Development, sensitivity and reliability of a French version of the Leeds Food Preference Questionnaire (LFPQ-fr) for the evaluation of food preferences and reward

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Abstract

Background. There is a growing global interest in the evaluation of food reward, necessitating the adaptation of culturally appropriate instruments for use in empirical studies. This work presents the development and validation of a culturally adapted French version of the Leeds Food Preference Questionnaire (LFPQ-fr).

Methods. The LFPQ-fr was developed and validated in healthy-weight adults using the following systematic approach: i) selection and validation of appropriate food pictures; ii) linguistic translation of liking and wanting constructs in the target population (n=430; 81% female; 42.2 ± 12.7 years); iii) validation of the sensitivity and reliability of the task performed in a fasted state and in response to a standardized test meal (n=50; 50% female; 30.0 ± 8.4 years).

Results. During the first and second phases, the nutritional and perceptual validation of culturally appropriate food pictures and pertinent reward constructs, respectively, was demonstrated in a healthy-weight French sample. Findings from the third phase indicated that all food reward components were sensitive to the test meal and showed moderate to high agreement in both fasted (Lin's CCC =.72-.94) and fed (Lin's CCC = .53-.80) appetitive states between visit 1 (V1) and visit (V2). Except for explicit liking fat bias, all primary outcomes were statistically consistent in fasted and fed states between V1 and V2. Changes in fat and taste biases in response to a standardized meal for all primary outcomes were also consistent between V1 and V2 except for explicit liking fat bias (Lin's CCC = .49- .72).

Conclusion. The LFPQ-fr developed and tested in this study is a reproducible and reliable method to assess food reward in both the fasted and fed states in a healthy-weight French population.

Key words. Food reward, Food liking, Food wanting, Food preferences

Introduction

There has been an increasing interest in the study of appetite control over the last decade as a potential vector for the regulation of body weight, and improvement of adherence to various types of intervention. Whilst long considered an entirely physiological process, the regulation of appetite is now understood to be determined by a complex integration of internal and external multi-sensory signals processed centrally by homeostatic and hedonic systems of the brain [1]. The homeostatic system has been extensively described and conceptualized as a network of peripheral-central crosstalk conveying tonic and episodic signals modulating hunger and satiety [2]. Simultaneously, the neural networks that operate as part of the hedonic (i.e., reward-related) system are also sensitive to our external food environment and endogenous processes [3]. Food reward may be characterized by two distinct yet integrated neurobehavioral feedback mechanisms that constitute the expression of appetite: Liking and Wanting [4]. Wanting, also referred to as Incentive Salience, represents the motivational component of reward, typically measured as the potential to elicit/reinforce consummatory behaviors. Conversely, Liking represents the affective component that is observed by the pleasure experienced upon consumption of a palatable food [5]. With the prevalence of obesity, eating disorders, and preoccupation with weight increasing in recent years, accurately and reliably measuring food reward may contribute to the design of interventions that improve appetite regulation [6].

While several methods have been proposed to assess an individual's food reward, the Leeds Food Preference Questionnaire (LFPQ) has been proposed and developed as a valid, systematic way to evaluate both liking and wanting for foods that vary on key nutritional and sensory properties. Briefly, the LFPQ is a computer-based platform that operationalizes these separable components through explicit assessment of liking and wanting for individual, familiar foods, and implicit assessment of wanting during simulated food choices [7]. The LFPQ has been shown to be sensitive to individual differences in eating behavior traits [8,9] and states of hunger and satiety in response to a meal or preload [11,12]. Importantly, it has been validated as a reliable predictor of actual food choice and intake in both laboratory and free-living settings [4,10].

However, the LFPQ was developed in the context of British culinary culture, thus its utility in assessing food reward and preferences among individuals from other cultures may be limited.

Cross-cultural studies have consistently shown that people indicate a stronger preference for foods that are familiar to their own culture compared with foreign foods [13,14]. Indeed, recent cross-cultural studies have clearly shown different neural, behavioral, perceptual and sensory responses to culturally consistent and foreign meal types (e.g., classical western *versus* non-western meals) [15-23]. While the construct validity of the LFPQ and its approach to measuring food reward has been well established, cultural adaptations based on population-specific food habits and identities may facilitate empirical research of appetite control in a culturally diverse world.

