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Abstract

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Keywords	childhood; cross-cultural differences; food rejection; healthy eating
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Data will be made available on request

We compared food neophobia (FN) across Europe using a child-friendly tool

The ICFNS is a robust and efficient tool to measure FN in European young consumers

The tool was able to detect cross-national differences in FN

FN is linked to lower consumption of fresh fruits, vegetables, seeds and nuts, and wholegrain products

The tool can be useful in interventions aiming to change FN related behaviors among children

Cross-national differences in child food neophobia: a comparison of five European countries

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Abstract

Food neophobia (FN) has been extensively explored, especially in children. However, very few studies have compared this food behavior in children from different countries. Considering the clear diversity between European countries in feeding practices and food consumption, it is important to deepen the understanding of cross-national differences in child FN. The aim of this study was to explore and compare FN in five European countries (Finland, Italy, Spain, Sweden and UK) using a food neophobia scale specifically designed for children. Five hundred and twenty-nine children (54% girls) aged 9-12 years were recruited from schools in each country and were asked to complete the Italian Child Food Neophobia Scale (ICFNS, Laureati et al., 2015a), which was translated into each respective language. Parents (n≈300) completed a food consumption frequency questionnaire for their child, and provided background information. Reliability of the tool was assessed through internal consistency and temporal stability. Total internal consistency was 0.76. When calculated by country, internal consistency was satisfactory (Cronbach's alpha > 0.70) for all countries. FN was negatively associated to fruit and vegetable consumption, liking of wholegrain biscuits, and timing of introduction of semi-solid food. There were small but significant cross-national differences in FN with British and Swedish children being the most neophobic and significantly higher in FN than Finnish children, who were the most neophilic. Results indicate that the tool can be successfully used in all the tested countries with children in the age range of 9-12 years. The tool can be useful to measure the effects of interventions aiming at changing food behaviors, such as reducing FN, among children.

Keywords: childhood; cross-cultural differences; food rejection; healthy eating

1. Introduction

It is widely recognized that following a balanced and varied diet is important for a healthy development throughout the life span (Foote et al., 2004). Considering that dietary habits formed in infancy often persist into later life (Nicklaus, Boggio, Chabanet, & Issanchou, 2004, 2005), it is desirable to establish healthy dietary patterns during childhood. A balanced diet includes a great variety of foods, whereas a reduced dietary variety is associated with poor micro-nutrient intake in adults and children (Foote at al., 2004; Evans et al., 2018). One factor that negatively influences dietary quality and variety is food neophobia (FN) (Falciglia, Couch, Gribble, Pabst, & Frank, 2000), which is the fear to try new and unknown foods (Pliner and Hobden, 1992). Children with higher neophobia may be more selective, leading to reduced dietary variety, which may contribute to inadequate nutrient intake (Falciglia et al., 2000). Thus, FN could potentially lead to important nutritional consequences (Zickgraf and Schepps, 2016; Jaeger et al., 2017). It is largely recognized that FN is negatively related to daily intake and liking of fruit and vegetables (Perry et al., 2015; Fletcher, Wright, Jones, Parkinson, & Adamson, 2017) as well as of food of animal origin, especially fish. Interestingly, literature indicates that this relation is the same over different countries and cultures (Knaapila et al., 2011; Zickgraf and Schepps, 2016; Jaeger et al., 2017; Laureati et al., 2018). Moreover, a positive association between FN and increased body mass index (BMI) has been observed in adults (Knaapila et al., 2015; Proserpio et al., 2018). Neophobic individuals may choose to eat familiar foods which are more energy dense than fruits and vegetables (Knaapila et al., 2011) or may be less willing to try healthy alternative versions of familiar products (Laureati et al., 2015b).

To tackle, prevent and try to decrease FN, it is necessary to deepen the understanding of factors associated with this eating behavior. In this context, standardized instruments are needed to measure FN across subjects with different ages and cultures. The Food Neophobia Scale (FNS) developed by Pliner and Hobden in 1992 (Pliner and Hobden, 1992) represents an established instrument to measure FN in adults across different cultures (Ritchey et al., 2003). There are different tools available for measuring FN in children (Damsbo-Svendsen et al., 2017). Some of them cannot be completed by children themselves but by a proxy (e.g., parent). Besides the fact that parents can only report about their children's behavior under their control/view, it has been shown previously that parents might pull the answers in the direction of parents'

behavior instead of their children's behavior (Mata et al., 2008). Laureati and collaborators (2015) adapted the Pliner and Hobden's FNS into an instrument that can be answered by children themselves (Laureati et al., 2015a). It is inspired from the 10-item questionnaire developed by Pliner and Hobden (1992) with some adaptations made to make the tool more child-friendly (i.e., 8 items answered on a 5-point facial scale with lexicon suitable to children). This instrument has been developed for Italian children and it has been found to be valid and reliable from the age of 8 years. However, it is of interest to investigate FN in different countries because feeding behavior and dietary habits differ between food cultures. These different practices from various food cultures might be positively or negatively associated with FN. To our knowledge, there is only one recent study in UK children that validated an instrument that was originally developed to assess food rejections in French children (Rioux et al., 2019). This instrument was valid for both cultures and could describe differences in food rejections among children from the two countries. Still, this instrument was answered by parents and not by children themselves. Moreover, in a recent review of factors related to picky eating and food neophobia in young children, Cole et al. (2017) highlighted that although there are a number of studies across different countries exploring food rejections in children, few studies have compared these behaviors in children from different cultural groups (Rioux et al., 2019).

In view of the above, the main aim of the present study was to apply a self-administered instrument consisting of the Italian version of the Child Food Neophobia Scale (ICFNS, Laureati et al., 2015a) in five European countries (Finland, Italy, Spain, Sweden and UK). The tool was used to compare food neophobic traits among children aged between 9 and 12 years from different cultures, and to explore the relation of this personality trait with a series of variables associated with food habits and consumption in children (i.e., age, gender, body mass index, weaning practices, food consumption frequency). Weaning practices were explored since previous research (Coulthard et al., 2009) reported an association between time of introduction of complementary food and food neophobia.

