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Construct validity of the Nutrition and Activity Knowledge Scale in a French sample of adolescents with mild to moderate intellectual disability

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ABSTRACT

The purpose of this study was to test the reliability (i.e. internal consistency and test–retest reliability) and construct validity (i.e. content validity, factor validity, measurement invariance, and latent mean invariance) of the Nutrition and Activity Knowledge Scale (NAKS) in a sample of French adolescents with mild to moderate Intellectual Disability (ID). A total sample of 260 adolescents (144 boys and 116 girls), aged between 12 and 18 years old, with mild to moderate ID was involved in two studies. In the first study, analysis of items' content reveals that many words from the original version were not understood or induced confusion. These items were reworded and simplified while retaining their original meaning. In the second study, results provided support for: (i) the factor validity and reliability of a 15-item French version of the NAKS; (ii) the measurement invariance of the resulting NAKS across genders and ID levels; (iii) the partial measurement invariance of the resulting NAKS across age groups and type of school placement. In addition, the latent means of the 15-item French version of the NAKS proved to be invariant across gender, age categories, and ID levels, but to vary across type of school placement (with adolescents schooled in self-contained classes from regular schools presenting higher levels of NAK than adolescents placed in specialized establishments). The present results thus provide preliminary evidence regarding the construct validity of a 15-item French version of the NAKS in a sample of adolescents with ID.

1. Introduction

International research among adults with Intellectual Disability (ID) showed that they tend to present higher rates of obesity, ranging from 13% to 58%, compared to the rates observed in non-ID individuals, ranging from 3.6% to 28% (for reviews see Melville, Hamilton, Hankey, Miller, & Boyle, 2007; Rimmer & Yamaki, 2006). These results have also been more recently confirmed in various samples of adolescents with ID. Indeed, scholars from several countries (i.e. Australia, China, France, Ireland, Japan, Taiwan, and United States of America) reported an overall prevalence of obesity in youth with ID ranging from 7% to 21.9% (Bandini, Curtin, Hamad, Tybor, & Must, 2005; Bégarie, Maïano, Ninot, & Azéma, 2009; De, Small, &

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Baun, 2008; Frey & Chow, 2006; Lin, Yen, Li, & Wu, 2005; Marshall, McConkey, & Moore, 2003; Takeuchi, 1994). These rates again tended to be higher than those observed in the general population (i.e. 6% for non-ID and 15% for ID).

Among the potential determinants that may be especially important in the etiology of obesity in adults or adolescents with ID is lack of knowledge about healthy lifestyle behaviors (Melville et al., 2007; Rimmer, Rowland, & Yamaki, 2007). According to these authors, individuals with ID may have limited knowledge or understanding of the potential consequences of the health risks associated with sometimes excessive and often inadequate nutritional choices and lower levels of physical activities. Nevertheless, very few studies have been published regarding the nutritional and exercise-related level of knowledge of persons with ID in relation to their weight status. Indeed, to our knowledge, only two studies were performed on this topic during the last 10 years. The first of those was performed by Golden and Hatcher (1997) among a sample of 57 adults (32 females, 25 males; $M_{age} = 39.9$, $SD_{age} = 10.8$) with mild to moderate ID living in community-based residences. In this study the authors developed and adapted a questionnaire from a series of nutrition-related achievement tests developed by the National Dairy Council (1979). The 75 questions they used, which is a lot for individuals with ID, measured five different content areas of nutritional knowledge: (i) nutritional/physiological aspects of food; (ii) nutrients and food groups; (iii) fat, sugar and caloric content of food; (iv) weight and weight loss; and (v) exercise. Nevertheless, although they reported acceptable reliability coefficients for the total scale score ($\alpha = .93$), they did not test the factor structure of their instrument; which might be explained by the very low participants to item ratio. Results from this study reported that: (i) the overall score of nutritional knowledge of this sample was acceptable (i.e. 65% of correct answers); (ii) the intellectual quotient (IQ) significantly and negatively predicted nutritional knowledge; (iii) the body mass index significantly and positively predicted nutritional knowledge. The second study was performed by Jobling and Cuskelly (2006) among a sample of 38 adolescents (17 girls, 21 boys; $M_{age} = 15.5$, $SD_{age} = 2.29$) with Down syndrome. A semi-structured interview, measuring health knowledge and behaviors, was specifically developed by the researchers on the basis of various instruments (e.g. Social and Prevocational Information Battery, National Heart Foundation primary school health education materials). The 59 items from this interview focused on hygiene, substance use, exercise and healthy eating. In contrast to the results from Golden and Hatcher (1997), this study revealed that knowledge about substance use, exercise, and healthy food was poor in this younger population.

One reason for the paucity of research in this area is the absence of available standardized and psychometrically sound assessment tools for quantifying nutritional and exercise-related knowledge among individuals (i.e. adolescents and adults) with ID. This led Illingworth, Moore and McGillivray (2003), on the basis of Golden and Hatcher's (1997) questionnaire, to develop and validate the Nutrition and Activity Knowledge Scale (NAKS). This instrument was "*designed to assess the level of knowledge that people with an intellectual disability have about nutrition: Nutrients and foods groups; fat, sugar and caloric content of foods; weight and weight loss and the impact and benefits of activity and exercise on health*" (p. 160). The factor validity and reliability of the NAKS was tested in a sample of 73 Australian adults with ID (35 females, $M_{age} = 33.06$, $SD_{age} = 8.51$; 38 males, $M_{age} = 31.35$, $SD_{age} = 9.82$) recruited from four private facilities offering them training (i.e. employment and education in literacy, etc.) and from one facility providing 24 h residential care. Information from the facilities records on the individuals included in this sample revealed that 16% were having a severe ID, 73% a moderate ID and 11% a mild ID. Moreover, 10% of the respondents lived independently, 50% lived with their parents and 40 were in community residential units or assisted care hostels.