To date, the LFPQ has been translated into about 20 languages (e.g., Japanese, Portuguese, Chinese and Danish [24-27]), but relatively few iterations have followed a uniform and systematic procedure to develop and implement cultural adaptations that would promote its reliable application in empirical research worldwide [28].

Although studies have evaluated food reward in French adults and children with healthy-weight, overweight or obesity using a French-language version of the original LFPQ [28], a rigorous, systematic procedure of cultural adaptation with appropriate food imagery has yet to be conducted for a French population. Therefore, the present work developed a cultural adaptation of the LFPQ for a French population in accordance with the systematic procedure outlined by Oustric and colleagues [28].

The reliability of the LFPQ-fr task would be supported by demonstration of consistent liking and wanting for foods based on fat content (high versus low fat) and taste (sweet versus savory) in the fasted state and after a fixed test meal during both lab visits (V1 and V2). Moreover, validation of the task would be demonstrated by a general preference for low-fat and savory foods in fasted, healthy-weight subjects and a shift towards bias for high fat and sweet foods in response to a savory, low fat meal similar to results from studies using the original British version [4].

Methods

The LFPQ-fr was developed and validated following a recommended procedure previously detailed [28]. First, a culturally appropriate database of food images was selected and validated based on familiarity, liking, intake frequency, and recognition of nutritional or sensory properties by a sample of healthy-weight French adults. Second, a French translation of the liking and wanting constructs was developed and tested for recognition in the same population. Finally, the LFPQ-fr, comprised of these validated components, was then tested for its sensitivity to different appetitive states (i.e., fasted versus after intake of a standardized meal) and reliability over two lab visits on different test days in subset of the initial sample. This study received an ethical agreement (CPP Ile de France III, 2019-A00853-54) and has been registered as a clinical trial (clinicaltrial.gov, NCT04041830).

i) Food database creation

To create a food database appropriate for the French culture, 36 common French foods were selected, prepared and photographed. The food database was pilot tested to contain: 1) ready to eat and familiar foods within the French culture, 2) an acceptable number of food items to complete the LFPQ tasks, 3) a typical portion size for each food, 4) foods appropriate to the time of day of the measurements, 5) foods appropriate to the culture and habits of the French population, 6) a diversity of foods within each category, and 7) food images of homogenous quality and size.

Selected food images in the database were then allocated to an appropriate category based on two nutrient- and sensory-based criteria: fat content and taste. Fat content was organized dichotomously into high fat and low fat categories, with high fat foods deriving more than 40% of their energy content from fat and low fat foods less than 20%. Foods were further categorized based on a distinct sweet or savory taste, resulting in four eligible food categories: High Fat Savory (HFSA), High Fat Sweet (HFSW), Low Fat Savory (LFSA), and Low Fat Sweet (LFSW). To account for the effect of other macronutrients on appetite, protein and carbohydrate levels were matched between high and low fat categories. Therefore, the savory foods had high protein and low carbohydrate levels relative to the sweet foods within each fat category (Table 1).

ii) Food database validation

An online questionnaire was created and disseminated by email to 3 areas in France (Dijon, Clermont-Ferrand and Paris) to undertake the validation of the food database. These 3 areas were either university or clinical sites but most of the respondents were working professionals (e.g., researchers, doctors, technicians, nurses, or secretaries). Respondents that did not live in France (n=7), were nutritionists/dieticians (n=3), or reported allergies to any of the foods presented (n=10) were excluded from analyses. Among the 570 respondents that completed the questionnaire, 430 had responses to all the food questions, thus were included in analyses. The survey aimed to identify food pictures that were familiar, frequently eaten, liked, accurately perceived as sweet or savory, and low or high in fat, and consistent with lunchtime consumption. Indeed, food image familiarity, recognizability, and quality must be tested and accounted for during validation due to the potential to confound liking and wanting scores [28]. To identify suitable food images, each image was presented independently, and the following eight questions were asked: Name: "Please name the food image?"; Frequency: "How often do you consume this food?" (5-point Likert scale, never to almost every day); Liking: "How pleasant does this food typically taste?" (100 mm-scale); Food categories: "Is this food more sweet or savory?" (100 mm-scale); "Is this food low or high in fat?" (100 mm-scale); Time appropriateness: "How appropriate is it to consume this food in the morning/afternoon/evening?" (100 mm-scale).