Moreover, as a secondary aim, the attitudinal measure obtained from the ICFNS was related to a behavioral measure (i.e. food acceptance) through the liking evaluation of wholegrain biscuits. Despite the fact that biscuits are well liked and familiar among children, we used formulations very high in fiber content, which has been related to neophobic reactions in children (Proserpio et al., 2019), probably due to the fact that it

imparts dark color as well as bitter taste and lumpy texture to food (Laureati et al., 2016). The biscuits provided to the children are available only in the Italian market and are targeted to adults thus, we assumed they would be unlikely to be familiar to children.

We hypothesized that the ICFNS would be culturally appropriate and would be able to detect country-related differences as well as associations between FN and background variables. Moreover, we expected that FN would be negatively associated with healthy foods consumption (e.g. fruits and vegetables) as well as liking of fiber-rich biscuits.

2. Material and Methods

2.1. Participants

Five hundred and twenty-nine children aged 9-12 years and their parents participated in a cross-sectional study (Table 1). They were recruited via primary schools in five countries (Finland, Italy, Spain, Sweden and United Kingdom) in order to include nations from Northern to Southern Europe with differences in food culture, consumption and, potentially, FN. This age range was chosen to have a relatively homogeneous group as these children have sufficient cognitive skills to understand most sensory tests and have sufficient reading skills to complete simple questionnaires individually (Laureati et al., 2015c). Children were balanced according to gender, except for Finland, which had a higher proportion of girls due to an imbalance in the class composition at the school. On average, 64% (n=339) of the parents completed the parental questionnaire. Occasionally, some parent did not reply to specific questions (e.g. parental age) thus, the number of parental responses varied slightly across questions. Mothers (81.5% of the parental respondents) more frequently completed the questionnaire than fathers. Parents were informed about the procedures and were asked to sign an informed consent when they agreed on participation. Children without a signed informed consent were excluded from the study. None of the enrolled children wished to withdraw from the study. The study protocol was approved by the Ethical Committees of each country. In countries where data collection was carried out after 28 May 2019 (General Data Protection Regulation enforceable), permission to store and handle the data in the authors' respective countries was obtained.

INSERT TABLE 1 ABOUT HERE

2.2. Procedures

Questionnaires and procedures for both children and parents were translated in English, reviewed by a native English speaker, and then translated in every language by two independent native speakers. The two translated versions were compared to identify discrepancies and reach consensus for an updated version. To improve comparability of the data collected in different cultures (Ares, 2018), procedures, experimental design and instructions to children and parents were the same in all countries and all tests and re-tests were carried out within a three-month period in the spring of 2018.

2.2.1. Tests completed by children

Children either performed the tests at their school or in a nearby facility, or their whole class visited the researcher's university department. All children independently provided their answers directly onto tablets or computers. The research team carefully explained the procedures to the children. Children were tested by class or in smaller groups (4-5 children) depending on the availability of tablets/computers. Firstly, children indicated their age and gender, then they self-completed the ICFNS, which was previously developed and validated for Italian school-aged children (Laureati et al., 2015a). This tool consists of 8 items representing 4 neophobic and 4 neophilic food situations (Table 2). For each item, children were asked to provide an answer using a 5-point scale with facial expressions (emoticons) representing different degrees of agreement (from left to right, "Very false for me"= a frown face with both thumbs down; "False for me"= a frown face with one thumb down; "So so"= a neutral face with no thumbs shown; "True for me"= a smiley face with one thumb up; "Very true for me"= a smiley face with both thumbs up). Emoticons are familiar to children and enable embedding the research task in a game-like situation, which is known to increase children's motivation and attention span. Moreover, representing a non-verbal method, emoticons may offer a standardized, universal way across countries to measure food behavior in children (Gallo et al., 2017).

In order to check reliability of the ICFNS, a sub-sample of children (N=65; 51% boys; Italy: n=22, Sweden: n=21 and UK: n=22) was re-tested within a period of approximately two months. They were asked to complete the ICFNS following the same procedures as with the first test.

INSERT TABLE 2 ABOUT HERE

After the completion of the questionnaire, children were provided with a series of six biscuits varying in fiber content (from 4.6% to 10%) and asked to rate their liking on a 7-point hedonic facial scale (Laureati et al., 2015c). Depending on the organization of the experiment in each country, the liking test was performed on the same day of the FN assessment, after a short rest, or a few days later. Children were tested by class or in smaller groups (4-5 children) in the presence of the teacher and/or the experimenters who instructed them to avoid any comment and not to share biscuits with other pupils. Children received the biscuits in random order and were instructed to clean their mouth with a sip of water between tastings. The liking test on biscuits served as a behavioral measure to be related to the attitudinal measure from the ICFNS. While biscuit is a child-friendly product category, we assumed, according to previous research (Proserpio et al., 2019), that wholegrain biscuits may generate different acceptance levels in neophobic and neophilic children. Moreover, the biscuits used in this study could reasonably be considered unfamiliar to children, as they are only present on the Italian market and even in this case are not targeted to children but to adult consumers.

2.2.2. Tests completed by parents

Parents provided information on their child's birthdate, height and weight. The Body Mass Index (BMI) was calculated as the weight (kg) per height (m^2). The gender-specific BMI-for-age percentiles were calculated according to the International Obesity Task Force (IOTF) cut-offs (Cole et al., 2000). In UK, children's height and weight were measured to the nearest 0.1 cm and 0.1 kg using a high-precision mechanical scale and a stadiometer, respectively. BMI was expressed as kgm^{-2}.

