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An alternative food neophobia scale (FNS-A) to quantify responses to new foods

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ABSTRACT

An alternative Food Neophobia Scale (FNS-A) was developed in three studies to measure food neophobia (reluctance to eat and avoidance of trying new foods). In Study 1, the original food neophobia scale, FNS (Pliner, & Hobden, 1992), was first critically examined leading to modifications in five and omission of two statements. Furthermore, eight positive and eight negative statements were elicited and introduced along with eight original or modified FNS statements to 575 respondents in South Africa, Lesotho, and Botswana. Study 2 (n = 1010) was used to confirm the factorial structure of the scale, and Study 3 (n = 141) was used to test the reliability of FNS-A through test–retest data. The structure of the scale was analyzed using exploratory (Study 1 and 2) and confirmatory (Study 2) factor analysis, eventually leading to four positive and four negative statements regarding new foods, loaded on two factors labelled approach and avoidance. Test-retest reliability at a 2 weeks' time interval as well as convergent and divergent validity measured against other scales was good (Study 3). In all three studies, predictive validity was evaluated against willingness to try or expected liking ratings of unfamiliar or novel food names or food concept descriptions. This evaluation showed satisfactory performance. FNS-A is a promising tool for the quantification of individual responses to unfamiliar or novel foods, but further studies in other populations and contexts are needed to confirm the applicability.

1. Introduction

Food neophobia, reluctance to eat or avoidance of new or unfamiliar foods, is considered an important determinant of food choice (Dovey, Staples, Gibson, & Halford, 2008). Previous studies have found that the diets of neophobic individuals display limited dietary variety (e.g., Siegrist, Hartmann, & Keller, 2013), eventually manifesting in poor dietary quality (Knaapila et al., 2015) and adverse alterations of health-related biomarkers (Sarin et al., 2019).

Food neophobia research started accumulating rapidly after the development and validation of the food neophobia scale (FNS) by Pliner and Hobden (1992). This instrument allows quantification of the individually varying neophobic disposition in humans. FNS fulfils the criterion of a classic verbal instrument by being composed of a balanced number of statements, five in favour of and another five against the target (new or unfamiliar food), to be rated on the Likert scale. It is simple, easy-to-handle and meant for adults, although modifications to measure children's disposition soon emerged along with other instruments meant for adults (Damsbo-Svendsen, Frøst, & Olsen, 2017). The FNS instrument has created immense interest and inspired many applications (Rabadán & Bernabéu, 2021). None of the newer scales have so far overtaken its popularity in regular research use.

Over the years, potential limitations of FNS have been observed. FNS was developed and validated in the 1990s with Canadian university

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students as subjects (Pliner & Hobden, 1992). Written statements originated from the cultural context in which they were developed, and these may lose or change their meaning in another culture (see Ares, 2018). Translating to other languages introduces risks (see Ritchey, Frank, Hursti, & Tuorila, 2003; Laureati et al., 2018). Statements may lose their topicality in time, as suggested by Metcalf, Wiener, and Saliba (2022). Given these considerations, a scale based on verbal statements that successfully serves the purpose all over the world and independently of time is unlikely.

The structure and individual items of FNS have been critically scrutinized, and in some research, only part of the items have been used. For example, Ritchey et al. (2003) recommended the omission of at least two items that did not fit well based on analyses of data from three Western countries (USA, Sweden and Finland). In their structural equation analysis of the FNS translated to Italian, Guidetti, Carraro, Cavazza, and Roccato (2018) concluded that six items out of the original ten would best characterise food neophobia within the Italian context. A recent analysis of FNS translated to Chinese found three dimensions: willingness to try new foods, trust in new foods and food pickiness (Zhao et al., 2020). Metcalf et al. (2022) critically discussed individual items of FNS and through confirmatory factor analyses, first developed an eight-item, two-factor solution, then ended up recommending a single-factor six-item solution. With the exception of the latter study's single-factor model, studies have reported that FNS consists of more than one dimension. Two-dimensional solutions have found one related to attraction or interest in new foods, and the other avoidance or disinterest (Metcalf et al., 2022; Nezlek, Forestell, & Cypryanska, 2021; Nezlek & Forestell, 2019; Tuorila, Lähteenmäki, Pohjalainen, & Lotti, 2001).

Pliner and Salvi (2006) defined the personality trait food neophobia as "a continuum along which people can be located in terms of their stable propensity to approach or avoid novel foods". Approach and avoidance are fundamental in our motivational behaviour (Elliot, 2006). As shown by the factor analyses performed in the studies cited above, both are present in the instrument FNS, yet research into the influence of food neophobia has largely concentrated on the hampering effect of food neophobia on responses to novel foods. Nezlek and Forestell (2019) and Nezlek et al. (2021) highlighted both ends of the continuum by developing a two-part Motivation to Eat New Foods (MENF) instrument to quantify the opposing tendencies. Nezlek et al. (2021) mentioned that "phobia" is considered too strong a term to be used for the avoidance tendency.

The development of the present Food Neophobia Scale - Alternative (abbreviated as FNS-A) took place in southern Africa. The starting point was the FNS (Pliner & Hobden, 1992), the statements of which were critically examined and modified into appropriate forms, while new statements were also developed and tested. The structure of the outcome was analyzed using factor analyses and compared with available published scales, and the predictive validity examined through responses to groups of unfamiliar or novel foods.