The original scale of this instrument comprised 35 items answered on a multiple-choice format, assessing two knowledge dimensions: (i) the Nutritional Value of Food (NVF) subscale, comprising 21 items (e.g. knowledge about food characteristics), and (ii) the Weight and Weight Control (WWC) subscale, comprising 14 items (e.g. knowledge about the benefits of exercises using sedentary and active prompts). Only one question is proposed per page and each of the multiple-choice answers are illustrated using colored "Clip art". Three fourth of the questions comprise four alternative illustrative answers presenting nutritional or physical activities alternatives. The picture comprising the correct answer is located in different positions on each of the pages to avoid a learning effect. Moreover, the same type of material was also covered in several questions to "*reduce possible confounding of understanding the question (general intelligence) and recognition/familiarity with the options offered*" (p. 160). When the response is correct one point is assigned to the participant, and in case of incorrect responses or failure to answer the question no point are deducted. Scores from the two subscales of the NAKS (i.e. NVF and WWC) are obtained by summing their respective questions and range from 0 to 21 and from 0 to 14, respectively. An overall score can be calculated and range from 0 to 35. During the administration of the instrument, the interviewer poses the relevant questions and the participants are asked to point the picture that represented their answer.

The Principal Component Analysis (PCA) performed within the aforementioned sample provided support for a truncated two factor 18-item version of the NAKS. In fact, 17 items from the original version were deleted because they failed to contribute to the factor solution. The first factor (WWC) comprises 10 items (scores ranges from 0 to 10) and the second factor (NVF) comprises 8 items (scores ranges from 0 to 8). Subsequent analyses showed that both factors were significantly correlated ($r = .33$) and presented acceptable internal consistency (WWC: $\alpha = .86$; NVF: $\alpha = .75$) and test–retest (WWC: $r = .67$; NVF: $r = .39$) coefficients. Finally, the response bias and level of acquiescence of the participants were also tested by the authors. On this topic, the results showed that the respondents did not tend to select the same quadrant/position in response to the various questions, or to systematically pick the answer (food or activity) that they liked or enjoyed the most.

A literature review conducted within several databases (i.e. Current contents, Medline, Psychology and Behavioral Science Collection, and PsycINFO) revealed that this study has yet to be replicated. This is worrying since it is a known fact that a single study is insufficient to reach clear conclusions regarding the psychometric properties of an instrument. The methodological limitations inherent in Illingworth et al. (2003) study reinforce this conclusion and the need for additional cross-validation efforts.

First, this study examined the dimensionality of the NAKS through PCA. Despite the relative accuracy of exploratory methods, Confirmatory Factor Analyses (CFA) appears to represent a more rigorous and complete approach to the verification of the construct validity of psychometric tools (e.g. Byrne, 2005). The advantage of CFAs is that they allow for 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 analyses. 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 (e.g. Byrne, 2005).

Second, the psychometric analyses of the NAKS have been confined to English-speaking samples of adults with ID. Whether the original factor structure of the NAKS can be generalized to other cultures and non-English-speaking countries is thus an open question. The analysis of the factor structure of the NAKS in another country, such as France, would ensure that the NAK construct is not biased by colloquialisms and idiosyncrasies of the language in which it was originally developed. Moreover, an accurate French version of the NAKS would help researchers interested in cross-cultural health issues to expand their studies to French-speaking samples. This would be particularly useful in bilingual countries, such as Canada, where target populations often comprise both French and English speaking participants. Studies based in Europe will also benefit from such a version since participants from at least five European countries (France, Belgium, Luxembourg, Monaco and Switzerland) tend to understand French better than English.

Third, Illingworth et al.'s (2003) study relied exclusively on a small sample of adults with ID. This clearly limits the generalizability of these results and the appropriateness of this instrument to younger samples. Indeed, it is currently unknown whether the factor structure of the NAKS is appropriate for adolescents with ID. To ensure that this instrument could be used among adolescents with ID, its factor validity and reliability in such populations must first be demonstrated. This observation is dramatically given the fact that the aforementioned epidemiologic research in adolescents with ID demonstrated that this population is at greater risk for obesity and that they should be targeted for health promotion and education programs on nutrition and exercise knowledge. Thus, before targeting youths with ID who present a higher risk of obesity based on an insufficient level of knowledge regarding healthy nutritional and behavioral habits, one needs to be able to rely on instruments that are appropriate for this population. Consequently, the appropriateness and the verification of the factor validity of the NAKS in sample of adolescents with ID should be a research priority.

Fourth, Illingworth et al. (2003) did not test the measurement invariance and the latent mean invariance of the NAKS across the specific subgroups composing their sample: gender, age categories, type of placement (i.e. integrated or segregated) and ID level (i.e. mild or moderate). This clearly questions its factor validity among these various subgroups and thus limits the NAKS generalizability. Indeed, to ensure that this test could be used among these different subgroups of individuals with ID and that comparison between these subgroups is valid, it should be shown to measure the same constructs in each of these different subgroups. In addition, measurement invariance represents a prerequisite to the verification of subgroups-based mean-level differences (e.g. Vandenberg & Lance, 2000).

Considering this, the main objective of the present series of studies was to test the construct validity of the NAKS in a large sample of adolescents with ID (i.e. content validity, factor validity and reliability, measurement invariance, latent mean invariance). Given the absence of a validated French version of the NAKS and the fact that this instrument was originally designed for adults with ID, the purpose of the first study was to develop a preliminary French version of the NAKS and to verify the content clarity of the resulting items in a sample of adolescents with ID. Indeed, in the general population, the suitability of adult versions of questionnaires within younger populations tend to be questioned, because they often relied on items in which the vocabulary is not clearly understood by children and adolescents (Harter, 1999). Thus, the appropriateness of the content of the adult NAKS items in younger populations with ID remains unknown. The second study sought to: (i) examine the factor validity and reliability (i.e. internal consistency and temporal stability) of the NAKS in a large sample of adolescents with ID; and (ii) to assess the measurement and latent mean invariance of the NAKS across gender, age, school placement and ID level.