In addition, parents completed a food frequency of consumption questionnaire (FFQ) based on the work of Hedrick et al. (2010). The questionnaire is extensively described in the paper by Laureati et al. (2020). Briefly, the FFQ consisted of 17 food categories, including conventional and whole grain versions of a series of bakery products, pasta and rice, as well as fruits and vegetables. For each item, parents had to indicate how often

their child had eaten the food products during the last month choosing among the following options: less than once a month or never, 1-3x per month, 1-3x per week, 4-6x per week, once a day, multiple times per day along with the option 'I don't know for my child'. The consumption frequency of the food items was converted to Daily Frequency Equivalents (DFE) calculated by allocating proportional values to the original frequency categories with reference to a base value of 1.0, equivalent to once a day (Daly et al., 2011; Ireland et al., 1994; Jayasinghe et al., 2017). The scores were calculated as follows: DFE of 0 = less than once a month or never, DFE of 0.07 = 1-3x per month, DFE of 0.28 = 1-3x per week, DFE of 0.71 = 4-6x per week, DFE of 1 = once a day, DFE of 2.5 = multiple times per day.

Moreover, parents also provided information on their child weaning practices by reporting the age of introducing semi-solid (e.g., yogurt, fruit/vegetable puree) and solid (e.g. pieces of bread) foods (before the age of 4 months, between 4-6 months, between 7-9 months, later than 9 months, I don't know/ I don't remember at all). Finally, parents reported on their own age, gender, their perceived socio-economic situation on a 7-point scale ("1= difficult", "4=moderate" and "7=well-off", Almli et al., 2011) and highest completed level of education for themselves.

2.3. Data Analysis

The answers to the 8 items of the ICFNS were summed up (with items 1, 4, 5 and 8 using reversed scoring; see Table 2) to have a ICFNS score ranged from 8 to 40. A higher score indicates a higher level of FN. The frequency distribution of FN scores was calculated over all countries and by country. According to Shapiro-Wilk test, the distributions were always normal. Children were divided into 3 groups according to the 25^{th} and 75^{th} percentiles calculated across total sample: ''low food neophobia'' (children in the lowest quartile, scores ≤ 17), ''high food neophobia'' (children in the highest quartile, scores ≥ 24) and ''medium food neophobia'' (children in the mid 50%, scores 18-23).

Reliability of the tool was assessed by calculating internal consistency (Cronbach's α) and temporal stability by test–retest evaluation. Analysis of Cronbach's α with deleted variables was performed in order to investigate whether all the items contributed in the same way to the construct. Temporal stability of each item and of total FNS score in the test–retest evaluation was checked through Pearson's correlation and

paired t-tests. Consistent with previous studies (Fernandez-Ruiz et al., 2013; Laureati et al., 2015a; Laureati et al., 2018), the relationship between each item was further evaluated with Principal Component Analysis (PCA). Data were standardized (i.e., scaled to unit variance) prior to modeling and cross validation was chosen as validation method.

The association between FN and FFQ was investigated using Pearson's correlation supported by two-way ANOVA considering Country, FN level and their interactions as factors and consumption frequency (expressed in DFE) as dependent variable. Three-way ANOVA considering Country, FN level, Biscuit and their interactions as factors and liking scores as dependent variable was used to explore the association between FN and biscuits liking.

The association between weaning practices and FN was tested with Spearman's correlation. The association between FN, BMI, parental age and socio-economic status (SES) variables was investigated through Pearson's correlation (i.e., BMI, parental age and perceived economic status) or through ANOVA (i.e., educational level).

When the ANOVAs showed a significant effect, the Bonferroni test *post-hoc* comparison adjusted for multiple comparison was used. A p-value of 0.05 was considered as threshold for statistical significance. A p-value lower than 0.10 was also reported for tendencies.

The SAS/STAT statistical software package version 9.3.1 (SAS Institute Inc., Cary, USA) and The Unscrambler X software version 10.4.1 (CAMO Software AS, Oslo, Norway) were used for the data analysis.

3. Results

3.1. Reliability of the tool in different EU countries

3.1.1. Internal validity: Cronbach's alpha

Cronbach's alphas calculated over all countries and by country are reported in Table 3. Total internal consistency was 0.76 (n=529), comparable to the suggested value of 0.70 given by Nunnally and Bernstein (1988). When calculated by country, internal consistency was satisfactory for all countries as well (alpha > 0.70). Cronbach's alpha values were recalculated (both overall and by country) where variables were removed in order to calculate the expected standardized alpha coefficient after removing one item at a time.

The standardized alpha coefficient provides information about how each item reflects the reliability of the scale. If the standardized alpha decreases after removing an item from the construct, then this variable is strongly correlated with other items in the scale. On the other hand, if the standardized alpha increases after removing an item from the construct, then removing this variable from the scale makes the construct more reliable (SAS Procedure Guide, version 9.4). In the present case, the standardized alpha coefficients did not show a significant increase or decrease both overall and by country, suggesting there was no improvement in removing some specific item from the scale.

INSERT TABLE 3 ABOUT HERE

The relationship between the items was further investigated through PCA (Fig. 1). PCA performed over all countries and by country showed that PC1 accounted for a total explained variance ranged from 34% to 45%, whereas PC2 explained a further 12%-15%. Total explained variance ranged from 49% to 57%. All items were positively related on PC1, indicating that they were measuring the same construct, i.e. FN.

INSERTI FIGURE 1 ABOUT HERE

3.1.2. Temporal stability

Temporal stability of the ICFNS was investigated in 3 countries (Italy, Sweden and UK) due to practical constraints. Total ICFNS scores and individual item scores by country in the test–retest evaluation are reported in Table 4. Paired t-test analysis performed over all countries and by country showed no significant differences between the total FNS scores and individual ICFNS items score across time, with the exception of item 8 in UK, indicating temporal stability. This result was supported by an overall positive and significant correlation between the two assessments (n=65, r=0.82, p<0.0001). The analysis by country also showed a positive and significant correlation between the two assessments (Italy: n=22, r=0.71, p=0.002; Sweden: n=21, r=0.89, p<0.0001; UK: n=22, r=0.90, p<0.0001).