2. Methods

2.1. Overview

Three data sets were collected: Study 1 to develop a set of 24 statements representing the avoidance and approach tendencies and to test their appropriateness, Study 2 to confirm the structure of the FNS-A scale in Confirmatory Factor analysis (CFA), and Study 3 to test its reliability through test–retest data. Besides CFA, construct validity was examined through correlations with scales aimed for measuring convergent (modified FNS, Pliner & Hobden, 1992; MENF, Motivation to Eat New Foods, Nezlek et al., 2021) and divergent (FTNS, Food Technology Neophobia Scale) (Cox & Evans, 2008) dimensions. Internal consistency (Cronbach's α) was computed to provide another measure of reliability. All studies 1–3 included items to test the predictive validity of the scale. The data collection is schematically presented in the graphical abstract.

Respondents of Study 1 were from sub-Saharan Africa countries and resided in three countries: South Africa, Botswana and Lesotho. In Studies 2 and 3, respondents resided in South Africa.

The research was approved by the Faculty of Natural and Agricultural Sciences Research Ethics Committee at UP (NAS 142/2019; NAS119/2021), and the approval at BUAN and NUL was finalized based on this documentation.

2.2. Study 1

2.2.1. Development of items for the alternative scale

Graduate students majoring in food science or consumer studies at the University of Pretoria, South Africa were invited to a workshop in which determinants of food choices were discussed. Participants (n = 15, 25–49 y, mean 34 y), residing in South Africa at the time of data collection, originated from several African countries, including South Africa, Zimbabwe, Lesotho, Democratic Republic of the Congo, Ghana, Nigeria, and Rwanda. The 2-day workshop started with the topic food neophobia. On the first morning, participants completed the FNS questionnaire (Pliner & Hobden, 1992) and engaged in an interactive discussion on the concept, antecedents, and consequences of food neophobia. Participants completed another questionnaire which included open-ended tasks to describe reasons why a person in the respondent's home country would be 1) extremely willing (approach) or 2) extremely reluctant (avoid) to try unfamiliar foods and beverages. Participants formed groups of 3–5 persons and critically discussed the suitability of the original items of FNS to their cultures and the potential use or benefits of the concept neophobia in their research and/or their home countries. A general discussion was held at the end of the session and notes taken of the issues raised.

Of the original 10 statements of FNS (Pliner & Hobden, 1992), three items (see Supplementary Table 1) were considered eligible as such. The remaining items were criticized either for culturally unfamiliar words or phrasing (e.g., "ethnic" or "dinner party") or for the assumption that new foods would be widely available, although in the local cultures they often are not. Five items were considered appropriate in an adjusted form, and two were omitted because of obscure meaning (item 8 *I am particular about the foods I will eat*) or cultural inappropriateness (item 10 *I like to try new ethnic restaurants*).

Additionally, eight statements negative to food neophobia and eight statements positive to food neophobia were formulated by the researchers based on the responses to open-ended questions to describe reasons why a person, in their home country, would be willing or reluctant to consume new foods.

The wording of 24 statements was edited and confirmed using informal pilot tests. The statements and their origins are shown in Supplementary Table 1.

2.2.2. Data collection: Quantitative phase

Data were collected using a questionnaire from October to November 2019 at three locations: the University of Pretoria, South Africa (UP); the Botswana University of Agriculture and Natural Resources (BUAN); and National University of Lesotho (NUL). At UP, an invitation to complete the questionnaire online was sent to approximately 1500 people (mostly students) that were registered on a database as potential participants in food evaluation studies. At BUAN and NUL, a 2-page paper-and-pencil

questionnaire was presented to students during their class hours. Informed consent was collected prior to the completion of the questionnaire. At UP, the ethical conditions of the study were described as part of the invitation to participate and continuing to the study link signified the consent. At BUAN and NUL a separate consent sheet was signed and returned.

The questionnaire was administered in English and started with demographic questions (year of birth, gender, education (1 = primary, 2 = secondary, 3 = tertiary) and home language (open-ended). To test predictive validity, four assumingly unfamiliar foods (couscous, kiwi fruit, asparagus, calamari) were rated along with four familiar foods (brown bread, banana, tomato, chicken) for familiarity (*How familiar are you with the following food item?* 1 = not at all familiar, 7 = very familiar) and for willingness to try or use (1 = not at all willing, 7 = very willing). The last part of the questionnaire presented the 24 potential FNS-A statements (Supplementary Table 1) to be rated from 1 (strongly disagree) to 7 (strongly agree).

In the online survey, presentation orders of foods within familiarity and willingness sections and of the 24 statements were individually randomized. In the paper-and-pencil survey, the items were in one randomized order (order as presented in Supplementary Table 1).

2.2.3. Respondents

The online questionnaire at UP, open for twelve days, resulted in 354 responses. Subjects older than 39 years (n = 13) were omitted to restrict the data to the age range included at BUAN and NUL, and responses from two subjects were discarded due to several missing values. Hence the final number of respondents at UP was 339. The number of BUAN respondents was 113 (after deleting three cases with several missing values). The number of NUL respondents was 123. Most respondents were students, with age ranging from 18 to 39, and women were the majority in all locations (Table 1).

The reported home languages showed a broad spectrum at UP and BUAN, at least 13 languages in each, while at NUL, one language dominated (Table 1). English was the most common language at UP (27 %), Setswana at BUAN (68 %), and Sesotho at NUL (99 %). In all three countries, English is a language of communication in the educational system, thus easy understanding of the questionnaire can be assumed.