2. Materials and methods

2.1. Participants and procedures

2.1.1. Study 1

Participants were 20 adolescents (10 boys, M_{age} = 14.56 years, SD_{age} = 2.13; 10 girls, M_{age} = 14.60 years, SD_{age} = 2.12), aged between 12 and 18 years (M_{age} = 14.58 years, SD_{age} = 2.06) and identified as having mild to moderate ID level by the Departmental Commission for the Right of Self-sufficiency of People with Disabilities (DCRSPD). All of these adolescents had an Intellectual Quotient (IQ) within the range of 70–35, were limited in their adaptive behavioral skills (Luckasson et al., 1992), attended full time one of two specialized school for ID adolescents. All participants have given written informed consent (none of the adolescents declined to participate or dropped out of the study), and the study protocol was approved by the local Ethical Committee. Items from the preliminary French version of the NAKS were read aloud by the interviewer and the adolescents were then asked whether they understood the sentence, the format of delivery and the response alternatives. The suitability of the format and the content were then more directly probed with open-ended questions such as: What is energy? What is a healthy heart? What is a food group? and What is a long walk?

2.1.2. Study 2

Participants were 240 adolescents (134 boys, M_{age} = 15.10 years, SD_{age} = 1.88; 106 girls, M_{age} = 15.08 years, SD_{age} = 2.01), aged between 12 and 18 years (M_{age} = 15.09 years, SD_{age} = 1.94) and identified as having mild to moderate ID level by the DCRSPD (IQ between 70 and 35 and limited adaptive behavioral skills). This overall sample comprised 125 adolescents with mild ID (IQ between 50 and 70) and 115 with moderate ID (IQ between 35 and 49). On the basis of the adolescents' current educational placement, two separate groups were also identified: (i) adolescents schooled full time in a regular school but within a self-contained class with other adolescents with ID (n = 102); and (ii) adolescents enrolled full time in a specialized school with other adolescents with ID (n = 138). This sample was drawn from 7 schools and 13 specialized establishments that agreed to participate in the study. All participants gave written informed consent and none declined to participate or dropped out of the study.

The French version of the NAKS developed in study 1 was administered to all participants in quiet classroom conditions in classes of up to 12 adolescents. As in study 1, items were read aloud by the interviewer and the adolescents were then asked to circle the answer directly on the questionnaire. In case of inability to circle the response, the participant was asked to point to the interviewer the picture that represented his/her answer. Additionally, 18 adolescents (M_{age} = 13.39 years, SD_{age} = 1.61), comprising 9 boys (M_{age} = 13.33 years, SD_{age} = 1.58) and 9 girls (M_{age} = 13.63 years, SD_{age} = 1.77) were re-tested after two-weeks.

2.1.3. Measures

The original version of the NAKS was translated into French following the standardized back-translation techniques widely described in the literature (Brislin, 1986; McKay et al., 1996; Van de Vrijver & Hambleton, 1996). Translation from English into French was done separately by two bilingual researchers and a bilingual translator. Thereafter, translation discrepancies between the three translated forms were discussed in order to develop an initial French version. A second bilingual translator whose native language was English, and who had not seen the original English version of the NAKS, translated this French version back into English. The back-translated version was then compared with the original English version and inconsistencies, errors, and biases were highlighted. The translation process was repeated until the back-translated versions were equivalent to the original English version. The final version exhibited no discrepancies with the original version when back-translated. As an additional check, the final version was independently reviewed by the translators to confirm that each item had kept its original meaning (Brislin, 1986).

2.2. Data analysis

In the second study, analyses were conducted in several stages. In the first stage, two first-order CFA model were used to test the factor structure of the NAKS developed in study 1. The first model hypothesized that: (i) the answers to the NAKS could be explained by one factor, (ii) each items would have a non-zero loading on the single factor, (iii) measurement error terms would be uncorrelated. The second CFA model hypothesized that: (i) the answers to the NAKS could be explained by two factors; (ii) each item would have a non-zero loading on the NAKS factor it was designed to measure, and zero loadings on the other factors; (iii) the two factors would be correlated; (iv) measurement error terms would be uncorrelated. This model was also compared to a one factor model with similar specifications. These CFAs were performed using Full-Information ML (FIML) estimation with AMOS 4.0 (Arbuckle & Wothke, 1999). FIML was selected because there were missing responses to items on the questionnaires (on the various items, the level of missingness varied from 1% to 2%).[1] The CFA model with the best fitting solution was retained. In case of inadequate fit of all of the estimated models, the best model was used as a starting point and modified on the basis of an examination of items' (i) intercorrelations, (ii) factor loadings, (iii) square multiple correlations, (iv) standard errors, (v) t values, and (vi) modification indices. The CFA was then rerun to determine whether the modification resulted in an improved fit. This process was continued until a reasonable model was generated as indicated by the absolute and incremental fit indices. Finally, the temporal stability of the resulting instrument was estimated with a test–retest reliability correlation for scale scores uncorrected for measurement errors on the data from the 18 adolescents who were re-tested after two-weeks.

