0.52 | 20.05 | 1.38 |
| Girls | 11.33 | 0.50 | 19.78 | 1.59 |
| Study 2 | | | | |
| Samples | | | | |
| Total | 13.82 | 1.30 | 19.56 | 2.37 |
| Boys | 13.84 | 1.37 | 19.65 | 2.71 |
| Girls | 13.66 | 1.34 | 19.47 | 2.02 |
| Test/retest sample | | | | |
| Total | 13.17 | 0.73 | 20.07 | 1.51 |
| Boys | 13.31 | 0.81 | 20.23 | 1.57 |
| Girls | 13.00 | 0.60 | 19.86 | 1.45 |
| Study 3 | | | | |
| Total | 13.89 | 1.63 | 19.34 | 2.99 |
| Boys | 13.87 | 1.58 | 19.80 | 2.77 |
| Girls | 13.90 | 1.68 | 18.95 | 3.12 |
| Study 4 | | | | |
| Total | 14.32 | 1.51 | 19.42 | 2.05 |
| Boys | 14.40 | 1.55 | 19.72 | 2.04 |
| Girls | 14.25 | 1.72 | 19.22 | 2.04 |
| Study 5 | | | | |
| Total | 15.13 | 0.82 | 17.58 | 2.41 |
| Anorexic | 15.20 | 0.86 | 15.98 | 1.72 |
| Nonclinical | 15.07 | 0.80 | 19.19 | 1.87 |

† Body mass index was calculated on the basis of the adolescents’ self-reported weight and height and the following formula: weight/height² (Cole 1979)

M Mean; SD Standard deviation; BMI Body mass index

was chosen in order to adapt the questionnaire to young adolescents.

Measure The original French version of the EDI (Criquillon-Doulet et al. 1993; Garner et al. 1983) was used to assess the disordered eating behaviors and the personality characteristics related to ED. This version comprises 64 items designed to evaluate the eight original dimensions (BD, BU, DT, IN, PF, ID, IA, MF: these dimensions were defined earlier). In this instrument participants were asked to indicate how frequently they were characterized by each

of the items on a six-point scale ranging from always (5) to never (0)⁴. The items were then summed to obtain global and subscale-specific scores.

In this study, the original response format was replaced by a five-point Likert scale designed to assess item clarity (i.e. from 1 = not at all clear to 5 = completely clear). The directives were specific regarding the fact that the term clarity referred to the meaning of the items and not to specific linguistic difficulties. Following the completion of the questionnaires individual interviews were conducted to investigate the reason for the lack of clarity of the items according to participants' answers (e.g. language difficulties, wording of items...).

Procedure The adolescents completed the original 64-item French version of the EDI (Criquillon-Doublet et al. 1993) in standardized conditions (i.e. isolation, quiet classroom conditions, assistance for reading if necessary).

Data Analysis The verification of items' clarity was performed following Vallerand's (1989) recommendations. An item with a clarity score of less than four out of five was considered unsatisfactory (Vallerand 1989). For the unsatisfactory items, follow up interviews were conducted with participants to identify the problems. The results from these interviews were used to adapt the items to French adolescents' vocabulary levels.

Results and Discussion

Analysis⁵ of item clarity of the original French version of the EDI in the first adolescents' sample (sample A) revealed that three fourths of the items (i.e. 47) were considered unsatisfactory using Vallerand's (1989) proposed criteria. Moreover, the subsequent interviews revealed that in the current French version of the EDI: (i) six items (i.e. 8, 14, 19, 22, 29 and 44) needed precision (e.g. Until what age are we a child?, What is an emotion?, What is a feeling?, etc.); (ii) 18 items (i.e. 1, 4, 7, 10–13, 16, 23–26, 40–41, 54, 58, 60, 64) needed to be slightly re-worded or simplified

(unclear words were, for instance: carbohydrates, ineffective, outstanding communicate, identify, etc.); and (iii) 23 items (i.e. 2, 3, 6, 15, 17–18, 20–21, 27–28, 30, 32–34, 36, 38–39, 42, 47–48, 50–51, 63) needed to be changed significantly [i.e. item 2: "I think my belly is swelled" rather than "I think my stomach is too big"; item 15: "I show my emotions (i.e. joy, sadness, anger) easily to others" rather than "I am open about my feelings", etc.]. A new version involving precisions, simplifications and complete rewording of the problematic items was thus developed in collaboration with two experts from the ED field [i.e. one clinical psychologist (PhD) and one psychiatrist (MD)]. In this version the scoring principles were the same as for EDI except that two items (33, 40) were now scored in the opposite direction (i.e. reversed score). This version will hereafter be referred to as the EDI for adolescents (EDI-A).

The evaluation of the clarity of the items from this new version was carried out with the second sample (sample B). The procedure was the same as described above and the item clarity was again scored on the same five-point Likert scale. Analyses⁶ revealed that the EDI-A items were now easily understandable by young adolescents. These results suggest that the EDI-A present a content and wording that is appropriate for French-speaking adolescents. Items from the French and English version of the EDI-A are provided in Table 3.

Study 2

The objectives of the second study were to: (i) examine the factor validity of the EDI-A in a nonclinical adolescent's samples through confirmatory factor analyses, and (ii) develop a *short* form of the EDI-A comprising three items per factor.

Method

Sample⁷ A sample of 597 adolescents⁸ (286 boys and 311 girls), aged between 11 years and 18 years and attending regular classes, was recruited from five middle and high schools located in southern France. In addition, 52 of those

⁴ The original untransformed scales were used, in all analyses, rather than the suggested "clinical" recoded scales (scores ranging from 0 to 3 with zero combining the three lower levels of the original six-point scale; see Garner et al. 1983). Indeed, many authors (Eklund et al. 2005; Lee et al. 1997; Machado et al. 2001; Schoemaker et al. 1994; van Strien and Ouwens 2003) showed that the transformation of the original scale to a four-point scale seriously damaged the validity and integrity of the EDI in nonclinical samples. This appears to be related to the resulting lower variability of the data and higher levels of skewness, which affected its factorial integrity and internal consistency.

⁵ Details about item-specific results are available upon request from the first author.

⁶ Details about item-specific results are available upon request from the first author.

⁷ All participants gave written informed consent, and the research protocol was approved by the local Ethical Committee.

⁸ All participants met the following inclusion criteria: (i) they had no self-reported history of eating disorders and obesity and were neither underweight, overweight or obese at the time of the study (according to body mass index cut-off scores for males and females adolescents provided by Cole et al. 2000, 2007); (ii) they had to be schooled in regular classes and thus presented no intellectual, motor or sensory disability (according to the French education policies); (iii) they had never repeated a school year according to their self-reports.