The French translation of LFPQ task-specific instructions was conducted, discussed among various French native speakers, and comprehension thereof pilot tested using the online survey. The food database was created in collaboration with researchers from Leeds, Dijon and Clermont universities.

Food images were considered appropriate if they satisfied the following conditions: 1) correctly recognized (defined by > 80% of the participants naming the food correctly); 2) habitually consumed (defined by a mean score greater than 2.5 out of 5, which was considered to be representative of frequent contact with the food); 3) liked (defined by mean liking >70mm), 4) correctly recognized as sweet versus savory and low fat versus high fat (sweet and low fat if the mean value was < 40 mm and savory and high fat if > 60 mm, respectively); and 5) time appropriate (defined by mean >70mm for the specific time of day).

iii) Validation of the sensitivity and reliability of the LFPQ-fr

Population. A total of 50 healthy-weight adults (50% female) aged between 20-40 years old took part in this validation phase. Respondents first had to pass a medical screening performed by a nutritionist physician in order to confirm their eligibility and ability to complete the study. Mainly, the nutritionist confirmed the absence of eating disorders or chronic eating-related pathologies based on its interview and on the Dutch Eating Behavior

Questionnaire (DEBQ) [29] and Three Factors Eating Questionnaire (TFEQ) [31] and the Binge Eating Scale (BES) [30]. Although not clear cut-offs are actually determined, the following have been used for the TFEQ: restraint behaviors with a score > 10; disinhibition score > 8 and susceptibility for hunger score > 7; for the DEBQ: Emotional, Restrained and External eating scores >2.5 and for BES: score >10. Moreover, participants must have been weight-stable and not undertaken any diet with an aim to lose weight within the last 6 months.

Design. Eligible participants completed anthropometric measurements and body composition using the Tanita MC780 bio-impedance meter. They were then asked to visit the laboratory on two occasions separated by at least 7 days. On both occasions, the participants were asked to refrain from any structured physical activity over the preceding 48 hours and consume the same prescribed breakfast at 08:00 am on each test day. The breakfast was individually composed based on the participants eating habits but represented 9.5 to 10 kcal per kg of body mass, respecting the appropriate nutritional recommendations (55% CHO, 30% lipids and 15% protein). Importantly, all the participants were usual breakfast consumer. During each test day, participants visited the laboratory at 11:00 am and compliance was checked by an experimenter. At 11:30 am, they were asked to perform the computerized LFPQ-fr task, which lasted about 15 minutes, before receiving a fixed test meal at 12:00pm. The test meal consisted of a fixed quantity of Uncle Ben's tomato and olive oil rice and natural yogurt that only varied based on the participant's gender (i.e., 900 kcal and 750 kcal for men and women, respectively). The portion and presentation of the test meals were identical during both test days. On both test days, meals were consumed alone over an allotted 30 minute period without access to media or other social distractions. Participants were then asked to repeat the LFPQ-fr task 15 minutes after consumption of the test meal. Additionally, appetite feelings (hunger, fullness, prospective food consumption and desire to eat) were assessed using 150-mm Visual Analogue Scales (VAS) [32] before and immediately after the test meal, as well as 30 minutes, 60 minutes, and 90 minutes after the meal.