In the four following stages, the French version of the NAKS was used to test the invariance of the two-factor CFA model across age category (Stage 2), gender (Stage 3), types of school placement (Stage 4) and levels of ID (Stage 5). Regarding the reduced number of participants in several of the ages categories, this variable was dichotomized into 12–14 (n = 108) and 15–18 (n = 132) years old. The models were first estimated separately in the various subsamples and then measurement

[1] It should be noted that all of these models (CFA and measurement invariance tests) were replicated using Mplus 5.22 (Muthén & Muthén, 2009). In this replication, all items were considered as categorical indicators (Millsap & Tein, 2004), and the models were estimated under the theta parameterisation and using the robust weighted least square estimator (WLSMV), which use a diagonal weight matrix with standard errors and a mean- and variance-adjusted chi-square test statistic that use a full-weight matrix (Flora & Curran, 2004; Muthén, du Toit, & Spisic, 1997). Since the results from both forms of analyses converged on the same results and to maximise the simplicity of the present manuscript, the results from the AMOS models were reported.

invariance tests were directly conducted across age categories, gender groups, types of school placement and levels of ID in the sequential order recommended by Meredith (1993). In these analyses, each model was compared to the preceding one that served as a reference model (Vandenberg & Lance, 2000).

Assessment of fit for the CFA models was based on multiple indicators (Byrne, 2005; Hu & Bentler, 1999; Vandenberg & Lance, 2000): the Chi-square statistic (χ^2), the comparative fit index (CFI), the Tucker-Lewis Index (TLI), the root mean square error of approximation (RMSEA), and the 90% confidence interval of the RMSEA. Values greater than .90 for CFI and TLI are considered to be indicative of adequate model fit (Byrne, 2005; Hu & Bentler, 1999; Vandenberg & Lance, 2000), although values approaching .95 are preferable. Values smaller than .08 or .06 for the RMSEA support respectively acceptable and good model fit (Hu & Bentler, 1999; Vandenberg & 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, Browne, & Sugawara, 1996). The factor loadings, square multiple correlations, standard errors and *t* values were inspected for appropriate sign and/or magnitude. Critical values for the tests of multi-group invariance in CFAs models were evaluated by the examination of several criterions: χ^2 difference tests and changes in CFI and RMSEA (Chen, 2007; Cheung & Rensvold, 2002; Vandenberg & Lance, 2000). A CFI difference of .01 or less and a RMSEA difference of .015 or less between a reference model and the following model indicate that the measurement invariance hypothesis should not be rejected. Vandenberg and Lance (2000) also indicate that CFI differences of .02 or more would be needed to clearly reject the measurement invariance hypothesis. Finally, the reliability was computed from the model's standardized parameters, using the formula provided by McDonald (1999): $\omega = (\Sigma\lambda i)^2/([\Sigma\lambda i]^2 + \Sigma\delta ii)$ where λi are the factor loading and δii the error variances.

3. Results

3.1. Study 1: format and content evaluation of the preliminary version of the French NAKS

The analysis of the items' content that was realized during the interview with the ID adolescents' sample reveals that three fourth of the items (i.e. 13) from the French back-translated version were problematic in this population (i.e. these items were either not understood or induced a particular answer). More precisely, four items (i.e. 4, 5, 11, and 17) needed precision or simplification: unclear words were, for instance "Healthiest breakfast", "...do you think might...", "which one...", "...would cause you to put...". In addition, nine items (i.e. 1, 2, 3, 7, 8, 9, 12, 14, and 16) needed to be significantly modified (i.e. items 3, 8, and 12: "If you want to lose weight, you should?" was replaced by "Which person will lose the most weight"; items 1 and 16: "Which activity needs the most energy?" was replaced by "Which person is spending the most energy?"; item 9: "Which foods should you not have too often" was replaced by "Which group of foods you must not eat too often?"). A new version involving precisions, simplifications and rewording of the problematic items was thus developed while retaining the original meaning of the items. In this version the scoring principles and the format of the four-point pictorial answering scale appeared adequate and was the same as for the original English version. All participants from this sample were then gathered again one week later and presented with the adapted French version of the questionnaire. This time, all adolescents clearly understood all of the questions. Consequently, these results suggest that the French adaptation of the NAKS present content and wording that is appropriate for speaking adolescents with ID. Items[2] from the adapted French version of the NAKS are provided in Table 1 with their English equivalents obtained following a back-translation procedure. One example of the answers choices used in this questionnaire is also presented in Fig. 1.

3.2. Study 2: factor validity of the French version of the NAKS

3.2.1. Stage 1

The goodness-of-fit statistics, as well as the factor loadings and uniquenesses of the CFA measurement models of the NAKS are displayed in Tables 2 and 3. The results from the one and two-factor CFA model showed (Table 2): (i) significant χ^2 values, (ii) CFI and TLI exceeding .95, and (iii) RMSEA lower than .07. Analysis reveals that the two correlated factors CFA model provide the best results (i.e. this version presented the highest scores on the CFI and TLI and the lowest scores on the RMSEA). Nevertheless, the examination of the items revealed that although most loadings were substantial and significant (Table 3), three of them (items 1, 4, and 11) were unsatisfactory (i.e. lower than .300). These items were removed and an alternative 15 items version of the French NAKS was obtained. As displayed in Table 2, the CFA for this version showed significant χ^2 values but acceptable fit indices. Moreover, all items' loadings in this CFA model were significant and exceeded .300 (Table 3).

In this 15-item version of the French NAKS, the mean scale score of the WWC and NVF scales were respectively of 7.42 (SD = 1.85) and 4.52 (SD = 1.54). These scales also presented acceptable reliability (ω) coefficients ranging from .89 for the WWC scale and .85 for the NVF scale. Latent variable correlations between the WWC and NVF scales were significant and acceptable (i.e. $r = .65$). Finally, the test–retest reliability correlation coefficients for the WWC and NVF scales were satisfactory, and respectively of .77 and .73.

[2] A full copy of the questionnaire can be obtained upon request from the first author.

Table 1
Items of the Nutrition and Activity Knowledge Scale.