Table 3 Items of the eating disorders inventory for adolescents

| | |
|---|-------|
| 1. Je mange des bonbons et des sucreries sans me sentir coupable (<i>I eat candies and sweets without feeling guilty</i>) | *DT§ |
| 2. Je trouve que mon ventre est gonflé (<i>I think that my belly is swelled</i>) | BD§ |
| 3. J'aimerais pouvoir me sentir protégé(e) comme dans mon enfance (<i>I would like to feel protected as when I was a child</i>) | MF§ |
| 4. Je mange quand je suis contrarié(e) (<i>I eat when I am upset</i>) | BU§ |
| 5. Je me gave de nourriture (<i>I stuff myself with food</i>) | BU† |
| 6. J'aimerais paraître plus jeune que je ne le suis (<i>I would like to look younger than I am</i>) | MF§† |
| 7. J'ai envie de faire un régime (<i>I feel like going on a diet</i>) | DT§† |
| 8. J'ai peur lorsque j'ai des émotions (joie, tristesse, colère...) trop fortes [<i>I get frightened when my feelings (joy, sadness, anger...) are too strong</i>] | IA§ |
| 9. Je trouve que mes cuisses sont trop fortes (<i>I think my thighs are too large</i>) | BD |
| 10. Je me sens nul(le) (<i>I feel worthless</i>) | IN§† |
| 11. Je me sens extrêmement coupable après avoir mangé plus que d'habitude (<i>I feel extremely guilty after eating more than usual</i>) | DT§ |
| 12. Je pense que mon ventre est juste à la bonne taille (<i>I think that my belly is just the right size</i>) | *BD§ |
| 13. Pour ma famille, seules les performances qui sortent de l'ordinaire comptent (<i>Only outstanding performances matter to my family</i>) | PF§† |
| 14. La période la plus heureuse de ma vie est l'enfance (entre 3 et 10 ans) [<i>The happiest time in my life is childhood (from 3 years to 10 years old)</i>] | MF§† |
| 15. Je montre facilement mes émotions (joie, tristesse, colère...) aux autres [<i>I show easily my emotions (joy, sadness, anger) to others</i>] | *ID§ |
| 16. J'ai très peur de grossir (<i>I am very afraid of becoming fat</i>) | DT§† |
| 17. Je fais confiance aux autres (<i>I have trust in others</i>) | *ID§† |
| 18. Personne ne s'intéresse à moi (<i>Nobody is interested in getting to know me</i>) | IN§† |
| 19. Je suis satisfait(e) de ma silhouette (forme générale du corps) [<i>I am satisfied with my figure (whole body shape)</i>] | *BD§ |
| 20. En general, je m'oppose à ce que les autres peuvent me dire (<i>I generally rebel against what I am told</i>) | *IN§ |
| 21. Je n'arrive pas à gérer les émotions (joie, tristesse, colère...) que je ressens [<i>I cannot manage to control my feelings (joy, sadness, anger)</i>] | IA§ |
| 22. Je préférerais être adulte plutôt qu'enfant (entre 3 et 10 ans) [<i>I would rather be an adult than a child (from 3 years to 10 years old)</i>] | *MF§ |
| 23. Je discute facilement avec les autres (<i>I easily discuss with others</i>) | *ID§† |
| 24. J'aimerais être une autre personne (<i>I would like to be someone else</i>) | IN§ |
| 25. J'accorde beaucoup d'importance à mon poids (<i>My weight is very important to me</i>) | DT§ |
| 26. J'arrive à reconnaître clairement les émotions (joie, tristesse, colère...) que je ressens [<i>I can clearly identify the emotions (joy, sadness, anger...) that I feel</i>] | *IA§ |
| 27. Je suis à la hauteur quelque soit la situation (<i>I am always up to the task, no matter what</i>) | *IN§ |
| 28. Il y a des moments où je suis capable de manger de très grandes quantités de nourriture sans pouvoir m'arrêter (<i>There are times when I can eat tons of food without being able to stop myself</i>) | BU§† |
| 29. Quand j'étais enfant (entre 3 et 10 ans), je faisais tout pour éviter de décevoir mes parents et mes professeurs [<i>As a child (from 3 years to 10 years old), I tried very hard to avoid disappointing my parents and teachers</i>] | PF§ |
| 30. J'établis facilement des contacts avec les autres (<i>I easily develop relationships with others</i>) | *ID§† |
| 31. J'aime la forme de mes fesses (<i>I like the shape of my buttocks</i>) | *BD† |
| 32. Je suis inquiet(iète) à l'idée de grossir (<i>I am worried about gaining weight</i>) | DT§† |
| 33. Je me sens bien dans ma peau (<i>I feel good about myself</i>) | *IA§ |
| 34. J'ai du mal à montrer mes émotions (joie, tristesse, colère) aux autres [<i>I have trouble expressing my emotions (joy, sadness, anger) to others</i>] | ID§ |
| 35. Les exigences du monde des adultes sont trop grandes (<i>The demands of adulthood are too great</i>) | MF |
| 36. J'aime être le(la) meilleur(e) quand je fais les choses (<i>I like to be the best when I do something</i>) | PF§ |
| 37. Je me sens sûr(e) de moi (<i>I feel confident about myself</i>) | *IN |
| 38. Je pense à manger de très grandes quantités de nourriture (<i>I think about eating very large amounts of food</i>) | BU§† |
| 39. Je suis heureux(se) d'être un(e) adolescent(e) et non plus un(e) enfant (entre 3 et 10 ans) [<i>I am happy to be a teenager rather than a child (from 3 years to 10 years)</i>] | *MF§ |
| 40. Je sens lorsque j'ai faim ou lorsque je n'ai pas faim (<i>I can feel when I am hungry and when I am not</i>) | *IA§ |
| 41. J'ai une mauvaise opinion de moi-même (<i>I have a bad opinion of myself</i>) | IN§† |
| 42. Je me sens capable d'atteindre les objectifs que je me fixe (<i>I feel that I can achieve the goals that I set for myself</i>) | *IN§ |
| 43. Mes parents se sont toujours attendus à ce que je sois excellent(e) (<i>My parents always expected excellence from me</i>) | PF |
| 44. J'ai peur de ne plus contrôler mes émotions (joie, tristesse, colère...) [<i>I worry that my feelings (joy, sadness, anger...) may get out of control</i>] | IA§† |
| 45. Je trouve que mes hanches sont trop fortes (<i>I think my hips are too big</i>) | BD |
| 46. Je mange modérément devant les autres et je me gave quand ils sont partis (<i>I eat moderately in front of others and stuff myself when they are gone</i>) | BU |