INSERT TABLE 4 ABOUT HERE

3.2. Effect of child age, gender, country and BMI on food neophobia

Results from 3-way ANOVA with interactions showed that the only demographic factor that had a significant effect on FN was country of origin ($F_{4,505}$=2.44, p=0.05), whereas neither age nor gender showed significant effects. British (M=21.7) and Swedish (M=21.4) children were comparable and significantly more neophobic than Finnish (M=19.2) children. Italy (M=19.5) and Spain (M=20.5) were comparable to all countries (Table 3). Although significant, country-related differences were very small. According to Pearson's correlation, there was no significant association between FN and BMI.

3.3. Association between food neophobia and food consumption frequency

Considering all countries, FN correlated negatively and significantly with consumption frequency of fresh fruits (r=-0.17, p=0.003), vegetables (r=-0.14, p=0.01), wholegrain biscuits (r=-0.14, p=0.02), seeds and nuts (r=-0.12, p=0.03), and pasta (r=-0.12, p=0.03), whereas a negative tendency was seen for wholegrain cereals (r=-0.10, p=0.09) and dried fruits (r=-0.10, p=0.09). When the analysis was conducted by country, there were occasionally negative and significant correlations such as, for example, wholegrain bread in Sweden and wholegrain biscuits and pasta in Spain (Table 5).

INSERT TABLE 5 ABOUT HERE

ANOVA confirmed a significant effect of the main factor FN on parent-reported fresh fruits ($F_{2,303}$=3.23, p=0.04) and vegetables ($F_{2,303}$=5.50, p=0.004) consumption. In both cases, children with a low FN level consumed the food items more frequently than the children with a high level of FN, while a medium FN was associated with intermediate fruits and vegetables consumptions (Figure 2). The interaction FN*Country was never significant indicating that this outcome was the same in all countries.

3.4. Association between food neophobia and wholegrain biscuits liking

The main factor FN was significant ($F_{2,2988}$=21.21, p<0.0001). Multiple comparison test showed that the three FN groups differed significantly from each other, with the children with low FN level showing the highest liking ratings (M=5.7; SEM=0.05), followed by the children with medium FN (M=5.4; SEM=0.04) and the lowest liking rating for children with high FN (M=5.1; SEM=0.05) (Figure 3). The interactions FN*Country,

FN*biscuit and FN*country*biscuit were not significant, indicating that this outcome was the same in all five countries independently of the biscuit type.

3.5. Effect of weaning practices on food neophobia

In general, semi-solid foods (e.g. yogurt, fruit/vegetable purée) were introduced into the children's diet mainly at 4-6 months (63.2%), while a smaller proportion of parents did so at 7-9 months (21.1%) and before 4 months (7.9%). Concerning the introduction of solid foods (e.g. pieces of bread/biscuit) into the child's diet, 44.4% of parents started at 7-9 months and 27.8% later than 9 months. A non-negligible proportion (16.7%) started at 4-6 months (Table 6). In this respect, Italy was somewhat different from the other countries reporting a later timing of introduction of both semi-solid and solid foods in the child's diet.

Spearman's correlation analysis showed that, over all countries, FN was significantly and negatively (ρ =-0.13, p=0.04) correlated to the age of introduction of semi-solids in the child's diet. The analysis by country showed that this association was significant (ρ=-0.23; p=0.03) only for UK. However, no significant effect was found between the start of fully solid foods and FN in children.

INSERT TABLE 6 ABOUT HERE

3.6. Effect of parental age, perceived economic status and educational level on food neophobia

Regarding parental age and economic status, no significant associations were found in the total sample. When the analysis was performed by country, sporadic associations were found. In Finland, a negative and significant relation between FN and parental age (n=32, r=-0.40, p=0.02) was seen, indicating that older parents have more neophilic children. In Spain, a positive association between FN and perceived economic status (n=89, r=0.27, p=0.01) was found, indicating that the higher the perceived family economic situation, the higher the child's FN level.

4. Discussion

Considering the clear differences between European countries in feeding practices and food consumption, it is essential to deepen the understanding of cross-national differences in children's FN. This study is the first

to compare FN in a sample of school-aged children from five different European countries using the same standardized and validated tool. As such, this study provides a relatively broad picture to the scarce literature about cross-national differences in children's FN.

The present study provided evidence that the ICFNS was a simple tool with age-appropriate vocabulary, items and response format (facial expressions), which facilitated the self-completion and understanding of the questionnaire in all tested countries. In fact, we found that the ICFNS internal consistency and temporal stability over all countries and by country were satisfactory and comparable to findings from previous research on children (Loewen & Pliner, 2000; Reverdy et al., 2008; Laureati et al., 2015a; Gomes et al., 2018). Moreover, ICFNS scores were negatively associated with liking of wholegrain biscuits and consumption frequency of healthy foods such as fruits, vegetables and wholegrain products. However, the correlation coefficients reflecting the association between FN and food consumption were weak, probably because, in the present study, the ICFNS was related to more general dietary items present in the FFQ (e.g. fruit, vegetable, pasta, and a cookie), and not to novel foods. An unexpected finding was that FN was related to pasta, which is a starchy product with bland taste that usually does not elicit neophobic reactions (Cooke et al., 2003; Laureati et al., 2018). This result may be due to the fact that in some countries pasta is eaten with ingredients (e.g. vegetables, meat or fish) that may be responsible of the neophobic reaction.