Table 1
Characteristics of respondents at the three locations UP (University of Pretoria, South Africa), BUAN (Botswana University of Agriculture and Natural Resources) and NUL (National University of Lesotho)(Study 1).

Characteristics		UP (n = 339)	BUAN (n = 113)	NUL (n = 123)	Total (n = 575)
Women (%)		72	66	55	67
Age (years)	Mean	22.2	24.2	23.3	22.8
	Standard deviation	*3.4*	*4.8*	*3.8*	*3.9*
Home language * (%)	English	27	–	–	16
	Afrikaans	13	–	–	8
	Sepedi	11	–	–	7
	Setswana	10	68	–	19
	Zulu	10	–	–	6
	Sesotho	7	–	99	25
	Kalanga	–	10	–	2
	Other African languages	22	22	1	17
	Total	100	100	100	100

*specified here, if mentioned by at least 10 % of respondents within a country.

2.2.4. Data analysis

The ratings for 12 potential FNS-A statements negative to food neophobia were reversed. For nine cases of sporadic (rare) single missing values for the 24 statements, imputation was done using a mean of either FNS positive or FNS negative ratings depending on the format of the statement.

All 24 items were subjected to a series of exploratory factor analyses (EFA) (maximum likelihood) and subsequently rotated using direct oblimin in IBM SPSS 27. The type of rotation was chosen because of the relatively high correlations among the factors. The EFA process, leading to ten FNS-A items to be further tested in Study 2 (thus, 14 items were excluded), is described in Supplementary Table 2.

Analysis of an FNS-modified (FNS-m) scale was based on eight items (four positive, four negative), three from the Pliner and Hobden scale and five modified from that scale (Supplementary Table 1). For each respondent, the mean of the eight items ratings (range 1 to 7) was multiplied by 10 to range from 10 (low food neophobia) to 70 (high food neophobia) and thus, to be comparable to the original FNS values. The Cronbach's α of FNS-m was 0.75.

Two composite variables were constructed to measure the familiarity of the four foods deemed unfamiliar and the willingness to try them. All respondents rated familiar foods highly familiar, so they were excluded from further analyses. The mean familiarity ratings for couscous, calamari, asparagus, and kiwi fruit were calculated, and the mean willingness ratings to try them were similarly calculated, resulting in new variables with a theoretical range from 1 to 7 and internal consistencies (Cronbach's α) 0.81 and 0.79, respectively. Ratings of both composite scales loaded on a single factor in respective EFAs which, together with the relatively high Cronbach's α values, justifies composite scales.

Predictive validity of FNS-A was tested through correlation (Pearson's r) with the willingness to try (composite scale).

Familiarity with and willingness to try unfamiliar foods, and FNS-m and FNS-A values from respondents in the three countries were compared with ANOVA at $p < 0.05$ and the means separated using the least significant difference (LSD) test.

2.3. Study 2

2.3.1. Data collection

Volunteers were invited via social media (LinkedIn and Twitter) and the UP consumer database (see Study 1) to complete an online questionnaire in August 2021. Respondents rated on a 9-point verbally anchored scale (1 = dislike extremely, 9 = like extremely) their expected liking for five food innovations (bread, porridge, pap, pasta, puffed snacks) containing either sweet potato, sorghum, or legumes and described as having climate-resilient and/or health-promoting improvements, compared to regular products made of wheat or maize.

Ten FNS-A statements, based on Study 1, were rated thereafter. Respondents were also invited to participate in sensory testing of the innovations (results not presented here).

2.3.2. Respondents

Of a total of 1010 respondents, 75% were women and 52% had completed tertiary education. Most (91%) were from 18 to 40 years, and 9% were 41 years or older. No information regarding the nationality of respondents was collected.

2.3.3. Data analysis

Mean ratings of expected liking for the five food innovations were computed for each individual. This composite variable, justified by all five ratings loading on a single factor in an EFA, had a theoretical range from 1 to 9 and internal consistency 0.71 (Cronbach's α). Predictive

validity of FNS-A was tested through correlation (Pearson's r) with the expected liking (composite scale).

Based on the outcome of data analysis in Study 1 (see 2.2.4), ten FNS-A items, those negative to FNS reversed, were submitted to EFA (IBM SPSS 27) and CFA (IBM SPSS Amos 27) for the confirmation of the structure and the final refinement of the instrument.

2.4. Study 3

2.4.1. Data collection

Data were collected in two phases, 3.1 and 3.2. Online questionnaires were submitted to potential respondents on the UP consumer database (see Study 1) in October 2021 (Phase 3.1) and November 2021 (Phase 3.2).

In Phase 3.1, the respondents were first asked whether they had ever tried, and then rated liking/expected liking (1 = dislike extremely, 9 = like extremely) for the taste and texture of plant-based burger patties. The ratings of respondents who had never tried such patties (n = 75) were used for testing the predictive validity of FNS-A. After these ratings the respondents completed 10 items of FNS-A.

After 2 weeks, in November 2021, another online questionnaire was sent to the same respondents (Phase 3.2). The questionnaire contained 10 items of FNS-A, 10 items of MENF (Motivation to Eat New Foods) (Nezlek et al., 2021), two of them overlapping with FNS-A items, and the 13-item Food Technology Neophobia Scale (FTNS) (Cox & Evans, 2008). All items were rated on a 7-point Likert scale from strongly disagree to strongly agree. For the sake of uniformity, MENF items were rated using the Likert scale and not the original (Nezlek et al., 2021) scale (not at all like me – very much like me).

