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The Child Food Rejection Scale: development and validation of a new scale to assess food neophobia and pickiness among 2- to 7-year-old French children

Camille Rioux\textsuperscript{a,b}\textsuperscript{*}, Jérémie Lafraire\textsuperscript{a}, & Delphine Picard\textsuperscript{b}

\textsuperscript{a}Center for Food and Hospitality Research, Paul Bocuse Institute, Ecully, France
\textsuperscript{b}Aix Marseille Université, PSYCLE EA3273, 13621 Aix en Provence, France

Abstract

Introduction. The two strongest obstacles to extend children’s consumption of fruit and vegetables are food neophobia and pickiness, assumed to be the main kinds of food rejection in children. Accordingly, psychometric tools that provide a clear assessment of these kinds of food rejections are greatly needed.

Objective. To design and validate a new scale for the assessment of food neophobia and pickiness, thus filling a major gap in the psychometric assessment of food rejection by French children.

Method. We concentrated on French children aged 2-7 years, as no such scale exists for this young population, and on the two known dimensions of food rejection, namely food neophobia and pickiness, as the nature of the relationship between them is still unclear. The scale was tested on two samples ($N_1=168$; $N_2=256$) of caregivers who responded for their children. Additionally, a food choice task was administered to 17 children to check the scale’s predictive validity.
Results. The resulting scale, called the Child Food Rejection Scale (CFRS), included six items relating to food neophobia and five items relating to pickiness. A factor analysis confirmed the two-dimensional structure of the scale. Internal consistency, test-retest reliability, and convergent and discriminant validity were all satisfactory. Moreover, results from the food choice task showed that scores on the CFRS accurately predicted children’s attitudes toward new and familiar foods.

Conclusion. Taken together, these findings suggest that the CFRS, a short and easy-to-administer scale, represents a valuable tool for studying food rejection tendencies in French children.

Keywords: Questionnaire development, Children, Food neophobia, Pickiness, Validation

L’échelle de rejets alimentaires pour enfant: développement et validation d’une nouvelle échelle pour mesurer la néophobie et la sélectivité alimentaire chez les jeunes enfants français de 2 à 7 ans.

Résumé

Introduction. La néophobie et la sélectivité alimentaire, responsables d’une réduction de la variété du régime alimentaire, sont présentées comme les deux facteurs principaux des rejets alimentaires chez les enfants. Par conséquent, afin de pouvoir étudier ces formes de rejets, il est important de disposer d’outils robustes permettant de les mesurer.

Objectif. Développer et valider une nouvelle échelle pour évaluer la néophobie et la sélectivité alimentaire, comblant ainsi une lacune importante dans l’évaluation psychométrique des rejets alimentaires chez les enfants français.

Méthode. Nous nous sommes concentrés sur les enfants français âgés de 2 à 7 ans, comme il n’existe pas d’échelle pour cette jeune population, et sur les deux dimensions connues des rejets alimentaires, à savoir la
néophobie et la sélectivité alimentaire, comme la nature de leur relation est encore inconnue. L’échelle a été testée sur deux échantillons (n1 = 168; n2 = 256) de parents qui ont répondu pour leurs enfants. De plus, une tâche de choix d’aliments a été administrée à 17 enfants pour vérifier la validité prédictive de l’échelle.

Résultats. L’échelle finale, appelée échelle de rejets alimentaires pour enfant (CFRS), comprend six questions relatives à la néophobie alimentaire et cinq relatives à la sélectivité. Une analyse factorielle a confirmé la structure bidimensionnelle de l’échelle. La cohérence interne, la fiabilité temporelle et la validité convergente et discriminante sont satisfaisantes. De plus, les résultats de la tâche de choix ont montré que les scores à la CFRS prédisent avec précision les attitudes des enfants à l’égard des aliments nouveaux et familiers.

Conclusion. Les résultats suggèrent que la CFRS, une échelle courte et facile à administrer, représente un outil adapté pour l’étude des rejets alimentaires chez les jeunes enfants français.

Mots-clés: Développement de questionnaire, Enfant, Néophobie alimentaire, Sélectivité, Validation

Introduction

Despite increasing wealth and purchasing power in the Western world, there is an alarming deterioration in dietary habits, including the increased consumption of foods rich in saturated fatty acids at the expense of foods rich in fibers, vitamins and minerals, such as fruit and vegetables (Carruth, Skinner, Houck, Moran, Coletta, & Ott, 1998; Cashdan, 1998; Jacobi, Agras, Bryson, & Hammer, 2003). Indeed there is a wide gap between recommended intake and actual consumption of fruit and vegetables (Cockroft, Durkin, Masding, & Cade, 2005; WHO, 2003). The two strongest obstacles to extend children’s intake of fruit and vegetables are food neophobia and pickiness, assumed to be the main
kinds of food rejection in children (Birch & Fisher, 1998; Dovey, Staples, Gibson, & Halford, 2008; Falciglia, Couch, Gribble, Pabst, & Frank, 2000). Accordingly, psychometric tools that provide a clear assessment of food neophobia and pickiness are greatly needed as they are important to the study of childhood food habits and the effectiveness of interventions or programs designed to expand children’s intake of fruit and vegetables. In the present paper, we describe how we developed and validated a new and much-needed scale to assess the food neophobia and pickiness dimensions of food rejection in young children.

Food neophobia is defined as a fear of new food, (Pliner & Hobden, 1992) and appears as children become mobile, but there is a contention in the literature as to whether it increases thereafter (Birch, McPhee, Soba, Pirok, & Steinberg, 1987; Cashdan, 1994; Harpers & Sanders, 1975) or remains stable during early childhood (Adessi, Galloway, Visalberghi, & Birch, 2005; Cooke, Wardle, & Gibson, 2003; Koivisto & Sjöden, 1996). In 1992, Pliner and Hobden (1992) designed the Food Neophobia Scale (FNS), which ask adult to specify the extent to which they approve or not ten declarations about eating practices, like “If I don’t know what is in a food, I won’t try it”. Originally devised to measure adults’ neophobia, the FNS was subsequently adapted to assess children’s neophobia (Children Food Neophobia Scale, CFNS; Pliner, 1994). Both of Pliner’s scales have since been widely used to measure food neophobia, adapted and translated into several languages, including French (Adapted Food Neophobia Scale; Reverdy, Chesnel, Schlich, Köster, & Lange, 2008) and Italian (Italian Children Food Neophobia Scale; Laureati, Bergamaschi, & Pagliarini, 2015).