Table 3 (continued)

| | |
|--|------|
| 47. Mon ventre est très gonflé après avoir mangé un repas habituel (<i>My belly is very stuffed after eating a regular meal</i>) | IA§† |
| 48. Je pense que j'étais plus heureux(se) quand j'étais enfant (entre 3 et 10 ans) [<i>I was happier when I was a child (from 3 years to 10 years old)</i>] | MF§† |
| 49. Si je prends 500 grammes, j'ai peur de continuer à grossir (<i>If I gain a pound, I worry that I will keep fattening</i>) | DT |
| 50. Je pense que les autres m'apprécient (<i>I think that others like me</i>) | *IN§ |
| 51. Quand je suis contrarié(e), je ne sais pas si je suis triste, si j'ai peur ou si je suis en colère (<i>When I feel annoyed, I don't know if I am sad, frightened or angry</i>) | IA§ |
| 52. Je dois faire les choses parfaitement ou ne pas les faire du tout (<i>I must do things perfectly or not do them at all</i>) | PF† |
| 53. Je pense à vomir pour perdre du poids (<i>I think of vomiting in order to loose weight</i>) | BU |
| 54. J'ai besoin de rester seul(e) (je me sens mal si quelqu'un essaye de se rapprocher) [<i>I need to be alone (I feel uncomfortable when someone tries to get close)</i>] | ID§ |
| 55. Je trouve que mes cuisses sont juste à la bonne taille (<i>I think that my thighs are just the right size</i>) | *BD† |
| 56. Je me sens vide intérieurement (émotionnellement) [<i>I feel empty inside (emotionally)</i>] | IN |
| 57. J'arrive à parler de mes sentiments (<i>I can talk about personal thoughts or feelings</i>) | *ID |
| 58. Les meilleures années de ma vie sont celles où je deviendrai adulte (<i>The best years of my life are when I will become an adult</i>) | *MF§ |
| 59. Je trouve que mes fesses sont trop grosses (<i>I think that my buttocks are too large</i>) | BD |
| 60. J'ai des sentiments (amour, amitié, haine...) que je n'arrive pas à définir clairement [<i>I have feelings (love, friendship, hate...) that I cannot describe quite clearly</i>] | IA§ |
| 61. Je mange ou je bois en cachette (<i>I eat or drink in secrecy</i>) | BU |
| 62. Je trouve que mes hanches sont tout à fait de la bonne taille (<i>I think that my hips are just the right size</i>) | *BD† |
| 63. Je me fixe des objectifs extrêmement élevés (<i>I set extremely high goals for myself</i>) | PF§† |
| 64. Quand je suis contrarié(e), j'ai peur de commencer à manger (<i>When I feel annoyed, I'm worried that I will start eating</i>) | IA§† |

*reversed score; DT Drive for thinness; BU Bulimia; BD Body dissatisfaction; IN Ineffectiveness; PF Perfectionism; ID Interpersonal distrust; IA Interoceptive awareness; MF Maturity fears; § items that were modified to develop the adolescent version of the EDI; † items that were retained in the final version of the EDI for adolescents

(29 boys and 23 girls), were retested after 2-weeks. The descriptive statistics of this sample are presented in Table 2.

Measures and Procedure The EDI-A developed in the first study was completed by all participants in the same aforementioned standardized conditions. This version comprises 64 items and evaluates the eight original dimensions of the EDI: BD, BU, DT, IN, PF, ID, IA, MF. Participants were asked to indicate how frequently they were characterized by each of the items on a six-point scale ranging from always (5) to never (0)⁹. The items were then totaled to obtain global and subscale-specific scores.

Data Analysis In this study, analyses were conducted in two stages. In the first stage, a CFA was used to verify whether the

hypothetical factor structure of EDI-A provided an adequate representation of the observed data. This CFA model hypothesized that: (i) answers to the EDI-A could be explained by eight factors; (ii) each item would have a non-zero loading on the EDI-A factor it was designed to measure, and zero loadings on all other factors; (iii) the eight factors would be correlated; and (iv) measurement error terms would be uncorrelated. Because of the significant multivariate non-normality of the data (normalized kurtosis coefficients of 388.258) for each of the eight subscales, the CFAs were performed using bootstrapped Maximum Likelihood (ML) estimation with AMOS 7.0 (Arbuckle 2006). All fit indices are thus based upon Bollen-Stine bootstrap p-value and bootstrap adjusted chi-square and goodness of fit indexes (Yuan and Hayashi 2003).

Because the overall length of the EDI-A may represent a problem in younger populations, this model will then be used as a starting point for the development of a short version of the EDI-A, even if the obtained fit indices are less than optimal. Development and selection of this 24-item version will be performed based on the criteria proposed by Marsh et al. (2005), and Smith et al. (2000). Thus, the following criteria were used in the selection of the items: (i) items that best measured the intended construct as

⁹ The original untransformed scales were used, in all analyses, rather than the suggested "clinical" recoded scales (scores ranging from 0 to 3 with zero combining the three lower levels of the original six-point scale; see Garner et al. 1983). Indeed, many authors (Eklund et al. 2005; Lee et al. 1997; Machado et al. 2001; Schoemaker et al. 1994; van Strien and Ouwens 2003) showed that the transformation of the original scale to a four-point scale seriously damaged the validity and integrity of the EDI in nonclinical samples. This appears to be related to the resulting lower variability of the data and higher levels of skewness, which affected its factorial integrity and internal consistency.

inferred on the basis of corrected item-total correlation and the size of standardized factor loading in CFA; (ii) items that had minimal cross-loadings as evidenced by modifications indices; (iii) items that had a minimal correlated uniquenesses, particularly with other items in the same scale as evidenced by modifications indices; (iv) items that were very seldom left blank by respondents; and (v) positive subjective evaluations made by the research team of the content of each item in order to maintain the breadth of content of the original construct.

In the second stage, the 24-item version of the EDI-A generated in the first stage was used to test the measurement invariance of CFA model across gender in the sequential order recommended by Pentz and Chou (1994): configural invariance (baseline), factor loadings invariance, factor variance invariance and factor covariance invariance. The invariance of the indicator uniqueness (error) terms was not tested as this was deemed too stringent a criterion for model invariance (Byrne 2004; Hagger et al. 2003, 2005). The reference model for comparison was the baseline (i.e. configural invariance). Finally, the temporal stability of the resulting EDI-A was estimated using test-retest correlations on a sub-sample of 52 adolescents who were re-tested over a 2-week period.

Assessment of fit for the CFA models was based on multiple indicators: the Chi-square statistic (χ^2), the Goodness of Fit Index (GFI), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Standardized Root Mean square Residual (SRMR), the Root Mean Square Error of Approximation (RMSEA) and the 90% confidence interval of the RMSEA (RMSEA 90% CI). Values greater than .90 for GFI, CFI and TLI are considered to be indicative of adequate model fit, although values greater than .95 are preferable (Byrne 2005; Hu and Bentler 1999). Values smaller than .08 or .05 for the RMSEA and smaller than .10 and .08 for the SRMR support respectively acceptable and good model fit (Hu and Bentler 1999; Vandenberg and Lance 2000). Concerning the RMSEA 90% CI, values less than .05 for the lower bound (left side) and less than .08 for the upper bounds (right side) or containing 0 for the lower bound and less .05 for the upper bounds (right side) indicate respectively acceptable and good model fit (MacCallum et al. 1996). Factor loadings, square multiple correlations, standard errors and *t* values were also inspected for appropriate sign and/or magnitude. Critical values for the tests of gender and multi-group measurement invariance were evaluated by the examination of several criteria: χ^2 difference tests and CFI's and RMSEAs changes (Chen 2007; Cheung and Rensvold 2002; Vandenberg and Lance 2000). A CFI difference of .01 or less and RMSEA differences of .015 or less between a baseline model and the resulting model indicate that the invariance hypothesis should not be rejected. Finally, reliability was computed from the model's standard-

ized parameters estimates, using the formula (Bagozzi and Kimmel 1995): $\rho = (\sum \lambda_i)^2 / ([\sum \lambda_i]^2 + \sum \delta_{ii})$ where λ_i is the factor loading and δ_{ii} the error variances.