Respondents rated nine written descriptions of unfamiliar burger patties (BP) for familiarity (1 = not at all familiar, 7 = very familiar) and willingness to try them (1 = not at all willing, 7 = very willing). The descriptions of burger patties (BP) were 1) plant-based BP, 2) BP made of cultured meat, 3) BP with insect powder as an ingredient, 4) 3D printed BP, 5) BP made with mycoproteins, 6) BP that contain GMO ingredients, 7) BP made from Bambara groundnuts, 8) BP made from legumes with microwave technology and 9) BP made from legumes treated with infrared technology.

2.4.2. Respondents

A total of 141 respondents completed both questionnaires. Of them, 79% were women and 54% had completed tertiary education. Most (94%) were from 19 to 40 years, and 6% were 41 years or older.

2.4.3. Data analysis

Based on the results of Studies 1 and 2, two FNS-A items were removed and the test–retest evaluation of FNS-A (8 items) was made through a correlation (Pearson's r) (Phase 3.1 *vs*. Phase 3.2).

In Phase 3.1, mean ratings of expected liking for taste and texture of the plant-based burger were computed for respondents who reported never having tried such a patty (n = 75). Cronbach's α for the two-item expected liking scale was 0.82.

In Phase 3.2, ratings of familiarity of nine unfamiliar patties confirmed their unfamiliarity (mean 2.3 on the 7-point scale) and ratings of the willingness to try them were loaded on a single factor when EFA was conducted. Consequently, mean ratings of willingness to try were computed for each individual, and this composite scale had Cronbach's α = 0.89.

Predictive validity of the FNS-A was tested by correlating individual FNS-A scores with the mean of ratings of expected liking for taste and texture of unfamiliar burger patty (Phase 3.1) and of willingness to try unfamiliar burger patties (Phase 3.2).

2.5. Factorial structure of the statements (Studies 1 and 2)

The factor structure of the 24 items (Study 1) was explored through a systematic stepwise process including ten EFAs (Supplementary Table 2). The first EFA, including all 24 items and an unlimited number of

Table 2
Factor loadings of the exploratory factor analysis (EFA), 10-item solution, to measure approach and avoidance dispositions related to new foods (Studies 1 and 2). In each Study, higher loadings are marked **bold**.

		Study 1 (n = 575)		Study 2 (n = 1010)	
No*	Statement	Approach	Avoidance	Approach	Avoidance
12	New foods mean an adventure for me. (R)	**0.760**	−0.012	**0.829**	−0.003
13	I like to challenge myself by trying new foods. (R)	**0.706**	0.023	**0.775**	0.036
6	New food eating experiences are important for me. (R)	**0.697**	0.008	**0.809**	0.002
18	It is exciting to try new foods when travelling. (R)	**0.681**	−0.043	**0.755**	−0.069
14	I am willing to try foods from different cultures. (R)	**0.644**	0.069	**0.614**	0.139
24	Foods that look strange scare me.	−0.052	**0.643**	−0.084	**0.723**
11	I don't trust new foods.	0.040	**0.600**	0.070	**0.702**
15	Foods from other cultures look too weird to eat.	0.060	**0.543**	0.047	**0.528**
7	I am afraid to eat things I have never had before.	0.111	**0.532**	0.066	**0.771**
4	If I don't know what is in a food, I won't try it.	−0.051	**0.465**	−0.008	**0.467**
	% Variance explained	32.7	8.6	43.5	8.4

*The numbers refer to the list of items in Supplementary table 1.

Table 3
Goodness-of-fit indices and Cronbach α values of the confirmatory factor analysis (CFA) of Study 2.

Goodness-of-fit indices	8-item CFA	Comments
Normed chi-square (CMIN/DF)	2.81	2 < CMIN/DF < 5 (acceptable)[a,b] CMIN/DF < 2 (very good)[a] > 0.90 (acceptable)[a,b]
Goodness-of-fit Index (GFI)	0.99	≥ 0.95 (excellent)[b]
Adjusted goodness-of-fit index (AGFI)	0.98	< 0.08 (acceptable)[b]
Normed Fit Index (NFI)	0.99	≤ 0.07 (good)[b]
Tucker Lewis Index (TLI)	0.99	≤ 0.03 (excellent)[b]
Comparative fit index (CFI)	0.99	< 0.08 (acceptable)[a]
Root mean square error of approximation (RMSEA)	0.04	< 0.05 (good)[a]
Standardised root mean square residual (SRMR)	0.02	< 0.03 (excellent)[a]
Cronbach α comparison		
Cronbach α of FNS-A scale	0.86	> 0.7 (acceptable)[a,c]
Cronbach α APPROACH factor	0.87	
Cronbach α AVOIDANCE factor	0.79	

[a] Hair, Black, Babin, & Anderson, 2014.
[b] Hooper, Coughlan, & Mullen, 2008.
[c] Pallant, 2011.

factors, resulted in four factors with eigenvalues > 1, yet the fourth factor added only 2 % to the total variance explained (Step 1, 38.3%). Subsequently, the number of factors were limited to three. Next, two items were removed from the analysis, either because of low communality (0.144) and < 0.3-factor loading in the pattern matrix or because of a relatively good communality (0.446) spread evenly among three factors. (Step 2). Using the remaining 22 items and the limit of three factors, a goodness of fit chi-square (df 168) = 309.5, p < 0.0001 was obtained. This model explained 37.3 % of the total variance(Step 3). The corresponding chi-square values for one-factor and two-factor solutions were 881.4 (df = 209) and 408.7 (df = 188), respectively, thus adding factors improved the goodness of fit. Next, the model was optimized by following a systematic process of identifying potential items to eliminate due to low communalities < 0.3 or based on cross-loadings or overall low loadings until a stable model with 10 items in two factors, explaining 41.3 % of variance, was identified (Steps 4–10).