Despite differences among FN scores being small, we found that British and Swedish children showed higher FN compared to Finnish children. Differences in FN among different food cultures are not surprising and may be ascribed to differences in feeding practices and different food availability. Research carried out on 11-years-old children in nine European countries showed that the vegetable intake of European children differs as a result of living country (Yngve et al., 2005). Unfortunately, only two of the five countries involved in the present study (Spain and Sweden) were considered in the work of Yngve et al. (2005) so the comparison between the two studies is difficult. Rioux et al. (2019) also found differences between French and British children's (2-7 years of age) food rejection, with France being more selective than UK. In a cross-cultural comparison of FN in adults, Ritchey et al. (2003) found that Swedish adults were less neophobic than their American and Finnish counterparts. The fact that differences in FN scores among countries found in the present study were not large may also be due to the fact that children tested in the present study were aged

9-12 years. At this age, FN is in a descending phase (Dovey et al., 2008; Nicklaus, 2009), thus it might be more difficult to detect differences in food rejections compared to younger children. The specific age range may also explain the lack of age-related differences in FN in the sample of children tested in the present study. Additionally, we did not find gender-related differences in FN, whereas other studies have reported boys being more neophobic than girls (Koivisto & Sjöden, 1996; Reverdy et al., 2008). Interestingly, Laureati et al. (2014) found gender-related differences in FN level in children aged 6 and 7 years with boys being more neophobic than girls. These differences, however, disappeared in children aged 8 and 9 years, suggesting that with increasing age, differences in FN due to gender may decrease. In adults, gender-related differences in FN are not found (Knaapila et al., 2015) or rarely found and when they are, the differences are marginal (Koivisto Hursti & Sjödén, 1997; Tuorila et al., 2001; Siegrist et al., 2013; Laureati et al., 2018) supporting the conclusion that gender effects are likely to be less important than many other variables related to food rejection (Nordin, Broman, Garvill, & Nyroos, 2004).

FN was not related to BMI in the children in this study, in agreement with previous research on children of similar age range (Laureati et al., 2015b). The link between FN and nutritional status might be bidirectional. FN might manifest in a diet with a limited variety of foodstuffs, thus reducing the energy intake; in contrast, food neophobics could prefer to consume traditional foods with a higher energy density compared with healthier food, resulting in a higher BMI (Knaapila et al., 2011). A positive association between FN and BMI has been highligthed in a couple of studies involving adults (Knaapila et al., 2015; Proserpio et al., 2018) but rather few research exist on children (Laureati et al., 2015b). It is possible to hypothesize that the relationship between FN and BMI becomes more evident with increasing age due to the fact that dietary habits established in infancy, such as food neophobia, often persist into later life, as demonstrated by the high percentage (up to 45%) of neophobic adults found in different countries (Meiselman et al., 2010; Jaeger et al., 2017; Laureati et al., 2018).

A weak, negative association between FN and the age of introduction of semi-solids in children's diet was seen in our data. In line with our finding, Robinson et al. (2007) showed that poorer-quality diets (i.e., less fruit, vegetable and wholegrain products) of young children (6-12 months) were more common in families where solid foods were introduced at an earlier age. The transition from an exclusive breast-feeding to a

mixed diet consisting of milk and semi-solid and solid foods is a crucial period as it is the first step toward child's diet variety (WHO, 2003). Consequences of timing of complementary food introduction in terms of food behaviour and acceptance are not very well documented (Nicklaus, 2011), and the arguments supporting an early or late introduction are contradictory. Delaying complementary feeding too long or starting too early may both have side effects (Costantini et al., 2019). For instance, if the introduction of complementary foods begins too early (before 4 months) it might increase the risk of allergies (Muraro et al., 2014). On the other hand, late introduction of complementary foods, especially of lumpy food, may lead to later infant feeding problems and increased fussiness (Coulthard et al., 2009). In principle, early exposure to a variety of food should favour child's later openess toward new food as repeated exposure is reported being one of the strongest factors to overcome FN in children of different ages (Maier et al., 2007; Laureati et al., 2014). In this context, our data seem to suggest rather that an early introduction of semi-solid food (but not solid food) may be associated with later food neophobia in children. Based on the data acquired in the present study, however, it is not possible to formulate a hypothesis about the variety of the child's diet when parents started introducing semi-solids as we did not ask explicity about the type of foods that were introduced. Moreover, starting early with complementary feeding does not necessarily mean early diet variety. Further research is needed to better understand the consequences of timing of complementray feeding introduction on later child's eating behaviour.

Some limitations of the study should be highlighted. As previously mentioned, the association between FN and food consumption frequency was explored using a questionnaire focused on general food products (mainly refined vs. wholegrain products) and not novel food. Moreover, we used a liking test on wholegrain biscuits as a behavioural measure of FN. Although the biscuits used were only present on the Italian market and in any case not addressed to children, we cannot exclude that some of the Italian children may have been familiar to some of the biscuits if theirs parents are consumers. Furthermore, although formulated with a high fiber content, biscuit are usually very popular among children. Despite this, there were clear differences related to the neophobic attitude of children towards whole-grain biscuits both on the total sample of children and on each tested country.

Since we do not exclude that attitudinal measurements may have low predictive validity, future studies should confirm the present results by combining questionnaires with actual behavioural measurements .

5. Conclusion

This study aimed at expanding the Italian Child Food Neophobia Scale (ICFNS), a self-administered questionnaire targeted at school-aged children, to four additional European cultures. The tool was successfully used in Sweden, Finland, UK and Spain. Our results indicate that the ICFNS is an easy-to-administer, robust and efficient tool to measure FN in young consumers, even when translated in other languages across different countries. Further, an investigation of FN scores and background variables revealed that higher FN in our European sample of 9-12 year olds is linked to lower consumption of fresh fruits, vegetables, seeds and nuts, pasta and wholegrain biscuits, to lower acceptance of wholegrain biscuits and to earlier introduction of semi-solid foods. Finally, cross-national differences were revealed, where children from Sweden and UK on average tended to be more neophobic than Italian and Spanish children, and significantly more neophobic than Finnish children. Altogether, these results indicate that the tool was able to detect cross-national differences and find associations with several background variables, which have been reported to be linked with food rejection in children. The tool can be useful in interventions aiming to change FN-related behaviors among European children.