Results and Discussion

Stage 1 The CFA models of the EDI-A are displayed in Table 4. The 64-item CFA model exhibited significant bootstrapped χ^2 values, GFI, CFI and TLI under .90 and SRMR and RMSEA were slightly over .05. Examination of the model parameters revealed that some items: (i) had low factor loadings; (ii) had low square multiple correlations; and (iii) presented elevated modifications indices (cross loadings, correlated uniquenesses, etc.). Thus, as illustrated in Table 5, the most problematic items were removed and the CFAs were replicated until a reasonable fit was obtained for the model. Finally, the best-fitting three items per subscale were kept and a 24-item version of the EDI-A was obtained (EDI-A-24). The CFA model for the EDI-A-24 still showed significant bootstrapped χ^2 values (Table 4). However, the obtained GFI, CFI and TLI now exceeded .90, and the SRMR and RMSEA were under .05. All loadings in this CFA model were significant and substantial (Table 5). These results support the factorial validity of the measurement model of the EDI-A-24.

In this version, all subscales presented modest to acceptable reliability (ρ) coefficients (i.e. ranging from .74 for the BD subscale to .96 for the full scale). These coefficients are encouraging at this stage given the low number of items included in each subscale. Latent variables intercorrelations are provided in Table 6. They are statistically significant in most cases. The test-retest reliability correlation coefficients of the EDI-A-24 were highly satisfactory in all cases (i.e. ranging from .75 for the BD subscale to .91 for the full scale).

Stage 2 The results from gender-based measurement invariance tests provided in Table 4 show that: (i) none of the χ^2 and $\Delta\chi^2$ tests were significant; (ii) the GFIs, CFIs, TLIs, SRMRs and RMSEAs values all indicate adequate model fit; (iii) Δ CFIs values did not exceed .01; and (iii) the Δ RMSEAs values did not exceed .015. This study thus provides satisfactory preliminary evidence regarding the psychometric properties of the EDI-A-24 for male and female adolescents.

Study 3

The objective of the third study was to cross-validate in a new independent sample of adolescents the factor structure and measurement invariance across gender of the EDI-A-24.

Table 4 Goodness-of-fit statistics of EDI-A and EDI-A-24 models^a

| Study and Stage | N° of items | CFA Model | Description | χ^2 (B-S) | df | GFI | CFI | TLI | SRMR | RMSEA | RMSEA 90% CI | $\Delta\chi^2$ | Δdf | $ \Delta CFI $ | $ \Delta RMSEA $ | | |
|----------------------|-------------|----------------------------------|--|-------------------------|-------|------|------|------|------|-------|--------------|----------------|-------------|----------------|------------------|------|------|
| Study 2 | | | | | | | | | | | | | | | | | |
| Stage 1 ^c | 64 | Garner et al. (1983) | 8-correlated factor | 5,153.426* ^b | 1,924 | .755 | .648 | .631 | .060 | .053 | | – | – | – | – | – | |
| | 24 | Alternative—Garner et al. (1983) | 8-correlated factor | 264.931* | 224 | .946 | .940 | .926 | .049 | .038 | .032–.043 | – | – | – | – | – | |
| Stage 2 ^c | 24 | Gender-invariance tests | A—No invariance | 544.304* | 448 | .915 | .925 | .907 | .056 | .029 | .024–.033 | – | – | – | – | – | |
| | | | B— λ s invariant | 569.447* | 464 | .912 | .921 | .906 | .057 | .029 | 024–.033 | 25.14 | 16 | .004 | .000 | .000 | |
| | | | C— λ s, ξ s invariant | 572.454* | 472 | .911 | .921 | .908 | .058 | .028 | 024–.033 | 28.15 | 24 | .004 | .001 | .001 | |
| | | | D— λ s, ξ s, φ s invariant | 605.697* | 499 | .908 | .919 | .910 | .062 | .028 | 024–.032 | 61.39 | 51 | .006 | .000 | .000 | .000 |
| Study 3 | | | | | | | | | | | | | | | | | |
| Stage 1 ^d | 24 | Alternative—Garner et al. (1983) | 8-correlated factor | 265.974* | 224 | .940 | .933 | .918 | .056 | .041 | 035–.046 | – | – | – | – | – | |
| Stage 2 ^d | 24 | Gender-invariance tests | A—No invariance | 551.992* | 448 | .907 | .923 | .905 | .058 | .031 | 026–.036 | – | – | – | – | – | |
| | | | B— λ s invariant | 575.975* | 464 | .903 | .917 | .901 | .061 | .032 | 027–.036 | 23.98 | 16 | .006 | .001 | .001 | |
| | | | C— λ s, ξ s invariant | 583.747* | 472 | .902 | .917 | .903 | .062 | .031 | 027–.036 | 31.76 | 24 | .006 | .000 | .000 | |
| | | | D— λ s, ξ s, φ s invariant | 605.174* | 499 | .895 | .913 | .902 | .066 | .031 | 027–.036 | 53.18 | 51 | .010 | .000 | .000 | |
| Stage 3 ^e | 24/24 | Multiple-group tests | A—No invariance | 534.048* | 448 | .942 | .934 | .918 | .047 | .028 | 025–.031 | – | – | – | – | – | |
| | | | B— λ s invariant | 552.272* | 464 | .940 | .931 | .918 | .049 | .028 | 025–.031 | 18.22 | 16 | .003 | .000 | .000 | |
| | | | C— λ s, ξ s invariant | 565.033* | 472 | .940 | .932 | .920 | .050 | .027 | 025–.030 | 30.99 | 24 | .002 | .001 | .001 | |
| | | | D— λ s, ξ s, φ s invariant | 599.258* | 499 | .939 | .933 | .925 | .059 | .027 | 024–.029 | 65.21 | 51 | .001 | .001 | .001 | .001 |

CFA Confirmatory factor analytic model; χ^2 (B-S) Bollen-Stine chi-square; *df* Degrees of freedom; *GFI* Goodness of fit index; *CFI* Comparative fit index; *TLI* Tucker-Lewis index; *SRMR* Standardized root mean square residual; *RMSEA* Root mean square error of approximation; *RMSEA 90% CI* Root mean square error of approximation 90% confidence interval; λ Factor loading; ξ Factor variance; φ Factor covariance; $\Delta\chi^2$ Change in goodness-of-fit χ^2 relative to baseline model; Δdf Change in degrees of freedom relative to baseline model; ΔCFI Change in comparative fit index relative to baseline model; $\Delta RMSEA$ Change in root mean square error of approximation relative to baseline model