Another EFA was conducted on data from Study 2 including the same ten items that were retained in Study 1 (Table 2). Once again, two factors were extracted that explained 51.9% of the variance, the first explaining 43.5% and the second 8.4%. Following the EFA, a CFA was performed on the 10 items to test the validity of the two-factor structure. Based on the standardised factor loadings, two items [*I am willing to try foods from different cultures R* (14)] and [*If I don't know what is in a food, I won't try it.* (4)] with lower factor loadings were identified and omitted to further improve the overall model fit. The validity of the two-factor structure was tested by performing another CFA on the eight remaining items. All the fit indices (CMIN/DF, GFI, AGFI, NFI, TLI, CFI, RMSEA and SRMR) reached acceptable thresholds and presented an excellent model fit, as reported in Table 3.

Fig. 1 shows the CFA for the final eight-item FNS-A solution. The two factors were labelled as Approach and Avoidance.

2.6. Reliability of FNS-A

Based on four determinations of Cronbach's α from Studies 1–3, the internal consistency (reliability) of the final 8-item FNS-A varied from 0.78 to 0.86 (Table 4). Cronbach's α in Study 2 remained constant from the 10-item (α = 0.86) to the 8-item (α = 0.86) scale, indicating good reliability. Separating the "approach" and "avoidance" factors demonstrated good internal consistency for both. Cronbach's α for "approach" was 0.87 (with 10 items 0.88), and for "avoidance" 0.78 (with 10 items 0.79).

In terms of repeatability, the 8-item FNS-A performed well, as the test–retest correlation was 0.82 (Table 5).

2.7. Construct validity of FNS-A

Using the data from Study 1, the convergent validity of FNS-A was tested against the FNS-m scale. Due to partial overlapping of the scales (two out of eight items, namely 7 and 11, were the same, both positive to food neophobia), this comparison is indicative only. The Cronbach's α of FNS-A (0.78) was slightly higher compared to FNS-m (0.75)(Table 4) and the two scales were highly (r = 0.83) correlated (Table 5). Thus, they appear to measure largely the same construct.

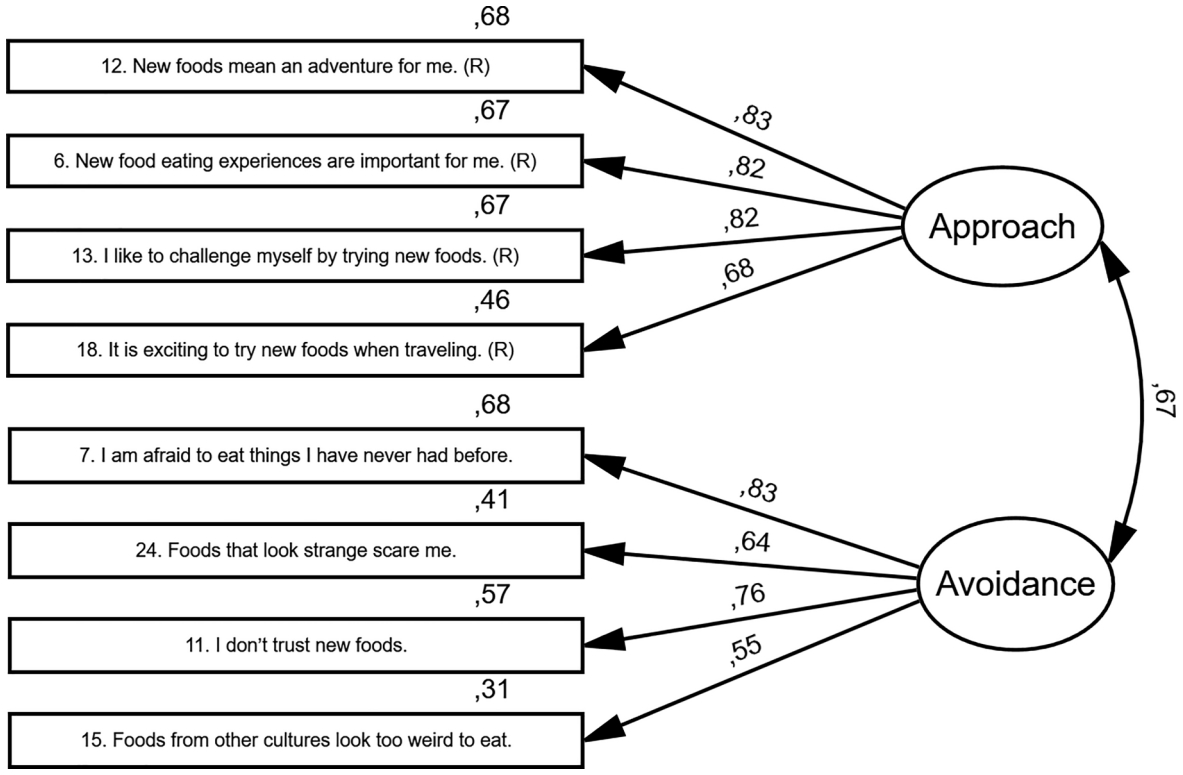

Fig. 1. Two-factor model of FNS-A based on confirmatory factor analysis (CFA) (Study 2). Rectangles containing a number and statement (See Supplementary table 1), represent the measured variables. The latent constructs (i.e., factors) are represented by ellipses. Numbers above vectors indicate the correlation (r) between item and construct, and numbers above rectangles indicate the predictive power (R^2) of each item.