Evaluation of food reward – Leeds Food Preference Questionnaire

The LFPQ consists of two distinct tasks. During the first task, explicit liking and wanting are assessed for 16 distinct food images from all food categories (HFSA, HFSW, LFSA, LFSW) individually using 100-mm VAS when presented with the following questions: i) "How pleasant would it be to taste this food now?" (explicit liking) and; ii) "How much do you want to eat this food now?" (explicit wanting). This was followed by a paired food task where the user is advised to choose between two food images from reciprocal food categories as rapidly and accurately as possible. In addition to quantifying choice frequency, an implicit wanting score is computed from reaction times covertly recorded during each selection that are adjusted for its selection frequency. During this task, there are a total 96 trials so that every possible food image pairing is presented and occurs in a random order. For each food reward component, two salient metrics are calculated: fat bias and taste bias. The fat bias score is calculated by subtracting mean scores of low fat foods from high fat foods, whilst taste bias score was obtained by subtracting mean scores of savory foods from sweet foods. Positive values for fat bias or taste bias indicates a preference for high-fat and sweet foods, respectively (for more details see Oustric et al. 2020 [28]).

Statistical analysis

The agreement of pre-meal and post-meal fat and taste biases for each salient reward component (i.e., explicit liking, explicit wanting, implicit wanting, and choice frequency) independently, between lab visits was analyzed using Lin's concordance correlation coefficients (CCC). To assess the reliability of scores in response to the test meal, delta scores were calculated by subtracting pre-meal from post-meal values and tested for agreement between visits using the same approach. To supplement these analyses, pre- and post-meal values were compared at each visit (V1 and V2) using random-effects models in order to analyze time (pre- and post-meal). Natural Logarithmic transformations of dependent variables were conducted when the assumption of normality was violated. Continuous variables were presented as means with standard deviation or median with interquartile range. The distribution of dependent variables and model residuals were tested for normality using Shapiro-Wilk test.

Statistical analyses were performed using Stata software (version 15, StataCorp, College Station, US). All statistical tests were carried out using a two-sided type I error rate at 5%. For the primary objective (i.e., to evaluate agreement), specific attention was paid to the magnitude of results reported with 95% limits of agreement and interpreted according to the conventions reported by Altman ([-0.7; -0.4] low agreement; [-0.4, 0.4] negligible agreement; [0.4, 0.7] mild agreement; and [>0.7] high agreement). No correction for multiple testing was applied in the analysis of secondary objectives. Findings from these analyses were interpreted as exploratory.

Results

Food database validation

Participants involved in this stage of the validation process (N=430) ranged in age between 19 and 82 years (M=42.2, SD=12.7) and were predominately female (81%). 16 out of 36 food pictures matched the initial validation criteria and were selected for the experimental validation of task reliability (third phase). Results from the food database validation and nutritional characteristics of the food are presented in Table 1 and Table S1 in the supplementary materials, respectively. All the food matched the selection criteria. However, it was difficult to find a diversity of foods within a category that are all liked and eaten at same time of day. This resulted in the LFSW category mainly being comprised of fruits, for example. Moreover, it is worth noting that yogurt was perceived as high fat and sweets were not considered appropriate for lunchtime in the French sample, contrary to the British population on which the original LFPQ was validated. Based on the approach outlined by Oustric et al. 2020 [27], a hierarchical clustering was performed on R to graphically support and statistically validate the perception of each food image as belonging to one of the four distinct food categories (HFSA, HFSW, LFSA and LFSW; see Figure 1). The 16 food images selected for the LFPQ-fr can be seen in Figure S1 (supplementary materials).

LFPQ-fr sensitivity and reliability

<u>Population characteristics.</u> This sample was 50% female and 30.0 ± 8.4 years old on average. All participants were healthy weight with a mean BMI of 22.4 ± 2.4 kg/m^2, mean weight of 66.5 ± 11.4 kg, mean fat mass (FM) of 20.2 ± 7.1%, and mean fat free mass (FFM) of 50.4 ± 11.2 kg. Regarding eating behavior traits, the sample had relatively low mean trait Binge Eating (BES; 6.4 ± 4.8). The TFEQ scores were: Cognitive Restraint = 1.71 ± 0.58, Disinhibition: 2.04 ± 0.49 and Susceptibility to hunger: 2.04 ± 0.49. The DEBQ scores were Emotional eating score:

1.86 ± 0.68; Restrained eating: 1.6 ± 0.4 and External eating: 1.8 ± 0.3. Altogether these scores indicated an absence of eating disorders and other deleterious eating patterns overall. No significant differences were observed between males and females. None of the volunteers were excluded based on these scores.