^a Bootstrapped goodness of fit indexes are reported in this table because of the significant multivariate non-normality within these data; ^b Non bootstrapped goodness of fit indexes; ^c $N=597$; ^d $N=542$; ^e $N=1,139$; * $p < .01$

Table 5 CFA's factor loadings-uniquenesses

| Factor | Item n° | Study 2 ^a | | Study 3 ^b |
|--------|---------|-------------------------|------------------|----------------------|
| | | EDI-A λ(δ) | EDI-A-24 λ(δ) | EDI-A-24 λ(δ) |
| DT | 1 | .002(.01) ^c | | |
| | 7 | .735(.54)† | .702(.49)† | .686(.47)† |
| | 11 | .630(.40) | | |
| | 16 | .839(.70) | .853(.73) | .864(.75) |
| | 25 | .665(.44) | | |
| | 32 | .806(.65) | .819(.67) | .836(.70) |
| | 49 | .646(.42) | | |
| IA | 8 | .382(.15) | | |
| | 21 | .403(.16) | | |
| | 26 | −.069(.01) ^c | | |
| | 33 | −.413(.17) | | |
| | 40 | −.100(.01) ^c | | |
| | 44 | .611(.37)† | .528(.28)† | .432(.19)† |
| | 47 | .465(.22) | .406(.16) | .425(.18) |
| | 51 | .442(.20) | | |
| BU | 4 | .414(.17) | | |
| | 5 | .584(.34) | .605(.37) | .573(.33) |
| | 28 | .618(.38)† | .658(.43)† | .663(.44)† |
| | 38 | .708(.50) | .788(.62) | .666(.60) |
| | 46 | .565(.32) | | |
| | 53 | .256(.07) ^c | | |
| | 61 | .482(.23) | | |
| | BD | 2 | .468(.22) | |
| 9 | | .452(.20) | | |
| 12 | | −.634(.40) | | |
| 19 | | −.656(.43) | | |
| 31 | | .442(.20) | .446(.20) | .575(.33) |
| 45 | | .422(.18) | | |
| 55 | | −.733(.54)† | .817(.67)† | .820(.67)† |
| 59 | | .581(.34) | | |
| IN | 10 | .605(.37)† | .635(.40)† | .628(.39)† |
| | 18 | .403(.16) | .432(.19) | .563(.32) |
| | 20 | .096(.01) | | |
| | 24 | .534(.29) | | |
| | 27 | −.390(.15) | | |
| | 37 | .539(.29) | | |
| | 41 | .677(.46) | .714(.51) | .665(.44) |
| | 42 | −.392(.15) | | |
| | 50 | −.351(.12) | | |
| | 56 | .244(.06) | | |

Table 5 (continued)

| Factor | Item n° | Study 2 ^a | | Study 3 ^b |
|--------|---------|-------------------------|------------------|----------------------|
| | | EDI-A λ(δ) | EDI-A-24 λ(δ) | EDI-A-24 λ(δ) |
| MF | 3 | .403(.16) | | |
| | 6 | .345(.12) | .401(.19) | .433(.21) |
| | 14 | .601(.36)† | .571(.33)† | .598(.36)† |
| | 22 | .002(.001) ^c | | |
| | 35 | .210(.04) | | |
| | 39 | −.195(.04) | | |
| | 48 | .583(.34) | .676(.46) | .883(.78) |
| PF | 58 | .119(.01) | | |
| | 13 | .453(.23)† | .491(.25)† | .437(.21)† |
| | 21 | .338(.16) | | |
| | 36 | .466(.22) | | |
| | 52 | .471(.22) | .517(.27) | .570(.33) |
| | 63 | .528(.28) | .440(.19) | .635(.40) |
| | 43 | .460(.21) | | |
| ID | 15 | .193(.04) | | |
| | 17 | .403(.16) | .442(.22) | .487(.28) |
| | 23 | .426(.18)† | .470(.18)† | .792(.63)† |
| | 30 | .812(.66) | .971(.74) | .742(.55) |
| | 34 | −.211(.04) | | |
| | 54 | −.124(.02) | | |
| | 57 | .271(.07) | | |

† item that was set to be 1.0; λ Loadings; δ Uniquenesses; *DT* Drive for thinness; *BU* Bulimia; *BD* Body dissatisfaction; *IA* Interceptive awareness; *IN* Ineffectiveness; *PF* Perfectionism; *ID* Interpersonal distrust; *MF* Maturity fears

^a loadings that were non significant ($p > .05$); ^b $N = 597$; ^c $N = 542$

Method and Analyses

A cross-validation sample of 542 adolescents^{10, 11} (251 boys and 291 girls), aged between 11 years and 18 years, was recruited from four middle and high schools located in southern France. The overall sample completed the previ-

¹⁰ All participants gave written informed consent, and the research protocol was approved by the local Ethical Committee.

¹¹ All participants met the following inclusion criteria: (i) they had no self-reported history of eating disorders and obesity and were neither underweight, overweight or obese at the time of the study (according to body mass index cut-off scores for males and females adolescents provided by Cole et al. 2000, 2007); (ii) they had to be schooled in regular classes and thus presented no intellectual, motor or sensory disability (according to the French education policies); (iii) they had never repeated a school year according to their self-reports.

Table 6 Factor correlations among latent factors according to EDI-A-24 version

| Scales | DT | BU | BD | IN | PF | ID | IA | MF |
|--------|-------------------|-------|--------|--------|-------|-------|-------|------|
| DT | 1.00 | | | | | | | |
| BU | -.04 ^a | 1.00 | | | | | | |
| | .10 ^b | | | | | | | |
| BD | -.43** | .12* | 1.00 | | | | | |
| | -.42** | .03 | | | | | | |
| IN | .45** | .15* | -.44** | 1.00 | | | | |
| | .46** | .23** | -.36** | | | | | |
| PF | .17* | .37** | .29** | .23* | 1.00 | | | |
| | .18** | .36** | .23** | .26** | | | | |
| ID | .02 | .01 | .23** | -.31** | .11 | 1.00 | | |
| | .10 | .01 | .16* | -.30** | .13 | | | |
| IA | .73** | .37** | -.26** | .65** | .49** | .09 | 1.00 | |
| | .71** | .50** | -.33** | .58** | .59** | .02 | | |
| MF | .10 | .26** | .05 | .44** | .36** | -.11 | .43** | 1.00 |
| | .14* | .07 | .03 | .34** | .31** | -.21* | .46** | |

DT Drive for thinness; *BU* Bulimia; *BD* Body dissatisfaction; *IN* Ineffectiveness; *PF* Perfectionism; *ID* Interpersonal distrust; *IA* Interoceptive awareness; *MF* Maturity fears

^a 24 items EDI-A from study 2; ^b 24 items EDI-A from study 3; * $p < .05$; ** $p < .001$

ously described EDI-A-24 in the same aforementioned standardized conditions. The descriptive statistics of the sample are illustrated in Table 2.