Food pickiness is characterized as a rejection of a certain amount of familiar and new foods to children (Birch, Johnson, Andresen, & Peters, 1991; Galloway, Fiorito, Lee, & Birch, 2005; Smith, Roux, Naidoo, & Venter, 2005; Taylor, Wernimont, Northstone, & Emett, 2015).
Pickiness also includes the intake of inadequate quantities of food (Rydell, Dahl, & Sundelin, 1995), or may relate to the rejection of certain food textures (Smith et al., 2005). A contention concerns the developmental path of pickiness (Taylor et al., 2015). According to Dubois, Farmer, Girard, Peterson, and Tatone-Tokuda (2007) the prevalence of pickiness remains relatively stable during early childhood (2.5-4.5 years), whereas a recent longitudinal study by Mascola, Bryson, and Agras (2010) showed that the highest prevalence of pickiness arises in toddlerhood, and subsequently decreases to very low levels by the age of 6 years. A further contention exists concerning the relationship between food pickiness and neophobia. In their review, Dovey et al. (2008) supposed that the two constructs are behaviorally distinct, as dissimilar factors foresee their extend and manifestation. However, other researchers have argued that these two kind of food rejections are undoubtedly linked (Potts & Wardle, 1998; Raudenbush, van der Klaauw, & Frank, 1995) or even indistinguishable (Wardle, Guthrie, Sanderson, & Ropoport, 2001). Up to now, a controversy exists concerning the relationship between food pickiness and neophobia, which arguably can be partly explained because there is clearly still some confusion surrounding the very concept of pickiness (Potts & Wardle, 1998; Taylor et al., 2015). While neophobia is usually assessed through Pliner’s scales (Pliner & Hobden, 1992; Pliner, 1994) or adapted versions, there is no such widely recognized scale for pickiness measurement. It has usually been assessed through various tools such as scales on eating practices that include subscales for pickiness, food neophobia, low enjoyment when eating, and so forth. Notable questionnaires include the Children’s Eating Behavior Questionnaire (CEBQ see Wardle et al., 2001; Tharner et al., 2014), and Children’s Eating Difficulties Questionnaire (CEDQ see Rigal, Chabanet, Issanchou, & Monnery-Patris, 2012). Other researchers have measured pickiness by merely
questioning caregivers if their children are picky (Carruth, Ziegler, Gordon, & Barr, 2004; Jacobi et al., 2003; Jacobi, Schmitz, & Agras, 2008).

In a recent review of methods to assess preschool children’s eating behavior, De Lauzon-Guillain and colleagues (2012) pointed out that most of existing scales measuring children’s food neophobia and/or pickiness are not entirely psychometrically sound. Indeed only the French Questionnaire pour Enfant de Neophobie Alimentaire (QENA, Rubio, Rigal, Boireau-Ducept, Mallet & Meyer, 2008) and the CEBQ (Wardle et al., 2001) achieved all validity and reliability criterion (other questionnaires such as the widely used FNS and CFNS failed to validate construct validity and/or temporal reliability). However, the QENA is a self-assessment questionnaire designed to measure neophobia for at least 5 years old children, while it would be of interest to measure neophobia for 2 years old children because it is the onset of food rejections. Additionally, the CEBQ does not differentiate between food neophobia and pickiness, while recent reviews and researches have proposed that they are two latent variables (Dovey et al., 2008; Galloway, Lee, & Birch, 2003; Rigal et al., 2012). Therefore there is a need for further development of tools to measure both neophobia and pickiness as two possible dimensions of food rejections in critical period (2-7 years old) in French toddlers.

In the present study, we adapted and validated a new scale for the assessment of food neophobia and pickiness, both thought to be dimensions of food rejection, in young French children. We concentrated on children aged 2-7 years, as no such scale exists for this young population. Moreover, contrary to previous scale measurement, we took special care to assess all aspects of pickiness behaviors and to measure all the properties that would be expected of any psychometric instrument,
namely internal consistency, factor structure, discriminant and
convergent validity, test-retest reliability, and construct validity (see, for
example, De Lauzon-Guillan et al., 2012; Hinkin, 1995; Ritchey, Frank,
Hursti, & Tuorila, 2003; Vallerand, 1989). Finally, we believed that
designing and testing the validity of a scale that included items on food
neophobia and items on pickiness would provide an insight into the
(currently obscure) relationship between these two constructs, as well as
the (currently opaque) nature of their developmental paths.

Preliminary experiment: Item generation and selection

Method

Questionnaire Design.

Our main concern was to propose a short and easy-to-administer
scale, all the while ensuring good content validity that is, capturing the
two specific constructs (i.e., food neophobia and pickiness) without
including any superfluous content. Developing a brief measure is an
efficient mean of minimizing participants' fatigue and response biases
(Hinkin, 1995). Our objective was to come up with a scale featuring a set
of around 10 carefully selected items (i.e., items loading strongly on one
of the two assumed dimensions). To this end, we adapted from existing
scale and developed more items than necessary for the definitive
questionnaire, so that we could reject any items that were potentially
inaccurate, recurrent or indistinct, and yet retain an enough figure of
items to ensure a reliable tool (Gehlbach & Brinkworth, 2011). To
generate these items, we first reviewed the literature, in order to precisely
define the two constructs under consideration and assess previous
measures (Lafraire, Rioux, Giboreau, & Picard, 2016). We then extracted
and adapted 18 items from existing scales that proved to accurately
capture the two constructs and predict food rejection behaviors. All items
regarding neophobia were adapted from the FNS (Pliner & Hobden,
or the QENA (Rubio et al., 2008) as the first scale is widely used to assess neophobia and the second was proved to be perfectly psychometrically sound. All items regarding pickiness were adapted from the CEBQ (Wardle et al., 2001) and the CEDQ (Rigal et al., 2012) as the first scale is usually used to assess pickiness and the second is a French scale targeting under 5 years old children, thus adapted to the population of the study. Additionally we created 23 additional items based on the definitions of the two constructs. The majority of the additional items concerned pickiness. Indeed, as the review of the literature revealed, while neophobia is a rather well defined construct, there is clearly still some confusion surrounding the very concept of pickiness, and existing scales do not encompass every suspected aspect of this construct (such as the rejection of certain texture). We thus compiled 41 items in total: 20 items relating to food neophobia and 21 items relating to pickiness. We decided to avoid reverse-scored items as this has been shown to diminish scale reliability and possibly introduce systematic errors (Gehlbach & Brinkworth, 2011; Schriesheim & Hill, 1981). Hence, each of the 41 items was a positive sentence, such as “My child is constantly looking for familiar foods”.