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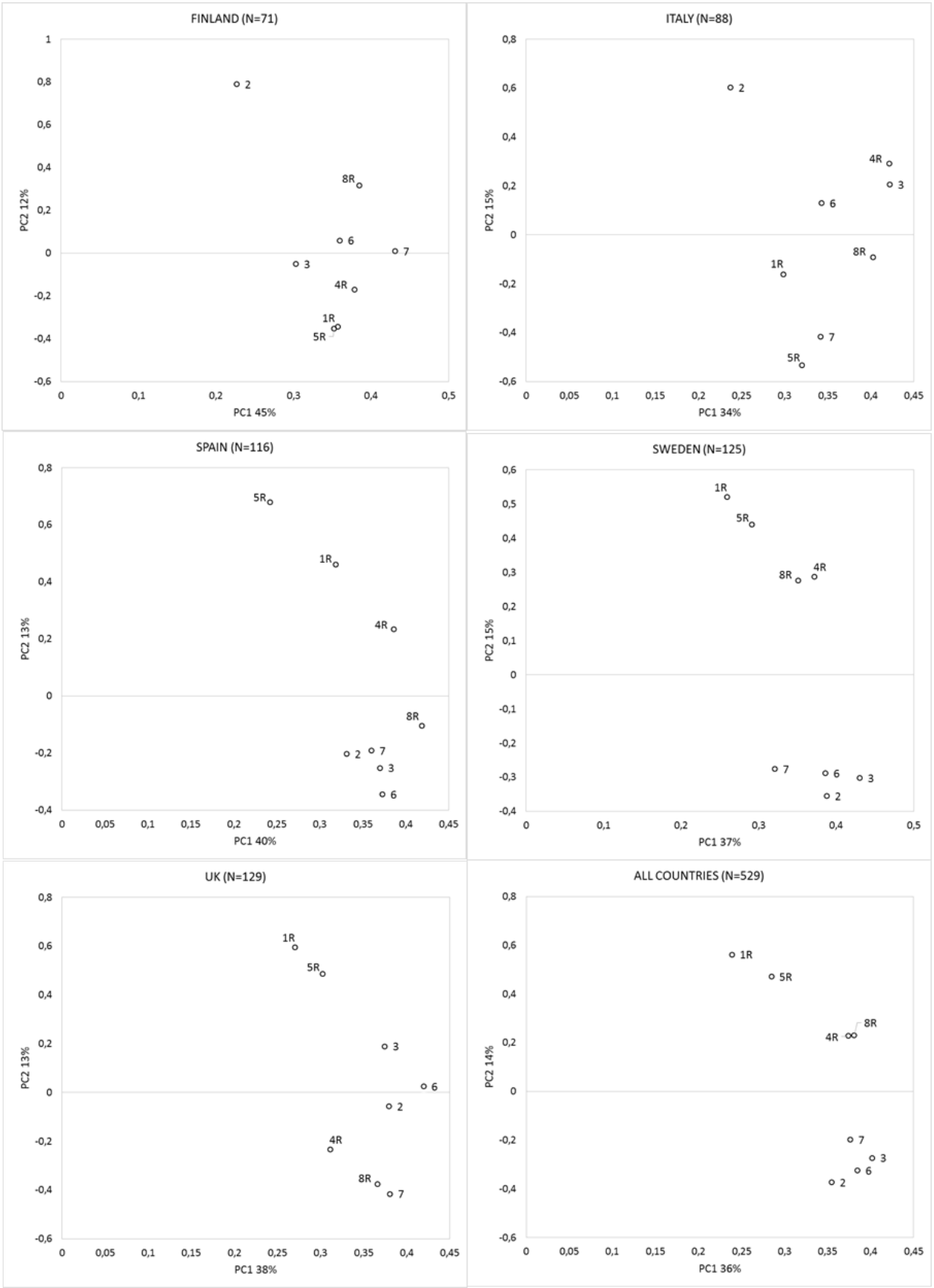

Figure 1. Loadings Plots obtained by PCA performed on scores of each item (R=reversed item) of the ICFNS overall and by country.

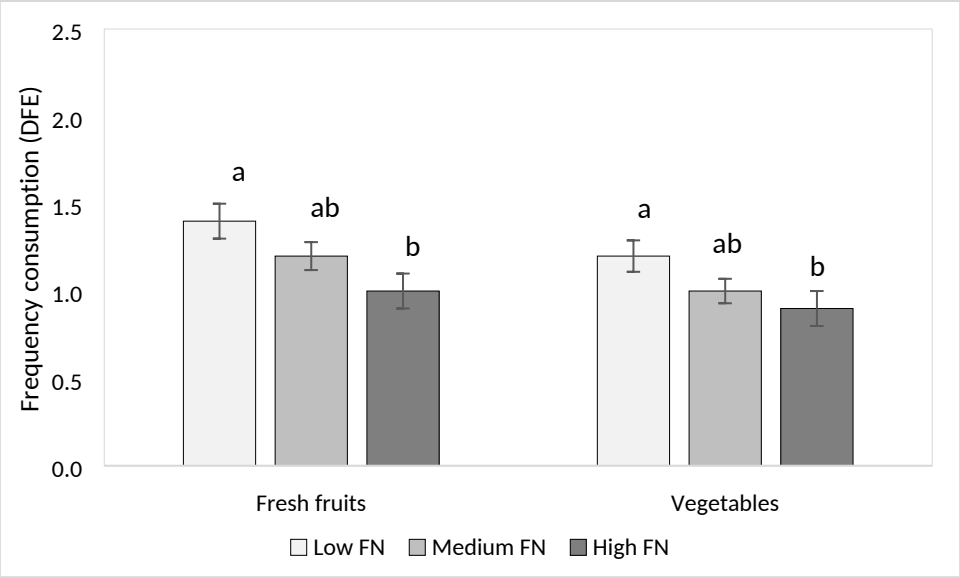

Figure 2. Consumption frequency (expressed in Daily Frequency Equivalents, DFE) of fresh fruits and vegetables in children with low, medium and high FN levels. Different letters indicate significantly different mean scores (Fresh fruits: p=0.04, Vegetables: p=0.004).