In this study, CFAs analyses of the 24 items EDI-A were performed in three stages using bootstrapped Maximum Likelihood (ML) estimation with AMOS 7.0 (Arbuckle 2006) for non-normal data (normalized coefficients values for kurtosis of 107.343). In the first stage, the CFA model was applied to this sample to cross-validate the determined factor structure of the 24-item EDI-A. Then, in the second stage, the measurement invariance of this model across gender was also verified in the sequential order recommended by Pentz and Chou (1994). Finally, in the third stage, multi-groups CFAs were conducted to test the invariance of the measurement model of the 24-item EDI-A between the samples from the second and third studies. These multiple-groups CFAs were conducted in the sequential order recommended by Byrne (2004).

Results and Discussion

Stage 1 As illustrated in Tables 4 and 5, the CFA models of the EDI-A-24 replicated, in this new independent sample, those from the second study and revealed acceptable goodness of fit indices (i.e. GFI, CFI, TLI >.90; SRMR <.06; RMSEA <.05; significant loadings and acceptable composite reliability coefficients). These results thus cross-

validate the factorial structure of the EDI-A-24 in a second independent sample.

Stage 2 The results from the CFA gender-based measurement invariance tests are reported in Table 4. These results also replicate the results from the second study in this new independent sample and confirm the measurement invariance across gender of the EDI-A-24.

Stage 3 The multiple-group measurement invariance tests (see Table 4) were used to compare the measurement model of the 24 items EDI-A across the samples from the second and third studies. The results from these analyses showed that: (i) none of the χ^2 and χ^2 values of differences tests were significant; (ii) the GFIs, CFIs, TLIs, SRMRs and RMSEAs values all indicate adequate model fit; and (iii) Δ CFIs and Δ RMSEAs values remained under the recommended cut-off points (.01 and .015, respectively). These results suggest that the measurement model of the EDI-A-24 was fully invariant across both samples.

Study 4

The objective of the fourth study was to verify the convergent validity of the EDI-A-24 with measures of self-esteem, social physique anxiety, body image disturbance and disturbed eating attitudes.

Method

Sample¹² and Procedure A sample of 114 adolescents¹³ (67 boys and 47 girls), aged between 11 years and 18 years and attending regular classes, was recruited from three middle and high schools located in southern France. The descriptive statistics of the sample are illustrated in Table 2. All adolescents completed, in the same aforementioned standardized conditions, the EDI-A-24, the French versions of the short form (26 items) of the Eating Attitudes Test (EAT-26; Garner et al. 1982), the Rosenberg Self-Esteem Inventory (Rosenberg 1965), the Social Physique Anxiety Scale (Hart et al. 1989) and the Body Image Avoidance Questionnaire (Rosen et al. 1991).

Measures The French version of the EAT-26 (Garner et al. 1982; Leichner et al. 1994) was used to evaluate the presence of disturbed eating attitudes and behaviors. Items on the scale examine restrictive eating, fear of gaining weight and becoming fat, binge eating, and some aspects of body image disturbance such as preoccupation with weight and shape. This instrument is comprised of three subscales that can be combined into a global composite score: (i) Dieting, (ii) Bulimia and food preoccupation, and (iii) Oral control. Participants were asked to indicate how frequently they were characterized by each of the items on a six-point scale ranging from always (6) to never (1). These answers were recoded according to Garner et al. (1982) recommendations into a four-point scale ranging from 0 to 3, with zero combining the least symptomatic answers (1-2-3) from the original rating scale. The items were then totaled to obtain global and subscale-specific scores. In this study, only the global scale score was used.

The French version of the Rosenberg Self Esteem Inventory (RSEI; Rosenberg 1965; Vallières and Vallerand 1990) was used to assess overall feelings of self-worth or self-acceptance. The ten items were rated on a four-point Likert scale ranging from strongly disagree (1) to strongly agree (4). The items are then totaled to obtain a global scale score.

The French version of the Social Physique Anxiety Scale (SPAS; Hart et al. 1989) was used to determine the extent to which participants became anxious when they reflected about what others would think of their physical appearance. The 12 items are rated on a five-point Likert scale ranging from not at all (1) to extremely (5). The items are then totaled to obtain a global scale score.

The French version of the Body Image Avoidance Questionnaire (BIAQ; Rosen et al. 1991; Maïano et al. 2009) was used to evaluate the behavioral manifestations of body image disturbances through situations that usually provoke body image concerns (i.e. wearing tight-fitting clothes, social activities, physical intimacy, weighing, exercising and eating with others). This instrument comprises four subscales that can be combined into a global composite score: (i) Clothing; (ii) Social activities; (iii) Eating restraint; and (iv) Grooming and Weighing. The 19 items are rated on a six-point Likert scale ranging from never (0) to always (5). The items were then summed to obtain global and subscale-specific scores. In this study, only the global scale score was used.

Data Analysis The convergent validity of the 24 items EDI-A with another measure of eating disorders (i.e. EAT-26) and with measures of self-esteem (i.e. RSEI) social physique anxiety (i.e. SPAS) and body image disturbance (i.e. BIAQ) was tested relying on Pearson correlations. A Bonferroni correction was applied to minimize Type I error rate inflation. The alpha error was thus set at $.05/5 = .01$.

Results and Discussion

As reported in Table 7, the internal consistency coefficients of the different instruments which were administered were all in the acceptable range (.73–.89). First, these results revealed that most of the EDI-A-24 subscales were positively and significantly correlated with the global scale score of the EAT-26 (see Table 7), with the largest coefficients for full scale ($r=.59, p<.001$), IA ($r=.56, p<.001$), DT ($r=.54, p<.001$) and PF ($r=.53, p<.001$). Second, the analyses showed that most of the EDI-A-24 subscales were significantly and positively correlated with the SPAS (see Table 7), with the strongest coefficients for IA ($r=.42, p<.001$) and IN ($r=.37, p<.001$). Third, most EDI-A-24 subscales were significantly and positively correlated with the global scale score of the BIAQ (see Table 7), with the greatest coefficients for IA ($r=.55, p<.001$) and full sale ($r=.37, p<.001$). Finally, some EDI-A-24 subscales were, as expected, negatively and significantly correlated with the RSEI (see Table 7), with the largest correlations for IN ($r=-.49, p<.001$) and IA ($r=-.35, p<.001$). These results thus support the convergent validity of the EDI-A-24.

¹² All participants gave written informed consent, and the research protocol was approved by the local Ethical Committee.