To verify that the items we had compiled and generated were clear and fully captured the two constructs, we tested the 41-item questionnaire for cognitive validity (Gehlbach & Brinkworth, 2011; Karabenick et al., 2007). To this end, a pilot study was run with a group of 10 women, either mothers or childminders, recruited from a nursery association in the French city of Lyons. These participants received the questionnaire at home and were asked to indicate whether or not they thought each item was clear and relevant to assess children food rejection behaviors on two separate 5-point Likert-like scales). Afterwards, a collective interview was held on the association’s premises, and questions and comments about the items raised by participants were
discussed. Additionally, the women were asked to indicate any other eating behaviors they could think of, displayed by children during mealtimes. Following this interview, six items were removed owing to vagueness and misunderstanding, and none were added, leaving a provisional 35-item questionnaire to be administered and psychometrically analyzed (see Appendix for the 35-item version of the questionnaire).

**Participants and Procedure.**

The 35-item questionnaire was administered online to 205 parents recruited on food blogs or social networks with no exclusion criteria, who each responded at the time of their convenience for their child aged between 2 and 7 years. None of them had been involved in the preliminary experiment. Parents who were not direct caregivers (n=11) or who did not finish the poll (n=26) were extracted from the study, leaving a first sample $N_1$ of 168 participants (138 mothers and 30 fathers). Caregivers rated each item according to their child’s behavior (83 girls and 85 boys aged 23-84 months, mean age = 48 months, $SD = 16$) on a 5-point Likert-like scale (*Strongly disagree*, *Disagree*, *Neither agree nor disagree*, *Agree*, *Strongly agree*). This 5-point Likert-like scale was chosen so as to allow for sufficient variance among the participants (Gehlbach & Brinkworth, 2011; Lissitz & Green, 1975). We used verbal anchors, rather than numerical ones, because numbers can have implicit meanings (Gehlbach & Brinkworth, 2011). Each answer was then numerically coded (from *Strongly disagree* = 1 to *Strongly agree* = 5), with a high score indicating high food rejection (scores could range from 35 to 175). Participants were informed they will receive a booklet providing nutritional advice and tips for recipes after completion of the survey. This preliminary experiment was performed in adherence with the principles established by the declaration of Helsinki.

**Data Analysis.**
For each child, we calculated a food rejection score ranging from 35 to 175, based on the caregiver’s answers. Preliminary analyses were ran on these scores to check the normality of the data distribution (Anscombe-Glynn kurtosis test). Then, the mean food rejection scores for each sex were measured and compared (Student’s t test), and correlations between food rejection scores and children’s age were assessed (Pearson correlation coefficient). Finally, we performed an iterative exploratory factor analysis using principal component analysis with promax rotation, to determine the number of dimensions of the scale and select the different items to include in the decisive scale. We set the alpha level at 0.05 for all statistical analyses. All statistical analyses were conducted using R 3.1.2 software, using the packages “psych” and “FactoMineR”.

Results

**Preliminary Analysis.**

Food rejection scores ranged from 45 to 171 ($M = 97.6$, $SD = 27$). Checks for kurtosis showed that the food rejection scores were distributed normally ($z = 0.81$, $p = 0.41$, ns). Then analysis revealed that these scores were not influenced by the gender of either the caregiver ($t = 1.51$, $p = 0.13$, ns) or the child ($t = 0.71$, $p = 0.94$, ns). Data were therefore computed across these factors in subsequent analyses.

Moreover, prior the analysis, we checked the items for sufficient item variability. The majority of items had medium means (between 2 and 4 on the 5-point Likert-like scale), signifying that there were no ceiling and floor effects (Clark & Watson, 1995). Additionally, standard deviations showed satisfactory variation (i.e., $SD > 1$ according to Whitley & Kite, 2013). Only three items did not satisfy these criterions, but given this small proportion, we decided to retain them for the factor analysis.

**Iterative Exploratory Analysis and Item Refining.**
We run a principal component analysis with promax rotation on the food rejection scores for all 168 respondents' children on the 35-item scale ($N_4$). The optimal number of factors was assessed with the Kaiser criterion (only the factors with eigenvalues above one are selected; Kaiser, 1960) and Cattell's scree plot criterion (determination of the point where the last important eigenvalues drop appears; Cattell, 1966). Following these two criterions, primary analysis indicated that the optimum number of factors was two, with an eigenvalue of 13.98 for the first factor (explaining 40% of the variance) and an eigenvalue of 3.99 for the second factor (explaining 11% of the variance). The other factors’ eigenvalues were close to or below 1. In total 51% of the variance was explained by the two-factor model which had an inter-factor correlation of 0.62.