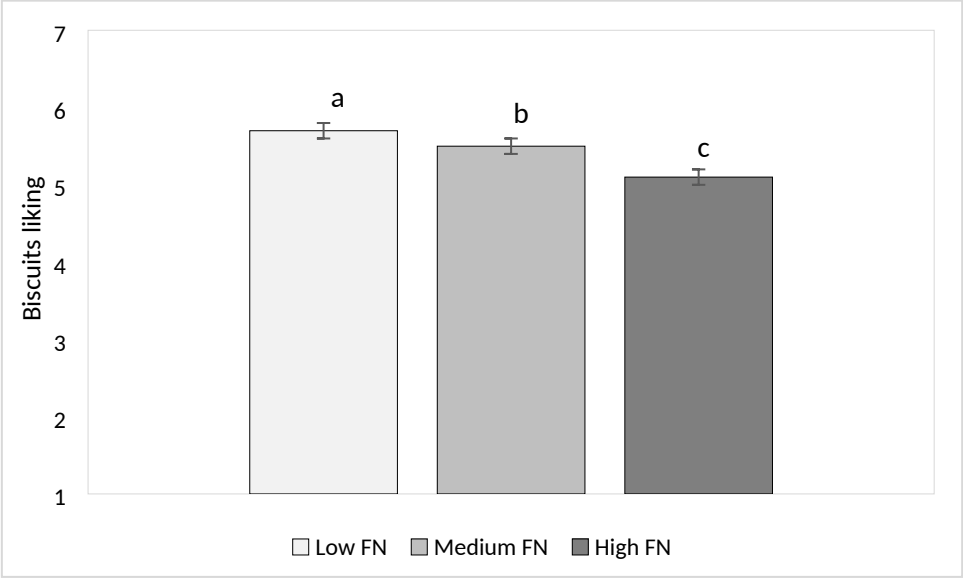

Figure 3. Mean biscuits liking scores in children with low, medium and high FN levels. Different letters indicate significantly different mean scores ($p<0.0001$).

Table 1. Characteristics of the participants (SEM=standard error of the mean)

Participant	Variable	Finland	Italy	Spain	Sweden	UK	Total
Child	N	71	88	116	125	129	529
	Gender (% girls)	81.4	48.8	54.0	44.1	52.0	54.1
	Age (years: mean; SEM)	10.6; 0.1	10.1; 0.1	10.5; 0.1	10.3; 0.1	10.6; 0.1	10.4; 0.1
	Age range (years)	9-12	10-11	9-12	10-11	9-11	9-12
Parent	N	32	46	89	79	93	339
	Gender (% females)	93.8	82.6	80.2	74.7	83.9	81.5
	Age (years: mean; SEM)	42.1; 1.0	45.3; 0.8	45.7; 0.4	42.7; 0.6	41.8; 0.6	43.2; 0.3
	Age range (years)	33-55	29-59	36-60	29-56	31-63	29-63

Table 2. Translation of the ICFNS in the 5 languages

Items	English (UK)	Finnish	Italian	Spanish	Swedish
1	Almost every day I eat new and unusual foods	Syön uusia ja epätavallisia ruokia melkein joka päivä	Mangio quasi tutti i giorni cibi nuovi e diversi dal solito	Casi todos los días como alimentos nuevos e inusuales	Jag äter ny och ovanlig mat nästan varje dag
2	I don't trust new foods	En luota uusiin ruokiin	Non mi fido dei cibi nuovi	No confío en los nuevos alimentos	Jag litar inte på ny sorts mat
3	If a food is new, I don't try it	En kokeile minulle uutta ruokaa	Se un cibo è nuovo, non lo assaggio	Si un alimento es nuevo, no lo pruebo	Jag provar inte ny sorts mat
4	I like to try weird tastes and foods, which are unusual and coming from different countries	Tykkään kokeilla outoja makuja. Tykkään myös epätavallisista ja toisista maista tulevasta ruoasta.	Mi piace provare sapori e cibi strani, diversi dal solito e provenienti da altri Paesi	Me gusta probar sabores y comidas raras, que son inusuales y provienen de diferentes países	Jag tycker om att prova konstiga smaker och mat som är ovanlig och kommer från andra länder
5	When I am at a friend's party, I like to try new foods	Kun olen kaverin juhlissa, tykkään kokeilla uusia ruokia.	Quando sono alla festa di un amico mi piace assaggiare cibi nuovi	Cuando estoy en una fiesta con amigos, me gusta probar nuevos alimentos	När jag är på kalas hos kompisar så tycker jag om att prova ny sorts mat
6	I am afraid to eat food I have never had before	Pelkään kokeilla ruokaa, jota en ole syönyt aiemmin	Ho paura di assaggiare un cibo che non ho mai mangiato prima	Me da miedo comer alimentos que nunca antes había probado	Jag är rädd för att äta mat som jag aldrig provat tidigare
7	I am very fussy when it's a matter of food	Olen hyvin nirso ruuan kanssa	Sono molto schizzinoso quando si tratta di mangiare	Soy muy quisquilloso (tiquismiquis) con la comida	Jag är väldigt petig när det gäller mat
8	I really eat everything!	Syön ihan kaikkea!	Mangio tutto, ma proprio tutto!	¡En realidad como de todo!	Jag äter verkligen allt!