¹³ All participants met the following inclusion criteria: (i) they had no self-reported history of eating disorders and obesity and were neither underweight, overweight or obese at the time of the study (according to body mass index cut-off scores for males and females adolescents provided by Cole et al. 2000, 2007); (ii) they had to be schooled in regular classes and thus presented no intellectual, motor or sensory disability (according to the French education policies); (iii) they had never repeated a school year according to their self-reports.

Table 7 Convergent and discriminant validity of the EDI-A-24

| Scales | EAT ^a | SPAS ^a | RSEI ^a | BIAQ ^a | Alpha ^a |
|--------------------|------------------|-------------------|-------------------|-------------------|--------------------|
| DT | .54** | .30** | -.27** | .29** | .75 |
| BU | .25** | .10 | -.08 | .11 | .74 |
| BD | .18 | .27** | -.21 | .15** | .75 |
| IN | .34** | .37** | -.49** | .21* | .73 |
| PF | .53** | .18 | -.12 | .30** | .75 |
| ID | .21* | .05 | -.10 | .20* | .73 |
| IA | .56** | .42** | -.35** | .55** | .75 |
| MF | .35** | .17* | -.15* | .29** | .73 |
| Full | .59** | .31** | -.29** | .37** | .89 |
| Alpha ^a | .89 | .84 | .81 | .78 | |

| Scales | Nonclinical sample ^b M(SD) | Anorexic sample ^b M(SD) | t(28) | p | d |
|---------|--|---------------------------------------|-------|-------|------|
| DT | 4.07(3.57) | 11.73(3.97) | 5.56 | <.001 | 2.02 |
| BU | 1.33(1.23) | 5.00(5.52) | 2.51 | .02 | 0.92 |
| BD | 6.00(4.54) | 12.00(4.19) | 3.76 | .001 | 1.38 |
| IN | 2.80(2.21) | 10.07(3.37) | 6.98 | <.001 | 2.55 |
| PF | 5.27(3.03) | 10.07(2.69) | 4.59 | <.001 | 1.68 |
| ID | 3.60(2.80) | 7.60(4.08) | 3.12 | .004 | 1.87 |
| IA | 4.73(4.27) | 11.33(2.72) | 5.05 | <.001 | 1.84 |
| MF | 4.60(4.14) | 8.40(3.38) | 2.76 | .01 | 1.01 |
| S-Index | 11.40(6.56) | 28.73(10.12) | 5.70 | <.001 | 2.16 |
| P-Index | 21(10.28) | 47.47(9.59) | 7.29 | <.001 | 2.76 |
| Full | 32.40(13.71) | 76.20(17.31) | 7.68 | <.001 | 3.10 |

DT Drive for thinness; BU Bulimia; BD Body dissatisfaction; IN Ineffectiveness; PF Perfectionism; ID Interpersonal distrust; IA Interoceptive awareness; MF Maturity fears; S-Index Symptom index; P-Index Personality index; EAT Eating attitudes test; SPAS Social physique anxiety scale; RSEI Rosenberg self-esteem inventory; BIAQ Body image avoidance questionnaire; d Cohen's effect size

^a N=114; ^b N=15; *p<.05; **p<.001

Study 5

The objectives of the fifth study were to: (i) test the discriminative validity of the EDI-A-24; and (ii) determine a cut-off score for the subscales and the full scale. Moreover, as recommended by Thurjfell et al. (2003), cut-off scores for a Symptom Index (S-Index) consisting of DT, B and BD and a Personality Index (P-index) consisting of IN, IA, ID, PF, MF were also calculated.

Method

*Sample*¹⁴ A sample of 30 participants, aged between 14 years to 17 years, composed of 15 nonclinical adolescent girls and 15 clinical adolescent girls suffering from Anorexia Nervosa, according to DSM-IV (American Psychiatric Association 1994) and to ICD-10 criteria (World Health Organization 1994). Nonclinical adolescents' volunteers

were recruited from a high-school in southern France. The patients were recruited from an inpatient psychiatric unit (i.e. "La Timone" Hospital) in southern France.

Measure The EDI-A-24 developed and described in the second study was used to assess the ED behavioral symptoms and associated psychological characteristics. The clinical diagnosis of the patients was reached with the fifth French version of the Mini International Neuropsychiatric Interview (MINI; Sheehan et al. 1998)¹⁵. The MINI is a short, structured diagnostic interview that can be used as a tool to diagnose 16 axis I psychiatric disorders according to DSM-IV and ICD-10 criteria. It consists of standardized, structured, close-ended questions. The interviewers read these questions verbatim to the interviewees. Psychiatric diagnosis was made according to the number of affirmative replies to diagnostic questions.

¹⁴ All participants gave written informed consent, and the research protocol was approved by the local Ethical Committee.

¹⁵ The French version of the EAT-26 (Leichner et al. 1994) was also used to confirm the results obtained with the MINI. Results from the EAT-26 both demonstrated that all patients had a score ≥ 20 , and that all nonclinical adolescents had a score < 20 .

Procedure The MINI was completed by one psychiatrist in the psychiatric unit, during the first clinical interview with the patient. Nonclinical adolescents' answers to an interview conducted by the third author with the MINI confirmed that they were physically healthy and did not suffer from any mental disorder (including ED). Each participant from this study completed the EDI-A-24 in the same standardized conditions.

Data Analysis For the discriminative validity, the difference between the clinical and nonclinical group on subscales and full scale scores were tested using several independent-samples student *t* tests (one tailed). A Bonferroni correction was applied to minimize Type I error rate inflation (alpha error was thus set at $.05/11 = .005$). For all of these analyses, the statistical power and effect sizes were computed following Cohen's (1992) suggestions. Finally, the cut-off score was computed using the formula provided by Jacobson and Truax (1991) for clinically significant change: $c = (S_{NP} * M_{CL} + S_{CL} * M_{NP}) / S_{NP} + S_{CL}$ where M_{NP} = mean of the normal population, M_{CL} = mean of the clinical group, and S_{NP} , S_{CL} = standard deviations of the normal and clinical group.

Results and Discussion

Means and standard deviations for the EDI-A-24 subscales and full scale and effect size and power estimates are presented in Table 7. Subscales and full scale scores of the EDI-A-24 were compared across the clinical and nonclinical girls' samples. Independent-samples student *t* tests performed on EDI-A's subscales and full scale revealed significant effects with large to very large effect sizes (Table 7), indicating that in all cases clinical participants provided higher scores than nonclinical participants. However, according to the Bonferroni correction (alpha set at $.005$) the BU and MF scales did not significantly allow for the differentiation of clinical and nonclinical participants. Considering the means and the standard deviations of the clinical and nonclinical girls' samples, the appropriate cut-off scores for the subscales and full scale of the EDI-A-24 were computed following the Jacobson and Truax (1991) recommendations. The different computed cut-off scores were: 8 for DT; 2 for BU; 9 for BD; 6 for IN; 8 for PF; 5 for ID; 9 for IA; 7 for MF; 18 for S-Index; 35 for P-Index and 52 for full scale¹⁶.