1. Quelle est la personne qui dépense le plus d'énergie?	WWCΔ
Which person is spending the most energy?	
2. Quel hamburger cet homme a-t-il l'habitude de manger?	WWC†
What burger does this man usually eats?	
3. Quelle est la personne qui va perdre du poids?	WWC‡†
Which person will lose weight?	
4. Quel est le meilleur petit déjeuner pour être en bonne santé?	NVF
Which is the best breakfast to be in good health?	
5. Quelle est la personne qui va perdre le plus de poids?	WWC⌂†
Which person will lose the most weight?	
6. Cette femme va faire une longue marche avec son chien. Quel petit déjeuner doit-elle manger?	NVF≈†
This woman is going on a long walk with her dog. What breakfast should she eat?	
7. Quel est le meilleur groupe d'aliments que tu dois manger pour garder ton cœur en bonne santé?	NVF†
Which group of foods should you eat to keep your heart healthy?	
8. Quelle est la personne qui va perdre du poids?	WWC‡†
Which person is going to lose weight?	
9. Quel groupe d'aliments tu ne dois pas manger trop souvent?	NVF†
Which group of foods must you avoid eating too often?	
10. Quel est l'homme qui va prendre le plus de poids?	WWC≈†
Which man will put on the most weight?	
11. Quel est l'aliment qui a le plus de protéines?	NVF
Which food has the most protein?	
12. Quelle est la personne qui va perdre du poids?	WWC‡†
Which person is going to lose weight?	
13. Quel est l'aliment le plus gras?	NVF≈†
Which food has the most fat?	
14. Quelle est la personne qui va perdre le plus de poids?	WWC⌂†
Which person is going to lose the most weight?	
15. Quel est le groupe d'aliments qui a le plus de sucre?	WWC≈†
Which group of foods has the most sugar?	
16. Quelle est la personne qui dépense le plus d'énergie?	WWCΔ†
Which person is spending the most energy?	
17. Quel est le groupe d'aliments qui fait le plus grossir?	NVF†
Which group of foods is the most fattening?	
18. Cet homme va faire une longue marche. Quel petit déjeuner doit-il manger?	NVF≈†
This man is going for a long walk. Which breakfast should he eat?	

Note—WWC: weight and weight control; NVF: nutritional value of food; ≈: items that were not modified; Δ/‡/⌂: the formulation of these items are similar, nevertheless they comprise different set of response choice; and †: items that were retained in the final version.

3.2.2. Stage 2

The results from the measurement invariance tests are reported in Table 2. The initial analyses performed separately within both age groups revealed acceptable fit indices in both groups, with an exception for the RMSEA fit that exceed .08 in the 12–14 years old group (see Table 2). The three first steps of invariance testing (i.e. hypothesis A through C) resulted in significant bootstrap χ^2, acceptable goodness-of-fit-indices (i.e. CFI and TLI > .95; RMSEA < .06), non-significant $\Delta\chi^2$, and ΔCFIs and ΔRMSEAs that did not exceed .01 and .015, respectively. In fact, the ΔRMSEA and ΔTLI even showed an improvement of the fit indices given the fact that these indexes incorporate a penalty for parsimony so that it is possible for a more parsimonious model (a model with added constraints) to have a better fit value than a less parsimonious model (i.e. the gain in parsimony is greater than the loss in fit) (Marsh, 2007). The fourth level of measurement invariance (i.e. hypothesis D: equality constraints on items' uniquenesses) provided significant bootstrap χ^2, acceptable goodness-of-fit-indices (i.e. CFI and TLI > .95; RMSEA < .05), and ΔCFI and ΔRMSEA that did not exceed .015, although all of the indices showed a slight decrease. However, this model resulted in a significant $\Delta\chi^2$. Modification indices for this model were inspected and suggested that the age-group equality constraint should be relaxed for the uniqueness of the items no. 9 and 11 (see Table 1 for description of the items). The fifth model (i.e. hypothesis *D′*) freely estimated this parameter across age groups while keeping the other constraints and provided evidence of partial strict measurement invariance (i.e. non-significant $\Delta\chi^2$; ΔCFI < .01; ΔRMSEA < .015). The sixth model (i.e. hypothesis E) did not support the invariance of latent factors variances across age groups (i.e. significant $\Delta\chi^2$). Modification indices for this model were inspected and suggested that the age-group equality constraint should be relaxed for the NVF factor. The seventh model (i.e. hypothesis *E′*) freely estimated this parameter across age groups while keeping the other factor variance constraints and provided evidence of partial factor-invariance (i.e. non-significant $\Delta\chi^2$; ΔCFI < .01; ΔRMSEA < .015). Finally, the eighth model (i.e. hypothesis F) supports the latent factor mean invariance across groups (i.e. non-significant $\Delta\chi^2$; ΔCFI < .01; ΔRMSEA < .015).

3.2.3. Stage 3

The analyses performed separately in both gender groups revealed acceptable fit indices in both groups (Table 2). The results from the various steps of the tests of gender-related measurement invariance showed that: (i) all of the χ^2 were significant; (ii) none of the χ^2 difference tests was significant; (ii) the CFI, TLI and RMSEA indicated adequate model fit;