Examination of factor loadings showed that the majority of items loaded rather strongly on one underlying factor. However, 15 items proved problematic: Items P1, P7, P9 did not load on the anticipated factor (these three items were extracted from existing tools measuring pickiness and yet loaded on the same latent factor that items supposedly measuring neophobia), Items P2, P8, P11 and N5, had medium loadings on both factors, N8 had extremely low loadings (< 0.1) and the comments made by participants revealed that Items P12-P18 were indistinguishable from items N12-N17 (the participants were not able to distinguish the term difficile, translated as picky, from the expression ne goûte pas un nouvel aliment, translated as won't try a novel food). We therefore decided to remove these 15 problematic items from the scale (P1, P7, P8, P9, P11-18, N5 and N8). Moreover, the test of internal consistency (Cronbach's alpha coefficient) showed some redundancy between items ($\alpha = 0.96$), and inspection of the correlation matrix confirmed that some items were strongly correlated. Items N14-17 were all removed because they were closely correlated with Item N9 (all
Pearson coefficients above 0.62). Items N3 and N11-13 were also removed to ensure a balance between the subscales. Altogether, 24 of the 35 items were removed. We then re-analyzed the data using the new and shortened version (11 items) of the scale.

Examination of the second scree plot indicated that it was suitable to extract two factors, with an eigenvalue of 3.77 for the first factor (explaining 34% of the variance) and an eigenvalue of 2.38 for the second factor (explaining 22% of the variance). Therefore, the two-factor model explained 56% of the variance with an inter-factor correlation of 0.54. Examination of factor loadings showed that all the items loaded rather strongly on the anticipated factors (see Table 1), and internal consistency was good (α = 0.87). We therefore ran a confirmatory factorial analysis (CFA) with the 11-item scale and to assess its psychometric properties. The 11-item scale resulting from the iterative exploratory analysis contained 6 items relating to food neophobia and 5 items relating to pickiness (all items derived from previous questionnaires for the pickiness subscale were removed during this item refining process).

--Insert Table 1 about here--

Main experiment: Validation of the Questionnaire

Methods

Participants.

The 11-item questionnaire was administered to 274 parents either recruited online on food blogs or social networks, or from schools through flyers posted in the Lyons urban area (France) with no exclusion criteria, who each responded for their child aged between 2 and 7 years. None of them had been involved in the preliminary experiment. Parents who were not direct caregivers (n=3) or who did not complete the entire survey
(n=15) were extracted from the study, that left us with a second sample
$N_2$ of 256 caregivers (mainly mothers). As in the preliminary experiment,
caregivers rated each item according their child’s behavior (130 girls and
126 boys aged 22-84 months, mean age = 47 months, $SD = 15$) at the
time of their convenience on a 5-point Likert-like scale (Strongly
disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree).
Each answer was then numerically coded with a high score indicating
high food rejection (scores could range from 11 to 55). Participants were
informed they will receive a booklet providing nutritional advice and tips
for recipes after completion of the survey. This main experiment was
performed in adherence with the principles established by the declaration
of Helsinki.

**Convergent and discriminant validity.**

In order to assess the scale’s convergent and divergent validities,
67% of the sample $N_2$ (172 caregivers) also filled in the Food Attitude
Survey (FAS, Frank & van der Klaauw, 1994) and the French version of
the Revised Children's Manifest Anxiety Scale (RCMAS; Turgeon &
Chartrand, 2003) for their child (the completion to these questionnaires
was not mandatory explaining the loss of participants, but caregivers had
the choice of filling these additional questionnaires after completion of the
first and main questionnaire). The subsample included 85 caregivers of
girls and 87 caregivers of boys, and these children were aged between
22 and 84 months (mean age = 46 months, $SD = 15$).

In the FAS questionnaire, which was successfully translated into
French by Ton Lu (1996), adults are questioned to specify the extent to
which they approve or not ten declarations about eating practices (e.g., “I
find that many foods I like are sweet”) on a 5-point Likert-like scale. We
selected the FAS to evaluate convergent validity as this questionnaire
has been used to measure attitudes toward familiar and new foods, and
has been shown to have sound internal consistency (Frank & van der
It is worth noting that we could have used the QENA (Rubio et al., 2008) or the CEBQ (Wardle et al., 2001) to assess the convergent validity of our scale as they are entirely psychometrically valid. However, we decided to use the FAS because the QENA is a self-assessment questionnaire used to measure only neophobia and the CEBQ was not translated in French and did not distinguish between neophobia and pickiness.

In the other hand, the RCMAS asks participants to answer “yes” or “no” to 36 statements about anxiety and low esteem issues, such as “I worry a lot of the time”. We selected this scale to evaluate discriminant validity because although it assesses anxiety and not food rejection, food rejection is sometimes associated with high anxiety toward food items (Galloway et al., 2003). Thus, we expected to find medium to high positive correlation values between FAS scores and food rejection scores, and lower positive correlation values between RCMAS scores and food rejection scores.

**Test-retest reliability.**

To evaluate the scale’s reliability, 44% ($n = 74$) of the sample $N_1$ underwent a retest procedure. These parents twice completed online the 11-item version of the scale with a four-week interval in between (the completion to this second session was not mandatory explaining the loss of participants). The test-retest sample included 37 caregivers of girls and 37 caregivers of boys, and these children were aged between 22 and 84 months (mean age = 49.1 months, $SD = 16.8$).

**Predictive value of the questionnaire.**

As in the seminal study by Pliner and Hobden (1992), we administered a food choice task to an additional sample of 17 children aged 31-78 months (mean age = 57 months, $SD = 15$) to evaluate the predictive validity of our scale. Children took the test individually in a quiet room during the time of the mid-morning break (which is usually
taking place inside the classroom around 10 am) and were led to believe that they would be able to choose that day's menu in their cafeteria. They were told that many foods were available and they had to choose between them. Following the procedure used by Pliner and Hobden (1992), we used color photographs of real foods as the material for the choice test. Eight pairs of food pictures were shown successively to the children (four pairs were designed to measure neophobia and four to measure pickiness, see table 2). These pictures were placed on a plastic plate to remind the children of an eating context.