¹⁶ To ensure comparability with Garner's (1991b) original results, the discriminative analyses and cut-off scores were also computed for the transformed scores. These detailed results are available upon request from the first author.

General Discussion

The objective of the first study was to verify item clarity in a French adaptation of the EDI in a nonclinical sample of adolescents. The results confirm what was previously noted by Williams (1987), Garner (1991b) and more recently illustrated by Franko et al. (2004) that three fourths of the original EDI items needed more precisions, slight modification or drastic reformulation to be clearly understood by adolescents. These results confirmed in the French sample the inadequacy of the items used in the original EDI when the test was used with younger populations. Subsequent analyses performed with a new version of the EDI showed that this adaptation, the EDI-A, was easily understood by French adolescents.

The purpose of the second study was to: (i) examine the factorial validity (factor structure and measurement invariance across gender) and reliability of the EDI-A; and (ii) develop a short version of this instrument, the EDI-A-24. The initial CFA failed to support the original eight-factor model of the 64-item version of the EDI-A. These preliminary results are consistent with those from previous studies realized in nonclinical adolescent's samples (Eklund et al. 2005; Phelps and Wilzenski 1993; Schoemaker et al. 1994; van Strien and Ouwens 2003). These findings also support Petty et al.'s (2000) affirmation that the overall length of the original EDI may represent a serious problem for adolescent populations, especially for those with reading difficulties and short attention spans. Indeed, after excluding the items deemed to be most responsible for misspecifications and keeping the best set of three indicators per construct, acceptable goodness of fit indices were observed for the resulting 24 items eight-factor model (EDI-A-24). These results are consistent with those of Lee et al. (1997), Machado et al. (2001), Raciti and Norcross (1987), van Strien and Ouwens (2003) and Wicks et al. (2004) for adult samples which previously found that stronger support for the original eight-factor model could be obtained with truncated versions of the EDI, comprising a number of items ranging from 45 (Raciti and Norcross 1987) to 64 (Wicks et al. 2004). Further analysis of the EDI-A-24 confirmed that the various subscales possessed adequate internal consistency coefficients (ranging from $.73-.76$), especially given their reduced length. Indeed, according to Streiner (2003), internal consistency coefficients increase and decrease as a function of the number of items included in the scale. Moreover, the test-retest reliability correlation coefficients were also satisfactory for all subscales. The strongest support to the psychometric properties of the EDI-A-24 clearly comes from the fact that all of these results were replicated in a second independent sample in the context of the third study. This replication of the results and the fact that the resulting measurement

model proved completely invariant across both samples offset the possibility that the satisfactory results from the second study could have been the result of capitalization on chance (i.e. over fitting the model to a single sample). Clearly, these results provide support for the factorial validity and reliability of the EDI-A-24. Researchers can thus be confident in the use of this instrument among French adolescents.

Additional results further reinforce this conclusion. First, although none of the previous studies verified the measurement invariance of the EDI across gender, which is especially problematic given the known gender differences in eating disorders prevalence, the present results confirmed that the EDI-A-24 measurement model was fully invariant across gender and replicated this result in a second sample. Second, the fourth study was specifically designed to evaluate the convergent validity of the EDI-A-24. The results from this study revealed moderate correlations between the various subscales of the EDI-A-24 and measures of related concepts such as disturbed eating attitudes, self-esteem, social physique anxiety and body image disturbance. These findings were in the expected directions and were very similar to those found in previous validation studies based on clinical as well as nonclinical samples (Berland et al. 1986; Garner et al. 1983; Raciti and Norcross 1987). Analyses support the convergent validity of the EDI-A-24. Finally, the fifth study was designed to test the ability of the EDI-A-24 to discriminate between adolescent girls suffering from anorexia nervosa from a nonclinical control group of adolescent girls. Girls with anorexia nervosa presented significantly higher scores than the control girls on all subscales of the instrument, with an exception for BU and MF scales. On the basis of these results, cut-off scores were developed to help researchers, as well as clinicians, in screening adolescent girls at risk for eating disorders. This last result should however be replicated in a larger clinical sample.

Four limitations of the current series of studies must be taken into account when interpreting these findings. First, the factorial structure and measurement invariance analyses of the French EDI-A-24 were based on a sample of nonclinical adolescents. The finding indicates that the use of this instrument should be limited to samples similar to this one. Clearly, before the generalizability of the EDI-A-24 to other cultural or linguistic groups (e.g. English speaking adolescents) can be systematically investigated in other studies, its cross-cultural or linguistic use cannot be recommended. Therefore, examining the factorial structure and measurement invariance of the French EDI-A across a more diverse sample of adolescents is a future research priority. Such research could be performed using various clinical samples of adolescents (e.g. with anorexia and bulimia nervosa) and from other cultural or linguistic groups.

Second, the reliance on a cross-sectional sample also precludes the verification of the developmental stability or change of the EDI-A-24 for adolescents. Although the present study allowed for the verification of the 2-week test/retest reliability of the instruments, a complete test of the construct validity of the EDI-A-24 would involve testing the developmental change of EDI-A-24 during the early to late adolescent years. This issue should clearly be addressed in the context of longitudinal studies with different age groups and as well as with different age by gender groups.

Third, the discriminant validity and the cut-off scores for the French EDI-A-24 were established using data obtained from relatively small samples of nonclinical and clinical adolescent girls with anorexia nervosa. The possibility exists that these results may be sample specific and hence of limited generalizability. Therefore, examining the discriminant validity and establishing cut-off scores for the EDI-A-24 across boys and both clinical and nonclinical samples of adolescents should be a future research priority.

Finally, it should be noted that the process of reducing the 64-item EDI-A to a final set of 24 items could have also been accomplished by mean of item response theory (IRT) modeling (e.g. Embretson and Reise 2000). An IRT approach would have allowed the direct evaluation of the measurement precision of each of the items to the measure of ED in the target population. In the present study, the alternative and more classical recommendations of Marsh et al. (2005) and Smith et al. (2000) for CFA models were followed, in part to avoid adding non-essential complexity to this paper. These recommendations represent up-to-date, accepted standards procedures that are generally considered efficient methods for shortening measurement scales. Anyhow, as Embretson and Reise (2000) pointed out, most IRT models can themselves be understood as factor models. These authors and others (e.g. Meade and Lautenschlager 2004) showed that after comparing IRT and traditional CFA models the IRT shows some superiority for IRT models for dichotomous items, while they observed that both methods tend to produce similar results with polytomous items. Thus, we have no compelling particular reason to believe that the current results would have been meaningfully different had we used more complex IRT models.

In conclusion, the present results validated the EDI-A-24 measurement model within two independent and heterogeneous adolescent samples and suggest that this instrument may represent a cost efficient alternative for extensive developmental studies or an early detection testing battery or screening test for the presence of eating disorders in French nonclinical adolescent populations. Regarding the aforementioned limitations of these studies, it would be premature at this time to recommend the use of the EDI-A-24 in clinical adolescent samples or for other cultural or linguistic groups.

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