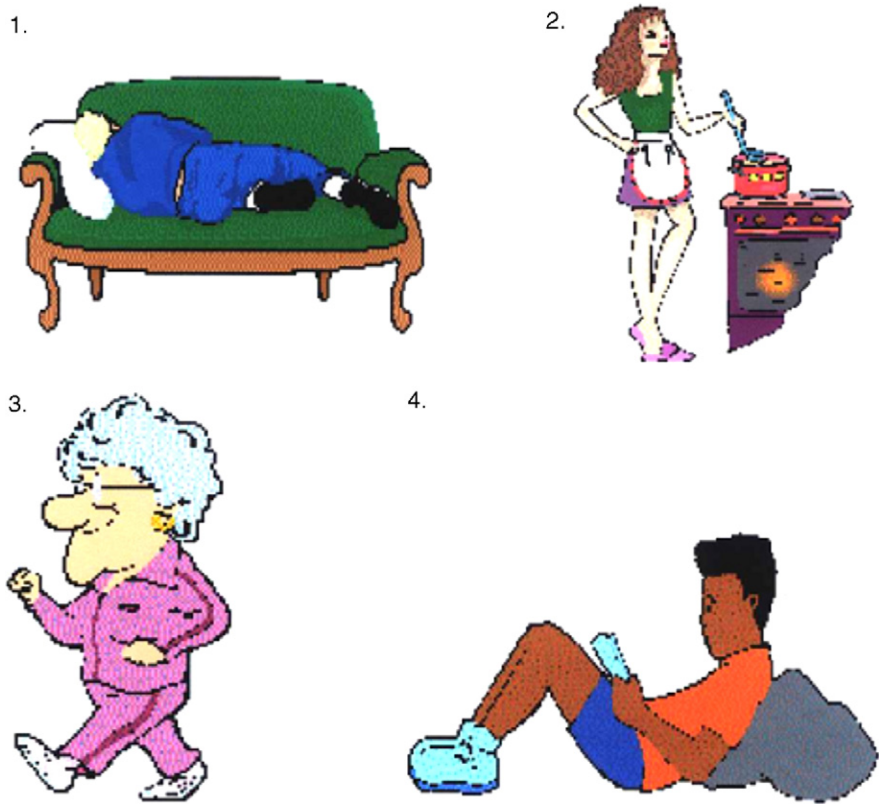

Fig. 1. Example of the third questions.

(iii) the ΔCFIs did not exceed .01; and (iv) the ΔRMSEAs did not exceed .015 and even improved. These results confirm the gender-based measurement invariance of the NAKS.

3.2.4. Stage 4

The analyses performed separately within both school placement groups revealed acceptable fit in both groups, with an exception for the RMSEA fit indices that exceed .08 in the self-contained classes group (Table 2). The three first steps of invariance testing (i.e. hypotheses A–C) resulted in significant bootstrap χ^2, acceptable goodness-of-fit-indices (i.e. CFI and TLI > .95; RMSEA < .05), non-significant $\Delta\chi^2$, and ΔCFIs and ΔRMSEAs that did not exceed .01 and .015, respectively. The fourth level of measurement invariance (i.e. hypothesis D) added the equality constraints on items' uniquenesses (strict measurement invariance). These results did not support the measurement invariance of the items' uniquenesses across school placement groups (i.e. significant $\Delta\chi^2$ and ΔCFI > .01). Modification indices for this model were inspected and suggested that the school placement-group equality constraint should be relaxed for the uniqueness of the items no. 3, 4, 5, 6, 7, 10, 13, 14 and 18 (see Table 1 for a description of the items). The fifth model (i.e. hypothesis *D′*) freely estimated these parameters across school placement groups while keeping the other constraints and provided evidence of partial strict measurement invariance (i.e. non-significant $\Delta\chi^2$; ΔCFI < .01; ΔRMSEA < .015). The sixth model (i.e. hypothesis E) did not support the invariance of the latent factors variances across school placement groups (i.e. significant $\Delta\chi^2$). Modification indices for this model were inspected and suggested that the school placement groups equality constraint should be relaxed for the WWC factor. The seventh model (i.e. hypothesis *E′*) freely estimated this parameter across school placement groups while keeping the other factor variance constraints and provided evidence of partial factor-invariance (i.e. non-significant $\Delta\chi^2$; ΔCFI < .01; ΔRMSEA < .015). Finally, the eighth model (i.e. hypothesis F) did not respectively support the latent factor mean invariance of the various school placement groups (i.e. significant $\Delta\chi^2$). Post hoc probing of this difference revealed that adolescents with ID schooled in self-contained classes did indeed present significantly higher scores in WWC (latent mean = .05, t = 2.54, p = .001, d = 0.33) and NVF (latent mean = .11, t = 2.95, p = .001, d = 0.39) scales than those schooled in a specialized school (latent means fixed at zero as reference).

3.2.5. Stage 5

The initial analyses performed separately within both ID level groups revealed acceptable fit. The results from the various steps of the ID level measurement invariance tests showed that: (i) all of the χ^2 were significant but none of the χ^2 difference

Table 2
Goodness-of-fit statistics of NAKS models[a].