To avoid misleading between food rejection and religious or widespread eating habits such as vegetarianism, we excluded the meat and fish categories. In the one hand each pair measuring neophobic behaviors contained one a priori known food and one a priori unknown food in the same general category (for example in one pair children had to choose between an apple and a persimmon, see Table 2, line 2), and data collection from the children supported this classification: the participants' mean familiarity ratings (the mean was assessed by attributing a score of 0 when the child told the experimenter he/she did not know the food and 1 when he/she told the experimenter she did know it), averaged across foods, were 0.08 for the four novel foods and 0.72 for the four familiar ones. These means were significantly different (t = 4.03, p = 0.02). In the other hand, each pair measuring picky behaviors contained a picture of a classical and familiar canteen dish with the different components sorted and separated from each other and a picture of the same dish but with the different components stirred together (for example in one pair children had to choose between a fruit salad with pears in one side, apples in the other and a fruit salad were apples and pears were mixed together, see table 2, line 2).

---Insert Table 2 about here---
For each of the eight pairs (presented in a counterbalanced order), the children were asked to choose the member of the pair they were willing to taste later at the canteen. For each participant, a caregiver was required to complete the 11-item scale in order to associate the children’s food choice scores with their food rejection scores.

Data analysis.

For each child, we calculated a food rejection score ranging from 11 to 55, based on the caregiver’s answers. Preliminary analyses were run on these scores to check if the data were normally distributed (Shapiro’s test). Then a confirmatory factor analysis (CFA) was conducted, using the maximum likelihood method. Finally, we conducted psychometric analyses to validate the final short version of the scale. First, we assessed our scale’s reliability by calculating its internal consistency (Cronbach’s alpha coefficient), and its temporal stability by assessing its test-retest reliability (we compared the mean values obtained for each session with paired Student’s t test). Second, we assessed our scale’s convergent, discriminant and predictive validity (Pearson and Spearman correlation coefficients). Finally, the mean food rejection scores for each sex were measured and compared (Student’s t test), and correlations between food rejection scores and children’s age were assessed (Pearson correlation coefficient). We set the alpha level at 0.05 for all statistical analyses. R 3.1.2 software and LISREL 9.10 (Jöreskog & Sörbom, 2012) were used to realize the statistical analyses.

Results

Preliminary Analysis

Food rejection scores ranged from 11 to 55 ($M = 34.8$, $SD = 8.6$). Results from Shapiro’s test indicated that the food rejection scores were
normally distributed ($w = 0.99$, $p = 0.38$, ns). Screens for appropriate
item variability revealed moderate means (between 2 and 4 on the 5-
point Likert-like scale) and sufficient variability (SD>1). Only one item
failed to meet this criterion, but given this small proportion, we decided to
retain this item for the CFA.

**Confirmatory factor analysis (CFA)**

We ran a CFA to test the two-factor model's fit to the 11-item
scale, using the maximum likelihood method with LISREL 9.10 (Jöreskog
& Sörbom, 2012). Items N1, N2, N4, N6, N7 and N10 loaded on the first
latent factor, named *food neophobia*, and Items S3, S4, S5, S6 and S10
loaded on the second latent factor, named *food pickiness*. Figure 1
displays the path diagram yielded by the CFA for the two-factor solution.

Figure 1 shows satisfactory factor loadings for each latent factor (range:
0.42-0.81), and a strong correlation between the two latent factors ($r =
0.76$). The CFA yielded acceptable fit indices: goodness-of-fit index (GFI)
= 0.958, comparative fit index (CFI) = 0.981, root mean square error of
approximation (RMSEA) = 0.041 and $\chi^2/df = 1.42$, as recommended by
Wheaton, Muthén, Alwin, and Summers (1977), and Jackson, Gillaspy,
and Purc-Stephenson (2009). Thus, the two-factor model was fully
relevant. It is worth noting that even if we found strong correlation
between food neophobia and pickiness, the two-factor model was more
relevant that the one-factor model (which displayed poorer fit indices: GFI
= 0.92, CFI = 0.93, RMSEA= 0.076 and $\chi^2/df = 2.47$). We then
assessed the psychometric proprieties of the final 11-item scale.

*Internal consistency.*
Internal consistency of the final 11-item scale was satisfactory overall (Cronbach’s $\alpha = 0.87$), as well as for each subscale ($\alpha = 0.87$ for the neophobia subscale and $\alpha = 0.69$ for the pickiness subscale).

**Convergent and discriminant validity.**

Spearman’s coefficient indicated that food rejection scores were significantly closely correlated with FAS scores ($r = 0.81$, $p < 0.001$). This correlation was positive, indicating that a high food rejection score corresponded to a high FAS score. This result attested to the convergent validity of our questionnaire. Additionally, food rejection scores were significantly and positively correlated with RCMAS scores, as indicated by Pearson coefficient ($r = 0.33$, $p < 0.001$). This correlation was positive, albeit much more moderate, indicating that our scale was discriminantly valid. It should be noted that we observed the same correlation ranges for each subscale (strong correlations between neophobia or pickiness scores and FAS scores respectively, $0.75$ and $0.4$, and moderate correlations between neophobia or pickiness scores and RCMAS scores, respectively $0.19$ and $0.21$).

**Test-Retest reliability.**

Table 3 sets out the mean scores at test and retest for the 11-item version of the scale. Statistical analyses indicated that test scores were closely correlated with retest scores (all $rs > 0.55$). Moreover, variations in the mean rejection scores between test and retest were not significant (all $ps > 0.5$). Taken together, these findings indicate that the final food rejection scale had satisfactory test-retest reliability.

---Insert Table 3 about here---

**Predictive value of the questionnaire.**
The degree to which a child behaved in a picky and neophobic manner was defined as the numbers of pairs for which he/she chose the familiar/sorted food for later tasting, divided by the total number of pairs ($N = 8$). Indeed if a child chose the familiar item in the pairs measuring neophobia (ordinary rice, apple, green beans and cow cheese) he/she behaved in a neophobic manner as neophobic children are reluctant to taste novel food items. Additionally, for pairs measuring pickiness if he/she chose the picture were foods were sorted, he/she behaved in a picky manner because picky children often sort their food in the plate.

A correlation analysis using Spearman’s correlation coefficient across the children indicated that questionnaire scores and children’s choice of familiar/sorted foods were significantly correlated ($r = 0.48$, $p = 0.049$). This correlation was positive, indicating that a high food rejection score corresponded to a high number of familiar/sorted foods chosen during the task (see Fig. 2).