Table 4
Characteristics of the final FNS-A scale (8 items), and of scales against which the construct validity was evaluated. Studies 3.1 and 3.2 refer to ratings from the same population at the interval of two weeks, 3.1 = 1st and 3.2 = 2nd measurement.

Scale	Study no.	n	Mean	*SD*	Range	Theoretical range	Cronbach alpha
FNS-A (8 items)	1	575	2.8	*1.1*	1.0–7.0	1–7	0.78
	2	1010	2.9	*1.1*	1.0 – 6.6	1 – 7	0.86
	3.1	141	2.6	*1.0*	1.0 – 5.6	1–7	0.84
	3.2	141	2.4	*1.0*	1.0 – 5.3	1–7	0.84
FNS-modified[a]	1	575	26.9	*10.4*	10–64	10–70	0.75
MENF-AppNewFoods[b]	3.2	141	6.3	*0.7*	3.8 – 7.0	1–7	0.82
MENF-AvdNewFoods[b]	3.2	141	2.7	*1.2*	1.0 – 6.2	1–7	0.82
Food Technology Neophobia Scale FTNS[c]	3.2	141	50.5	*11.6*	21 – 86	13–91	0.79

[a] Mean of 8 ratings × 10 (Pliner & Hobden, 1992, modified).
[b] Mean of 5 ratings from 1 to 7 (Nezlek et al., 2021); MENF – Motivation to Eat New Foods; App = Approach; Avd = Avoid.
[c] Sum of 13 ratings, each rated from 1 to 7 (Cox & Evans, 2008).

Table 5
Correlations[1] (Pearson r) between FNS-A (8 items) and variables that indicate its reliability and validity.

Indicator Variables	Study no.	r^2	r^3
Reliability (test – retest)			
FNS-A in Phase 3.1 *vs* FNS-A in Phase 3.2	3	-	0.82
Construct validity			
FNS-A *vs* FNS-modified[4]	1	0.83	-
FNS-A-Approach *vs* MENF[5] AppNewFoods	3	0.84	0.68
FNS-A-Avoidance *vs* MENF[5] AvdNewFoods	3	0.87	0.67
FNS-A *vs* Food Technology Neophobia Scale[6]	3	0.41	0.27
Predictive validity			
FNS-A *vs* Willingness to try unfamiliar foods (mean of 4 food names)	1	-0.38	-
FNS-A *vs* Expected liking of food innovations (mean of 5 food names)	2	-0.28	-
FNS-A *vs* Expected liking[7] of plant-based patties (mean of taste and texture ratings)	3	-0.36	*-0.27*
FNS-A *vs* Willingness to try unfamiliar plant-based burger patties (mean of 9 food names)	3	-0.43	-0.35

[1]All correlations highly significant ($p < 0.001$) except the one in italics ($p=0.018$).
[2]The correlation between measurements within the same session.
[3]The correlation between measurements taken 2 weeks apart.
[4]The FNS-modified scale (8 items), based on Pliner and Hobden (1992).
[5]Motivation to eat new foods (MENF) Approach (5 items) and Avoidance (5 items) of new foods (Nezlek et al., 2021), were correlated with Approach and Avoidance parts (4 items each) of FNS-A, respectively
[6]Thirteen-item scale (Cox & Evans, 2008).
[7]Ratings from respondents who had never tried plant-based burger patties, n=75.

Table 6
Country-specific mean (SD) ratings (Study 1). Familiarity of foods deemed to be unfamiliar and willingness to try them are means of responses to 4 unfamiliar items, and FNS-modified and FNS-A are mean scores of respondents in South Africa (UP), Botswana (BUAN) and Lesotho (NUL).

Characteristic	Possible range	UP South Africa = 339		BUAN Botswana = 113		NUL Lesotho = 123	
		Mean	*SD*	Mean	*SD*	Mean	*SD*
Familiarity	1–7	4.5a	*1.7*	2.8b	*1.5*	1.9c	*1.2*
Willingness to try	1–7	5.8a	*1.3*	5.4b	*1.8*	4.6c	*1.9*
FNS-modified	10–70	24a	*9*	30b	*11*	33c	*10*
FNS-A	1–7	2.5a	*0.9*	3.2b	*1.1*	3.4b	*1.2*

Significant ($p < 0.05$) differences on each row are signified by lower case letters a, b, and c.

Data from Study 3 allow comparisons with existing, validated scales (Table 5). When measured within the same session (Phase 3.2), the MENF Approach and Avoidance subscales were highly correlated with the FNS-A Approach and Avoidance factors (r = 0.84 and 0.87, respectively). When comparisons were made between the FNS-A Approach and Avoidance factors measured two weeks earlier than MENF subscales, the correlations were lower (r = 0.68 and 0.67, respectively), but they still suggest a clear relationship between the constructs.

Divergent validity was tested by comparisons with the FTNS (Table 5). When measured within the same session, the correlation with FNS-A was 0.41, and with the two weeks' interval, r = 0.27. Thus, the correlation coefficients were considerably lower than in convergent validity measurements.