Model	Description	χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI	$\Delta\chi^2$ (Δdf)	ΔCFI	ΔTLI	ΔRMSEA
CFA	1-Factor	294.348	135	.979	.973	.070	.059–.081				
	2-Factor correlated	274.77*	134	.988	.985	.051	.042–.059				
	2-Factor correlated—alternative	148.61*	89	.991	.988	.053	.038–.068				
CFA, age-invariance tests	12–14 (n = 108	168.04*	89	.974	.972	.091	.070–.112				
	15–18 (n = 132)	118.33*	89	.992	.989	.021	.021–.073				
	A—No invariance	286.44*	178	.983	.978	.051	.040–.061				
	B—λs invariant	302.19*	191	.983	.979	.049	.039–.060	15.75 (13)	.000	+.001	+.002
	C—λs, τs invariant	316.94*	204	.983	.980	.048	.038–.058	14.75 (13)	.000	+.001	+.001
	D—λs, τs, δs invariant	356.78*	219	.979	.977	.052	.042–.061	39.83 (15)*	−.004	−.003	−.004
	D′—λs, τs, δs ($\delta_{9,11}$ free) invariant	334.22*	217	.982	.980	.048	.038–.058	17.27 (13)	−.001	.000	.000
	E—λs, τs, δs ($\delta_{9,11}$ free), ξs invariant	340.78*	219	.981	.979	.049	.038–.058	6.57 (2)*	−.001	−.001	−.001
	E′—λs, τs, δs ($\delta_{9,11}$ free), ξs (ξ_{NVF} free) invariant	336.49*	218	.982	.980	.048	.037–.058	2.27 (1)	.000	.000	.000
	F—λs, τs, δs ($\delta_{9,11}$ free), ξs (ξ_{NVF} free), ηs invariant	336.87*	220	.982	.980	.047	.037–.057	0.38 (2)	.000	.000	+.001
CFA, gender-invariance tests	Boys (n = 134)	121.87*	89	.991	.987	.053	.026–.075				
	Girls (n = 106)	147.29*	89	.981	.974	.079	.056–.101				
	A—No invariance	269.22*	178	.987	.981	.046	.035–.057				
	B—λs invariant	277.49*	191	.987	.983	.044	.032–.054	8.26 (13)	.000	+.002	+.002
	C—λs, τs invariant	288.18*	204	.987	.985	.042	.030–.052	10.69 (13)	.000	+.002	+.002
	D—λs, τs, δs invariant	309.30*	219	.986	.984	.042	.031–.052	21.12 (15)	−.001	−.001	.000
	E—λs, τs, δs, ξs invariant	313.81*	221	.986	.984	.042	.031–.052	4.51 (2)	.000	.000	.000
	F—λs, τs, δs, ξs, ηs invariant	316.45	223	.986	.984	.042	.031–.053	2.64 (2)	.000	.000	.000
CFA, placement-invariance tests	Self-contained classes (n = 102)	158.05*	89	.979	.971	.088	.065–.110				
	Specialized schools (n = 138)	116.87*	89	.992	.989	.048	.018–.070				
	A—No invariance	275.03*	178	.985	.980	.048	.036–.059				
	B—λs invariant	290.29*	191	.985	.981	.047	.036–.057	15.26 (13)	.000	+.001	.000
	C—λs, τs invariant	304.31*	204	.985	.982	.045	.034–.056	14.01 (13)	.001	+.001	.000
	D—λs, τs, δs invariant	385.39*	219	.975	.973	.057	.047–.066	81.09 (15)*	−.010	−.009	−.012
	D′—λs, τs, δs ($\delta_{3,4,5,6,7,10,13,14,18}$ free) invariant	312.19*	210	.984	.982	.045	.034–.055	7.88 (6)	−.001	.000	.000
	E—λs, τs, δs ($\delta_{3,4,5,6,7,10,13,14,18}$ free), ξs invariant	319.12*	212	.984	.981	.046	.035–.056	6.94 (2)*	.000	−.001	−.001
	E′—λs, τs, δs ($\delta_{3,4,5,6,7,10,13,14,18}$ free), ξs (ξ_{WWC} free) invariant	312.43*	211	.984	.982	.045	.034–.055	0.24 (1)	.000	.000	.000
	F—λs, τs, δs ($\delta_{3,4,5,6,7,10,13,14,18}$ free), ξs (ξ_{WWC} free), ηs invariant	326.03*	213	.983	.981	.047	.037–.057	13.60 (2)*	−.001	−.001	−.002
CFA, intellectual disability level-invariance tests	Mild ID (n = 125)	119.91*	89	.990	.987	.053	.024–.076				
	Moderate ID (n = 115)	152.18*	89	.980	.974	.079	.057–.100				
	A—No invariance	272.11*	178	.986	.980	.047	.036–.058				
	B—λs invariant	280.16*	191	.986	.983	.044	.033–.055	8.02 (13)	.000	+.003	+.003
	C—λs, τs invariant	291.71*	204	.986	.984	.043	.031–.053	11.54 (13)	.000	+.001	+.001
	D—λs, τs, δs invariant	310.81*	219	.986	.984	.042	.031–.052	19.10 (15)	.000	.000	+.001
	E—λs, τs, δs, ξs invariant	313.62*	221	.986	.984	.042	.031–.052	2.81 (2)	.000	.000	.000
	F—λs, τs, δs, ξs, ηs invariant	315.47*	223	.986	.985	.042	.031–.052	1.85 (2)	.000	+.001	.000

Note: CFA: confirmatory factor analytic model; χ^2: chi-square; df: degrees of freedom; CFI: comparative fit index; TLI: Tucker-Lewis index; RMSEA: root mean square error of approximation; RMSEA 90% CI = 90% confidence interval for the RMSEA point estimate; λ: factor loading; τ: intercept; ξ: factor variance; δ: uniquenesses; η: factor mean; $\Delta\chi^2$: change in goodness-of-fit χ^2 relative to the preceding model; Δdf: change in degrees of freedom relative to the preceding model; ΔCFI: change in comparative fit index relative to the preceding model; ΔTLI: change in Tucker-Lewis index relative to the preceding model; ΔRMSEA: change in root mean square error of approximation relative to the preceding model; NVF: nutrition value of food; WWC: weight and weight control.

[a] $N = 240$

* $p < .05$.

Table 3
CFA factor loadings and uniquenesses[a].

Factor	Item no.	NAKS λ^a (δ)	NAKS-alternative λ^a (δ)
WWC	1	.252(.063)†	
	2	.314(.098)	.308(.095)†
	3	.448(.201)	.454(.206)
	5	.345(.119)	.333(.111)
	8	.706(.499)	.719(.516)
	10	.316(.100)	.318(.101)
	12	.662(.438)	.657(.432)
	14	.691(.478)	.702(.493)
	15	.330(.109)	.318(.101)
	16	.367(.135)	.350(.122)
NVF	4	.214(.046)†	
	6	.551(.304)	.521(.272)†
	7	.663(.439)	.525(.276)
	9	.663(.439)	.686(.471)
	11	.224(.050)	
	13	.348(.121)	.330(.109)
	17	.516(.267)	.505(.255)
	18	.341(.116)	.369(.136)

Note: †: item that was set to be 1.0; λ: loadings; δ: uniquenesses; WWC: Weight and weight control; NVF: nutritional value of food.
[a] All loadings are significant ($p < .001$).

tests was significant; (ii) the CFI, TLI and RMSEA indicated adequate model fit; (iii) the ΔCFI did not exceed .01; and (iv) ΔRMSEA remained under .015. These results confirm the measurement invariance of the NAKS across ID level.