**Variations in food rejection scores according to children’s sex and age.**

Results from mean comparisons using a $t$ test showed that boys and girls did not differ significantly on food rejection scores ($t = 0.67$, $p = 0.49$, $ns$). We observed the same absence of sex effect for each subscale (both $p$ values $> 0.3$). Finally, correlation coefficients indicated that neither the neophobia, pickiness nor total food rejection scores were significantly correlated with age (all $rs < 0.13$, $ns$). We also assessed Spearman correlations between age and each of the 11 items, to see whether any item was more closely correlated with age than the others, but results indicated that none of the items were correlated with age (all $rs < 0.15$).

**General Discussion**
The threefold aim of this study was to (i) validate a new food rejection scale that would simultaneously measure food neophobia and pickiness, thereby filling a gap in the psychometric assessment of food rejection by young French children, (ii) clarify the definition of pickiness and (iii) unpick the relationship between food neophobia and pickiness, as well as the developmental paths of these two constructs. To our knowledge, ours was the first attempt to design a scale that included pickiness and food neophobia as two possible dimensions of food rejection by children, and which had all the properties of a reliable test.

First, our findings showed that the final 11-item food rejection scale, which we named the Child Food Rejection Scale (CFRS), displayed good psychometric properties (it important to note that in the final scale, half of the retained items of the neophobia subscale were adapted from the FNS (Pliner & Hobden, 1992), while all the pickiness subscale’s retained items were created for this research). Reliability, as measured through internal consistency and test-retest reliability was satisfactory, with coefficients comparable to those found in previous research on children’s food neophobia or pickiness when it was measured. For instance, Rubio, and colleagues (2008) reported a Cronbach’ alpha of 0.84 and a Pearson coefficient of 0.74 for the test-retest reliability of their neophobia scale, while Rigal and collaborators (2012) reported an alpha of 0.73 for their fussiness subscale (Rubio et al., 2008; Rigal et al., 2012). The construct validity of the CFRS was also adequate, as attested by measures of convergent and discriminant validity. Results further showed that the predictive validity of our scale was satisfactory: using food pictures was an efficient strategy for measuring food choice, as proposed by Guthrie, Rapoport, and Wardle (2000), as well as by Rubio and colleagues (2008). Although significant, the correlations between food rejection scores and food choices were quite moderate. As pointed out by Laureati and colleagues
the use of real food items, might have led to stronger

correlations. Nevertheless, to offset the limitations of using of food

to pictures, we tested the children in an ecological environment, namely the

room where they usually have their morning snack, as ecological validity

can be achieved with real-world stimuli as well as with natural settings.

The correlation obtained within this sample was nevertheless within the

range of those previously found by studies assessing the predictive

validity of the FNS \( r = 0.43 \) in Loewen & Pliner, 2000; \( r = 0.43 \) in Pliner &

Hobden, 1992; \( r = 0.34 \) in Rubio et al., 2008). It is also interesting to note

that these studies used self-assessment questionnaires, whereas we

used proxy assessment. Therefore, we can reasonably assume that

caregivers are relevant predictors of their children’s behaviors toward

foods.

Second, factor analyses supported the two-dimensional structure

of our scale, namely the distinction between food neophobia and

pickiness in young children refuting Wardle et al. (2001) position i.e.

neophobia and pickiness are indistinguishable. There was, however, a

strong positive correlation between these two kinds of food rejection,

indicating that they are closely related (i.e., a child with a high neophobia

level was likely to display a high pickiness level as well). These findings

are in line with the claims of Potts and Wardle (1998), Raudenbush et al.

(1995) and Rigal et al. (2012). They also partly explain the view put

forward by Dovey and colleagues in their review (2008) that some social

factors, such as pressure to eat and parental practices/styles, have

similar effects on the severity of expressions of both food neophobia and

pickiness. Concerning the developmental paths of food rejection, the

pattern we found for food neophobia is consistent with the view put

forward by Adessi et al. (2005), Cooke et al. (2003), and Koivisto and

Sjöden (1996), that neophobia increases promptly around 2 years of age,

when children are liable to ingest poisonous compounds because of their
increasing mobility, and remains quite stable until 6-7 years. For pickiness, the absence of changes in its prevalence with age is consistent with the view of Dubois et al. (2007). However, as pointed out by a recent research review of pickiness undertaken by Taylor et al. (2015), consensus on the developmental path of pickiness will only be reached if an agreement on the definition is achieved and assessment across study is undertaken with homogenous and fully validated tools. Finally, we found no evidence that food rejection (either neophobia or pickiness) varied across the sexes in early childhood. This finding is consistent with previous results for sex comparisons in food rejection by young children (see Koivisto-Hursti & Sjöden, 1997, for food neophobia, and Xue et al., 2015, for pickiness), and is particularly noteworthy, for in teenagers, there are generally clear sex differences in attitudes toward food, attributed partly to social factors such as girls’ growing concerns about their weight and body image (Wardle et al., 2001). It would hence be interesting to follow the developmental path of sex differences across the years, to better understand the respective roles of cognitive and social factors in food rejection.

We acknowledge that there were several limitations to this study. First, the fairly moderate response rate to the questionnaire led us to presume that it was mainly filled in by families interested with nutrition, and hence not entirely representative of the national population. Further studies could thus extend the investigation of children’s food rejection assessment to more representative and generalizable samples and to test the applicability of the scale for non-French children. Second, we lacked dual-caregivers reports or children perspective on their own food neophobia and pickiness. Further studies could therefore assess the concordance of caregiver ratings for the same child or the concordance of children and caregiver ratings (for an older child who could answer for their own to the questionnaire). Third, it would seem that the subscale for
neophobia is more robust and consistent than that for pickiness which has a lower consistency. Pickiness is a construct which is still not well defined and further studies are much needed to better grasp this construct. Finally, in our food choice task, the food pictures used to measure pickiness were based on only one aspect of this construct (namely that a picky child is likely to sort his/her food), whereas its definition also includes the consumption of an inadequate amount of food or the rejection of certain food textures. In future research, therefore, it would be worth assessing the predictive validity of the CFRS with another feature of picky behaviors (e.g., by presenting children with foods of different textures). Nevertheless, despite these limitations, we believe that the CFRS represents an efficient and valuable tool for studying food rejection tendencies in young French children through their caregivers. This new scale could be useful for measuring the effectiveness of interventions promoting the adoption of healthier food habits, by children.