Table 3. Cronbach's alphas and ICFNS scores (mean ± standard error) calculated over all countries and by country. Different superscripts indicate significantly different ICFNS mean scores according to ANOVA.

Country	N	Cronbach's	ICFNS
Finland	71	0.82	19.2 ± 0.9 [a]
Italy	88	0.71	19.5 ± 1.1 [ab]
Spain	116	0.76	20.5 ± 0.5 [ab]
Sweden	125	0.77	21.4 ± 0.5 [b]
UK	129	0.76	21.7 ± 0.5 [b]
Total	529	0.76	20.7 ± 0.2

*Table 4. Mean value ± standard error, Cronbach's alpha and significance of the difference of each ICFNS item score and total ICFNS scores by country in the test–retest evaluation. In the first column, R indicates the neophilic items for which the score was reversed (n.s.=not significant; *=p<0.05 according to paired t-tests).*

Item	Italy (n=22)			Sweden (n=21)			UK (n=22)		
	Test α=0.79	Retest α=0.83	p-value	Test α=0.92	Retest α=0.92	p-value	Test α=0.86	Retest α=0.74	p-value
1R	3.8±0.9	3.6±1.1	n.s.	3.2±0.7	3.4±0.8	n.s.	3.3±0.8	3.5±0.8	n.s.
2	2.7±1.3	2.1±1.2	n.s.	2.4±0.9	2.4±1.1	n.s.	2.2±0.9	2.2±0.9	n.s.
3	1.9±1.1	2.2±1.0	n.s.	2.0±1.0	2.3±1.1	n.s.	2.2±0.9	2.1±0.8	n.s.
4R	2.2±1.2	2.2±1.4	n.s.	2.4±0.9	2.4±1.1	n.s.	2.6±1.0	2.6±1.0	n.s.
5R	2.0±1.0	1.8±0.9	n.s.	2.2±0.9	1.9±1.0	n.s.	2.3±0.7	2.4±1.0	n.s.
6	2.7±1.1	2.5±1.2	n.s.	2.4±0.9	2.6±1.1	n.s.	2.5±1.2	2.1±0.9	n.s.
7	2.3±1.2	2.4±1.2	n.s.	2.6±1.2	2.4±1.3	n.s.	2.8±1.3	2.7±1.1	n.s.
8R	3.1±0.9	2.9±1.1	n.s.	3.2±0.8	3.1±0.9	n.s.	3.5±1.1	3.2±1.1	*
ICFNS	21.7±3.6	19.7±6.2	n.s.	20.5±5.6	20.6±6.2	n.s.	21.4±5.3	20.7±4.6	n.s.

*Table 5. Pearson's correlation coefficients between food consumption frequency and FN overall and by country. (*) trend p<0.10; * significant p<0.05; ** significant p<0.01.*

Food item	Total (n=317)	Finland (n=31)	Italy (n=43)	Spain (n=86)	Sweden (n=77)	UK (n=80)
White bread	-0.07	0.11	-0.15	-0.06	0.05	-0.02
Wholegrain bread	-0.02	0.10	-0.15	-0.05	**-0.22***	0.09
Wholegrain porridge	-0.07	-0.14	-0.09	-0.06	-0.19	-0.04
Cornflakes	-0.03	0.01	-0.16	-0.04	-0.10	-0.06
Wholegrain cereals	-0.10(*)	-0.09	0.02	-0.17	-0.21(*)	-0.10
Biscuits	0.02	0.06	-0.06	-0.09	0.15	0.09
Wholegrain biscuits	**-0.14***	0.05	-0.05	**-0.26***	-0.05	0.02
Fresh fruits	**-0.17****	-0.11	-0.14	**-0.22***	-0.17	-0.06
Dried fruits	-0.10(*)	**-0.36***	-0.20	-0.03	-0.06	-0.16
Seeds/nuts	**-0.12***	**-0.41***	-0.15	-0.12	-0.08	-0.06
Vegetables	**-0.14***	-0.12	-0.07	**-0.33****	**-0.26***	-0.05
Potatoes	-0.04	-0.01	-0.16	-0.12	-0.06	-0.03
Legumes	-0.03	-0.17	0.15	0.04	-0.10	-0.03
Rice	0.03	-0.01	-0.03	0.03	-0.01	0.02
Wholegrain rice	0.08	0.06	-0.19	-0.16	0.07	0.21
Pasta	**-0.12***	-0.08	-0.18	-0.06	0.09	-0.04
Wholegrain pasta	-0.07	0.17	-0.23	**-0.27***	-0.19	0.08

Table 6. Percentage of mothers introducing semi-solid and solid foods (in months, m) in the child's diet at different ages and Spearman's correlation coefficients (ρ) between FN and weaning practices (significant for p<0.05).*

Country	N	ρ	Introduction of semi-solids (%)					N	ρ	Introduction of solids (%)				
			< 4 m	4-6 m	7-9 m	> 9 m	don't remember			< 4 m	4-6 m	7-9 m	> 9 m	don't remember
Finland	32	-0.13	12.1	63.6	21.2	3.0	-	32	-0.23	-	18.2	45.5	33.3	3.0
Italy	42	0.18	-	55.6	28.9	6.7	8.9	42	0.24	-	-	44.4	46.7	8.9
Spain	82	-0.15	8.8	57.1	25.3	-	8.8	80	0.05	2.2	17.6	34.1	36.3	9.9
Sweden	75	0.02	10.0	53.0	12.0	-	3.0	66	0.02	-	17.0	38.0	11.0	12.0
UK	86	**-0.23***	5.4	68.5	18.5	-	7.6	84	-0.01	-	19.6	51.1	19.6	9.8
Total	318	**-0.13***	7.9	63.2	21.1	1.2	6.7	304	-0.04	0.6	16.7	44.4	27.8	10.5

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