4. Discussion

The objective of the first study was to verify the clarity of the NAKS original items within a first sample of adolescents with ID. These results highlighted that several items from the original version developed for Australian adults with ID were not easily understood or induced confusion when used with adolescents with ID. They thus confirmed, as in the general population, that items developed for adults with ID could be inadequate and unsuitable for younger populations with ID (Harter, 1999). Subsequent analyses showed that the reworded and simplified French version was easily understood by adolescents with ID.

The first purpose of the second study was to examine the factor validity and reliability of the NAKS in a large sample of adolescents with ID. The present results showed the inadequacy of the Illingworth et al.'s (2003) model with a French sample of ID adolescents. Indeed, this model was carefully examined and three items (i.e. items 1, 4 and 11) were excluded from further analyses. The resulting 15-item two-factor model fit the data well and possessed significant and appreciable latent factor correlations (i.e. >.50), satisfactory internal consistency coefficients and test/re-retest reliability correlation coefficients that were of similar magnitude to those found by Illingworth et al. (2003). Clearly, these results provide strong evidence in favor of the NAKS construct validity. Researchers can thus be quite confident in their use of this instrument among French adolescents with ID.

Subsequent CFAs analyses were performed with the objective of assessing the measurement and latent mean invariance of the 15-item version of the French NAKS. These results are of particular interest, because this is the first study to verify the measurement and latent invariance of the NAKS (or of any similar instrument for that matter) across gender, age categories, type of school placement and ID level. It is thus particularly interesting to note that the present results fully supported the complete measurement invariance of the NAKS factor and latent mean structure across gender and ID level groups. Researchers can thus be quite confident regarding the appropriateness of the NAKS with males or females of differing levels of ID and as a tool to conduct meaningful comparisons of NAK levels across these groups. However, the measurement invariance of the NAKS across the type of school placement and age groups did not hold as well. Still, the results from these analyses confirmed the complete invariance of the factor loadings and intercepts across groups and the partial invariance of items uniquenesses. Moreover, it should be noted that complete invariance of the uniquenesses has often be found to be a too stringent condition for multiple group comparisons and do not appear to represent a necessary condition to conduct meaningful mean-level comparisons across groups – partial invariance would in this case be sufficient (Vandenberg & Lance, 2000). Additional results also suggest that the latent factor variance may also be non-invariant across school placement types and age, suggesting that the NVF factor may present a higher level of within-group variability in the oldest age group and that the WWC factor may present a higher level of within-group variability in the self-contained school placement type. This substantive result should not however be interpreted as a lack of measurement invariance (Vandenberg & Lance, 2000), but only as an indication of within group variability that should be explained in future studies. Another interesting result comes from the fact that the latent mean of the NAKS are not invariant across types of school placement. This suggests that adolescents with ID placed in self-contained classes or specialized schools differ in the WWC and NVF scales scores. Indeed, in self-contained classes, adolescents with ID have higher scores on both subscales than their counterparts placed in specialized school. This suggests that schooling in self-contained classes within a regular school might be more beneficent for the acquisition of knowledge regarding healthy nutritional and behavioral habits. Overall, these results suggest that researchers can thus be quite confident when using of the NAKS among: (i) boys or girls with ID; (ii) young adolescents with ID or older adolescents with ID; (iii) adolescents with mild or moderate ID; and (iv) ID adolescents placed in self-contained classes or specialized schools.

In addition to what was previously noted, three limitations of the present series of studies must be taken into account in the interpretation of the findings. First, the present studies were based on a on a mixed (boys and girls) sample of a priori nonclinical adolescents with ID, which could not be considered as representative of the French population with ID. Indeed, during this study it was impossible to obtain either a self-reported or an objective measure of the height and weight of the respondents or any objective rating of their psychological or physical health. In consequence, examining the factor structure and measurement invariance of the French NAKS across even more diversified samples of adolescents with ID, particularly among those presenting various weight statuses, should be a future research priority.

Second, the present results rely on a single sample of adolescents and in consequence they must be interpreted with caution. Indeed, the modifications suggested by the data, regardless of whether they are conceptually plausible, have a tendency to capitalize on chance, providing a better model fit for this data set but inhibiting the generalizability of the results. As such, these modifications are presented as preliminary possibilities for further study rather than as evidence confirming the ultimate validity of the modified model. More work, thus, needs to be done to explore whether the French 15-item version of the NAKS provides similar results with additional samples of French adolescents with ID.

Third, the present series of studies were based on a French sample of adolescents with ID, and the use of this instrument should thus be limited to samples with the same characteristics. Clearly, before the generalizability of this instrument to other cultural background (e.g. French speaking Maghreb adolescents) or linguistic groups (e.g. Spanish or English speaking adolescents) can be systematically investigated in other studies, its cross-cultural or linguistic use cannot be recommended. Therefore, examining the measurement and latent mean invariance of the NAKS across diverse cultural or linguistic groups of adolescents with ID should also represent a future research priority.

Fourth, the discriminant validity of the French NAKS was not tested in this study. It is thus still unknown, as suggested by Melville et al. (2007) and Rimmer et al. (2007), whether this instrument could discriminate: (i) adolescents with ID from various weight status (i.e. normal, overweight and obese); and (ii) adolescents with and without ID from various weight status. Therefore, as a consequence of these limitations, the verification of the NAKS's discriminant validity using obese, overweight and normal-weight samples of adolescents with ID and without ID should be considered as a future research priority.

5. Conclusion

In conclusion, despite that the psychometric properties of the French NAKS were found to be adequate, they must be cross-validated in at least a second independent sample of French adolescents with ID. Consequently, based on the present results and their limitations, this instrument may be used in research or practice, but it should restricted to samples of French adolescents similar to this one in gender, age, type of placement and ID levels.

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