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Conflict of interest: The authors declare no conflict of interest.
References


Table 1: Descriptive statistics and factor loadings from the exploratory factor analysis.

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3. Mon enfant refuse de manger certains aliments à cause de leurs textures (My child refuses certain foods due to their texture)</td>
<td>3.3</td>
<td>1.2</td>
<td>0.14</td>
<td>0.48</td>
</tr>
<tr>
<td>P4. Mon enfant fait le tri dans son assiette (My child sorts his/her food on the plate)</td>
<td>3.3</td>
<td>1.2</td>
<td>0.28</td>
<td>0.56</td>
</tr>
<tr>
<td>P5. Mon enfant rejette certains aliments après les avoir goûté (My child rejects certain foods after tasting them)</td>
<td>3.9</td>
<td>0.7</td>
<td>0.14</td>
<td>0.75</td>
</tr>
<tr>
<td>P6. Mon enfant peut manger un aliment aujourd'hui et le refuser demain (My child can accept one food one day and refuse it the next day)</td>
<td>3.4</td>
<td>1.3</td>
<td>0.24</td>
<td>0.89</td>
</tr>
<tr>
<td>P10. Mon enfant peut manger certains aliments en grandes quantités et d'autres pas du tout (My child can eat some foods in large amounts and completely reject others)</td>
<td>4.0</td>
<td>1.1</td>
<td>0.15</td>
<td>0.69</td>
</tr>
<tr>
<td>N1. Mon enfant recherche constamment des aliments familiers (My child is constantly looking for familiar foods)</td>
<td>3.2</td>
<td>1.2</td>
<td>0.79</td>
<td>0.05</td>
</tr>
<tr>
<td>N2. Mon enfant se méfie des aliments nouveaux (My child is suspicious of new foods)</td>
<td>3.2</td>
<td>1.2</td>
<td>0.78</td>
<td>0.05</td>
</tr>
<tr>
<td>N4. Mon enfant aime seulement la cuisine qu'il connait (My child only likes the familiar foods)</td>
<td>2.6</td>
<td>1.2</td>
<td>0.83</td>
<td>0.07</td>
</tr>
<tr>
<td>N6. Mon enfant rejette un nouvel aliment avant même de l'avoir goûté (My child rejects a novel food before even tasting it)</td>
<td>3.0</td>
<td>1.3</td>
<td>0.73</td>
<td>0.10</td>
</tr>
<tr>
<td>N7. Mon enfant est angoissé à la vue d'un nouvel aliment (My child gets upset at the sight of a novel food)</td>
<td>2.0</td>
<td>1.1</td>
<td>0.90</td>
<td>0.20</td>
</tr>
</tbody>
</table>
N10. Mon enfant ne goûte pas un nouvel aliment si cet aliment est en contact avec un autre aliment qu'il n'aime pas (My child won't try a novel food if it is touching another food he/she does not like)

Note. The criterion for loading was > 0.45. Items referring to neophobic behaviors are coded $N$ and items referring to picky behaviors are coded $P$. 

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6</td>
<td>1.1</td>
<td>0.62</td>
<td>0.13</td>
</tr>
</tbody>
</table>
Table 2: Pairs of foods used in the food choice task.

<table>
<thead>
<tr>
<th>Food categories</th>
<th>Food pairs used for neophobia</th>
<th>Food pairs used for pickiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starchy products</td>
<td>ordinary rice-black rice (N)</td>
<td>pasta with tomato sauce</td>
</tr>
<tr>
<td>Fruit</td>
<td>Apple-persimmon (N)</td>
<td>fruit salad</td>
</tr>
<tr>
<td>Vegetables</td>
<td>green beans-winged beans (N)</td>
<td>green peas with carrots</td>
</tr>
<tr>
<td>Dairy products</td>
<td>Cow’s milk cheese-tofu (N)</td>
<td>yoghurt with blackberries</td>
</tr>
</tbody>
</table>

*Note.* The novel foods are marked (N).
Table 3: Mean scores and standard deviation (SD) on the 11-item scale at test and retest (n= 74). Comparisons between mean values made using paired $t$-tests and Pearson’s coefficient.

<table>
<thead>
<tr>
<th>Item</th>
<th>Test</th>
<th>Re-test</th>
<th>$t$-test</th>
<th>Pearson’s coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>P3</td>
<td>3.3</td>
<td>1.2</td>
<td>3.3</td>
<td>1.2</td>
</tr>
<tr>
<td>P4</td>
<td>3.3</td>
<td>1.2</td>
<td>3.1</td>
<td>1.2</td>
</tr>
<tr>
<td>P5</td>
<td>3.9</td>
<td>0.7</td>
<td>3.8</td>
<td>0.8</td>
</tr>
<tr>
<td>P6</td>
<td>3.4</td>
<td>1.3</td>
<td>3.4</td>
<td>1.2</td>
</tr>
<tr>
<td>P10</td>
<td>4.0</td>
<td>1.1</td>
<td>3.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Overall P</td>
<td>17.9</td>
<td>5.5</td>
<td>17.5</td>
<td>5.6</td>
</tr>
<tr>
<td>N1</td>
<td>3.2</td>
<td>1.2</td>
<td>3.1</td>
<td>1.2</td>
</tr>
<tr>
<td>N2</td>
<td>3.2</td>
<td>1.2</td>
<td>3.1</td>
<td>1.2</td>
</tr>
<tr>
<td>N4</td>
<td>2.6</td>
<td>1.2</td>
<td>2.6</td>
<td>1.1</td>
</tr>
<tr>
<td>N6</td>
<td>3.0</td>
<td>1.3</td>
<td>2.9</td>
<td>1.2</td>
</tr>
<tr>
<td>N7</td>
<td>2.0</td>
<td>1.1</td>
<td>2.1</td>
<td>1.0</td>
</tr>
<tr>
<td>N10</td>
<td>2.6</td>
<td>1.1</td>
<td>2.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Overall N</td>
<td>16.5</td>
<td>4.0</td>
<td>16.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Overall</td>
<td>34.4</td>
<td>8.6</td>
<td>33.9</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Note. Ns = no significant difference. *** $p < 0.001$. 
Appendix. 35-item version of the CFRS