2.8. Predictive validity of FNS-A

The predictive validity of FNS-A can be judged from the correlations with willingness to try unfamiliar foods and expected liking of unfamiliar foods (Table 5). In Study 1, FNS-A was correlated r = −0.38 with willingness to try unfamiliar foods. In Study 3, the corresponding correlations were r = −0.43 (within a session) and r = −0.38 (two weeks' interval). For ratings of expected liking, in Study 2 the correlation was r = −0.28, and in Study 3, r = −0.36 (within a session) and −0.27 (two weeks' interval).

2.9. Differences of the three respondent populations (Study 1)

The four foods assumed to be less familiar were rated as such in all three locations, but they were most familiar for UP and least familiar for NUL respondents (Table 6). Location differences in willingness to try less familiar foods were less pronounced than in familiarity ratings. Also, the mean FNS-m and FNS-A scores for the respondents at UP were lower than those for respondents at BUAN and NUL.

3. Discussion

In this study, we developed an alternative food neophobia scale. With a group of graduate students, we first selected and modified eight statements of the original FNS (Pliner & Hobden, 1992) and then generated 16 further statements for and against new foods. In a series of exploratory and confirmatory factor analyses, a two-factor "approach and avoidance" structure was identified to form an 8-item FNS-A scale. This new scale updates statements and it hopefully avoid ambiguities of the original FNS (Pliner & Hobden, 1992) frequently identified as its possible weaknesses (Metcalf et al., 2022; Rabadán & Bernabéu, 2021).

The items, constructed to be simple and unambiguous, should reflect the perceptions of modern consumers. The approach items of FNS-A appear to reflect the tendency for adventure-seeking more pronouncedly than the original FNS (Pliner & Hobden, 1992). The avoidance items are emotion-driven emphasizing fear and mistrust. Two (out of four) well-performing avoidance items refer to mistrust of unfamiliar foods due to their appearance (Dovey et al., 2008; Lafraire, Rioux, Giboreau, & Picard, 2016; Santagiuliana, Bhaskaran, Scholten, Piqueras-Fiszman, & Stieger, 2019). This may be a coincidence or it may emphasize the importance of the visual impression known to be critical for the acceptance of unknown foods. The 8-item, two-factor model fits the data well and all the fit indices reached acceptable thresholds, presenting a close to excellent model fit. Confirmatory factor analysis is part of construct validity, and the present analyses supports success in this respect.

An advantage of the FNS-A scale is that it contains fewer items than the original FNS, i.e. eight versus ten. A concise scale, thus parsimony, is important as respondents generally turn reluctant when facing a lengthy task (Hannum & Simons, 2020; see also Guidetti et al., 2018). We tested a 10-item version in Studies 1 and 2, but based on results, two items (*I am willing to try foods from different countries* (R) and *If I don't know what is in a food, I won't try it*) did not improve the scale. Therefore the present report focused on the performance of the 8-item scale.

To replace the original FNS (Pliner & Hobden, 1992), the FNS-A is to be used as a composite 8-item instrument with two opposite tendencies. We note the proposition by Nezlek et al. (2021) to divide the instrument into two separate subscales as used in MENF, yet one continuum reflecting the entire spectrum of food neophobia has proven to be useful in a vast number of research settings.

Testing FNS-A against FNS-m and MENF confirmed the convergent validity of the new scale. All within-session correlations were > 0.8 and also sessions at two weeks' interval led to correlations at least 0.67. We conclude that convergent validity is acceptable. As to the divergent validity, the correlations of FTNS with FNS-A were 0.27 (two weeks apart) and 0.41 (within the same session). In a recent review (Tuorila & Hartmann, 2020), five correlations between FNS and FTNS ranged from −0.12 to 0.33, suggesting that the scales measure different constructs. Even though here, the within-session correlation was higher (0.41) than those reported in the review, we conclude that FNS-A measures a disposition clearly different from the FTNS.

Test-retest correlation of FNS-A (r = 0.82) is satisfactory. Pliner and Hobden (1992) reported three test–retest correlations from laboratory studies (n = 31–59) for FNS test–retest evaluation: r = 0.91 and 0.87 (2–4 weeks' interval) and r = 0.82 (15 weeks' interval). Zhao et al. (2020) reported a test–retest correlation of 0.761 (two weeks' interval). In general, a time interval between test–retest measurements weakens the connection between them; the longer the time gap, the weaker is the connection likely to be (e.g., Bhattacherjee, 2012). This also explains the difference between the within-session correlations and those based on measurements at two weeks' time interval described above.

The correlations of FNS-A and willingness to try unfamiliar foods ranged from −0.35 to −0.43 while correlations with expected liking were somewhat lower, thus corresponding the findings reported by Pliner and Salvi (2006). Pliner and Hobden (1992) reported predictive correlations of the same magnitude that we obtained. Zhao et al. (2020), comparing the FNS scale translated to Chinese and using a different procedure, reported correlations supporting predictive validity −0.54 (willingness to try) and −0.29 (proportion of novel foods chosen). Studies 1–3 presented written descriptions of a range of unfamiliar foods, but we do not know if they sufficiently or optimally represent unfamiliar foods or contemporary novel foods. The familiarity of food items varies among individuals and depends on various external factor, such as location, culture, socioeconomic status.