Pickiness subscale

P1= mon enfant accepte une variété limitée d’aliments (my child accepts only a small variety of foods, adapted from the CEDQ; Rigal et al., 2012)
P2= mon enfant mange en petites quantités (my child eats in small quantities, novel item)
P3= mon enfant refuse de manger certains aliments à cause de leurs textures (my child refuses certain foods due to their texture, novel item)
P4= mon enfant fait le tri dans son assiette (my child sorts his/her food on the plate, novel item)
P5= mon enfant rejette certains aliments après les avoir goûté (my child rejects certain foods after tasting them, novel item)
P6= mon enfant peut manger un aliment aujourd’hui et le refuser demain (my child can accept a food one day and refuse it the next day, novel item)
P7= il est difficile de faire plaisir à mon enfant avec un plat que j’ai cuisiné (my child is difficult to please with homemade meals, adapted from the CEBQ; Wardle et al., 2001)
P8= mon enfant préfère lorsque les aliments sont en petites quantités dans son assiette (my child prefers having small quantities on the plate, novel item)
P9= une mauvaise expérience alimentaire empêche mon enfant de goûter l’aliment à nouveau (a bad experience would keep my child from trying a food again, from the FAS; Frank & van der Klaauw, 1994)
P10= mon enfant peut manger certains aliments en grandes quantités et d’autres pas du tout (my child can eat some foods in large amounts and completely reject others, novel item)
P11= mon enfant est sélectif pour la nourriture (my child is a picky eater, novel item)
P12=mon enfant est difficile avec la nourriture lorsqu'un aliment est en contact avec autre aliment qu'il n'aime pas (my child is picky when one food touches another food that he/she does not like, novel item)

P13=à la cantine scolaire, mon enfant ne mange qu'une partie des aliments proposés (in the school canteen my child eats only a small variety of foods, novel item)

P14=quand on mange chez des amis, mon enfant fait le tri dans son assiette (when we eat with friends my child sorts his/her food on the plate, novel item)

P15=mon enfant est difficile pour la nourriture même en présence de camarades faciles pour la nourriture (my child is picky even when he/she is with friends who are not picky eaters, novel item)

P16=mon enfant est difficile pour la nourriture quand il est invité à des fêtes (my child is picky when he/she is invited to parties, novel item)

P17=mon enfant est difficile pour la nourriture même si on lui dit que ce qu'il y a dans son assiette a bon goût (my child is picky even if we tell him/her that the food on the plate is tasty, novel item)

P18=mon enfant est difficile pour la nourriture même si on ajoute un aliment qu'il aime dans son assiette (my child is picky even if we add a food he/she likes on the plate, novel item)

Neophobia subscale

N1=mon enfant recherche constamment des aliments familiers (my child is constantly looking for familiar foods, adapted from the FNS; Pliner & Hobden 1992)

N2=mon enfant se méfie des aliments nouveaux (my child is suspicious of new foods, adapted from the FNS; Pliner & Hobden 1992)
N 3=si **mon enfant ne sait pas ce qu’il y a dans un plat, il n’y goûte pas** (if my child does know what is in a food, he/she won’t try it, *from the FNS; Pliner & Hobden 1992*)

N4=**mon enfant aime seulement la cuisine qu’il connaît** (my child only likes the food he/she knows, *adapted from the FNS; Pliner & Hobden 1992*)

N5=**mon enfant ne goûte pas un nouveau plat si un de ses ingrédients lui déplait** (my child won’t taste a dish if he/she dislikes one of its components, *adapted from Ton Lu, 1996*)

N6=**mon enfant rejette un nouvel aliment avant même de l’avoir goûté** (my child rejects a novel food before even tasting it, *novel item*)

N7=**mon enfant est angoissé à la vue d’un nouvel aliment** (my child gets upset at the sight of a novel food, *novel item*)

N8=**mon enfant aime identifier chacun des aliments présents dans son assiette** (my child likes to identify each of the foods on the plate, *novel item*)

N9=**mon enfant a peur de goûter des aliments nouveaux** (my child is afraid to taste novel foods, *adapted from the QENA; Rubio et al., 2008*)

N10=**mon enfant ne goûte pas un nouvel aliment si cet aliment est en contact avec un autre aliment qu’il n’aime pas** (my child won’t try a novel food if it is touching another food he/she does not like, *novel item*)

N11=**a la cantine scolaire, mon enfant refuse de manger des aliments nouveaux** (at school canteen, my child refuses to eat novel foods, *novel item*)

N12=**mon enfant montre des signes d’anxiété lorsque l’on va manger chez des amis** (my child gets anxious when we eat with friends, *adapted from the FNS; Pliner & Hobden 1992*)

N13=**quand on mange chez des amis, mon enfant choisit des plats qu’il connaît** (when we eat with friends, my child picks foods he/she knows, *adapted from the FNS; Pliner & Hobden 1992*)
mon enfant évite les aliments nouveaux même en présence de camarades goûtant à ces aliments (my child avoids novel foods even when he/she is with friends trying these new foods, adapted from the QENA; Rubio et al., 2008)

mon enfant évite les aliments nouveaux quand il est invité à des fêtes (my child avoids novel foods when he/she is invited to parties, adapted from the QENA; Rubio et al., 2008)

mon enfant ne goûte pas un nouvel aliment même si on lui dit qu’il a bon goût (my child won’t try a novel food even if we tell him/her it is tasty, adapted from the QENA; Rubio et al., 2008)

mon enfant ne goûte pas un nouvel aliment même si on ajoute un aliment qu’il aime dans son assiette (my child won’t try a novel food even if we add a he/she likes on the plate, adapted from the QENA; Rubio et al., 2008).