We observed country-specific differences in ratings of familiarity, willingness to try, FNS-m and FNS-A responses in southern Africa. Familiarity with and willingness to try the less familiar foods were generally rated highest at UP and lowest at NUL, with BUAN in the middle. Despite the lower familiarity ratings at BUAN and NUL, the willingness to try was relatively high in the latter two groups, suggesting openness to new experiences if available. Reasons for the location differences could be various. A much larger proportion of the population in Lesotho live in rural areas compared to Botswana and South Africa (The World Bank, 2019). On the other hand, both Lesotho and Botswana are largely dependent on foods imported from South Africa (Black, Edwards, Is, Makundi, & Morris, 2019). Young adults in South Africa, especially those located in Pretoria, a large city in the most densely populated urban province of the country (Gauteng), have more access and exposure to large shopping malls and restaurants. Several authors (Flight, Leppard, & Cox, 2003; Siegrist et al., 2013; Tuorila et al., 2001) reported lower food neophobia scores for urban, compared to rural respondents. In a comprehensive review of 102 FN studies, Rabadán and Bernabéu (2021) concluded that FN decreases with increased education, income and urbanization. Responses to unfamiliar foods are bound to differ by cultural diversity, and we need to be aware of such differences in food-related research. The ability of the scale to differentiate neophobic tendencies in different populations is valuable.

Developing novel foods to suit the specific needs of different groups requires insight into consumer traits represented in a particular market (Tuorila & Hartmann, 2020) as one-size-fits-all solutions have proven to be unsuccessful. Individual and group differences in food neophobia determine reactions to novel foods. For many African countries, research

programs to improve the nutritional value of staple foods through technology e.g., biofortification, and other product development strategies are in progress. These efforts often lead to slight or substantial changes in the sensory properties of food products. The extent to which such technological and sensory novelty will appeal to consumers in different countries needs to be better understood.

As to the limitations of the study, the respondents were mostly young and educated, and therefore not representative of the broader population in the countries in terms of age, education, and socio-economic levels. In this regard, however, the development and validation were not different from studies such as Pliner and Hobden (1992), Zhao et al., 2020, and Nezlek et al. (2021). Studies of a wider range of respondents are needed to further validate the FNS-A scale. A further limitation is that the predictive validity was tested against food names or descriptions only. Pliner and Hobden (1992) showed food samples and Zhao et al. (2020) showed pictures of food. Responses to real foods would provide further evidence of the validity of the scale. Rubio, Rigal, Boireau-Ducept, Mallet, and Meyer (2008) warned that neophobic respondents may react more strongly to real foods than to food names. Future applications will broaden our understanding of the usefulness of FNS-A in various research settings.

The procedure of data collection needs constant attention. English is a language of business communication in many African countries and globally, but not the mother tongue for most of the world's population. Although not considered a risk in the present populations, translation of the FNS-A to the vernacular may yield different results. Differences in data collection methods, online and paper-based, may also influence the results. In online surveys, the presentation of items can be randomized, but with paper-and-pencil technique, this is considerably more demanding and seldom done.

4. Conclusions

Here we present a FNS-A scale tested and validated with respondents in southern African countries. Further research on the use of the scale to better understand the reasons for accepting or rejecting novel foods, especially in the context of improving food security on the African continent, is recommended.

To encourage others to apply the FNS-A, Appendix A shows the instructions, scale items and response options for administering the scale. A link to obtain one's individual FNS-A is also provided. In order to compare the FNS-A scores (ranging from 1 to 7) with Pliner and Hobden (1992) FNS scores ranging from 10 to 70, each rating of an individual or a mean of a group can be multiplied by 10.

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CRediT authorship contribution statement

Henriëtte L. De Kock: Project administration, Funding acquisition, Investigation, Methodology, Resources, Supervision, Writing – review & editing. **Pulane Nkhabutlane:** Investigation, Resources, Supervision, Writing – review & editing. **Rosemary I. Kobue-Lekalake:** Investigation, Resources, Supervision, Writing – review & editing. **Jeanine Kriek:** Methodology, Investigation, Resources, Supervision, Writing – review & editing. **Annelize Steyn:** Investigation, Methodology. **Van Heerden Clarissa:** Investigation, Methodology. **Lucy Purdon:** Investigation, Methodology. **Christi Kruger:** Investigation, Methodology. **Marise Kinnear:** Investigation, Methodology. **Hanri Taljaard-Swart:** Statistical analysis, Writing – review & editing. **Hely Tuorila:** Visualization, Conceptualization, Methodology, Supervision, Statistical analysis, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A Alternative Food Neophobia Scale (FNS-A)

Please answer the following statements by circling a number beside each statement in an appropriate column. Circle any number to describe your personal degree of agreement. Make your ratings promptly, based on your first impression. No right or wrong responses exist, only your personal opinion counts.	Disagree strongly	Disagree moderately	Disagree slightly	Neither disagree nor agree	Agree slightly	Agree moderately	Agree strongly
New food eating experiences are important for me. (R)	1	2	3	4	5	6	7
I am afraid to eat things I have never had before.	1	2	3	4	5	6	7
I don't trust new foods.	1	2	3	4	5	6	7
New foods mean an adventure for me. (R)	1	2	3	4	5	6	7
I like to challenge myself by trying new foods. (R)	1	2	3	4	5	6	7
It is exciting to try new foods when travelling. (R)	1	2	3	4	5	6	7
Foods from other cultures look too weird to eat.	1	2	3	4	5	6	7
Foods that look strange scare me.	1	2	3	4	5	6	7

(R) Indicates statements where the ratings are reversed (*8-x*) during data analysis. (R) should not appear on the questionnaire.

When presented to respondents, the order of statements should preferably be randomized.

The questionnaire is available via link: bit.ly/FNS-A

When ratings have been completed, the final page gives your FNS-A score varying between 1 and 7.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2022.104626.

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