Task validity and sensitivity. Table 2 details the descriptive statistics for all LFPQ-fr values in fasted and fed states on V1 and V2. The measures of central tendency of fat and taste biases for all primary outcomes were consistent with previous investigations and validations of the original British version and other cultural adaptations in both fasted and fed states and in healthy-weight samples [4, 24, 25, 28]. Indeed, similar to these previous studies, a preference for low-fat and savory foods was demonstrated in a fasted state and shifted towards stronger reward for high-fat and sweet foods in response to intake of a low-fat, savory meal, indicative of sensory-specific satiety [9] (Table 3). Although significant changes in taste bias were observed for all dimensions during both visits, significant changes in fat bias were only observed for explicit wanting during both visits and explicit liking during V2.

Task reliability and agreement. Analyses of fasted and fed values revealed that all primary reward components of the LFPQ-fr were statistically consistent except for explicit liking fat bias. That is, statistical differences were consistently detected between V1 and V2, indicative of good test re-test reliability. However, in the case of explicit liking fat bias, differences between visits in the fasted state were not significant (p=.191) whilst significant after the standardized test meal (p=.019). Importantly, Lin's CCC revealed moderate to high agreement between the two visits for all the LFPQ-fr dimensions in fasted (CCC=.72-.94) and fed (CCC=.53-.80) appetitive states. The 95% limits of agreement obtained from the Bland & Altman analysis of pre- and post-meal values further support the moderate to high agreement between visits (Table 2).

In analyses of changes in response to the test meal, only the explicit liking fat bias demonstrated inconsistent results between V1 and V2 as it was statistically significant on V2 (p=.005) but only approached significance on V1 (p=.086). The results for all other dimensions demonstrated consistency between V1 and V2. Moreover, delta values (i.e., changes from baseline to post-meal) for all LFPQ-fr dimensions were found to be reliable between V1 and V2 (CCC=.49-.72). The 95% limits of agreement obtained from the Bland & Altman analysis of delta values can be seen in Table 3 and graphically depicted in Figure 2.

Appetite sensations. Trends in appetite sensations over the course of each test day were statistically similar between V1 and V2 (hunger: p=0.095; fullness: p= 0.707; desire to eat: p=0.740 and prospective food consumption: p=0.421) as indicated by the non-significant time (pre-meal, post-meal, post+30min, post+60min, post+90min) x visit interactions. Figure 3 presents the evolution of hunger, fullness, desire to eat and prospective food consumption during V1 and V2.

Discussion

Although a French translation of the original British LFPQ has been used in several studies for the last 10 years approximately, the present work addressed a pressing need to validate a culturally adapted version of this instrument to reliably evaluate food reward and the hedonic control of appetite in a French population. Importantly, this cultural adaptation has been conducted following the rigorous and standardized set of procedures previously described [28]. Results from this study indicate that the food items and images selected during the developmental process and used to develop the LFPQ-fr were correctly identified and perceived by the population to be either low or high-fat and sweet or savory foods. Furthermore, the experimental evaluation of the newly developed LFPQ-fr demonstrated the reliability and reproducibility of salient food reward outcomes in both fasted and fed states.

In line with the methodological recommendations formulated for adapting the LFPQ to diverse cultures [28], the final set of 16 images that compose the LFPQ-fr was selected after an online survey conducted among 430 French adult participants who were asked to identify frequently consumed and liked food items that they could correctly recognize as sweet or savory and low or high fat, and typical of lunch time consumption. Specifically, the selected items were easily recognized by between 96.5% and 100% of the sample, which is highly satisfactory and in line with what was observed in similar previously published studies [24, 28]. Similarly, the sensory (sweet versus savoury) and nutritional (high versus low fat) qualities of the selected items were properly identified by the vast majority of the sample as displayed in Table 1 and the statistical validation displayed in Figure 1. Taken together, these results support the validity and cultural adaptation of the LFPQ-fr for a French population, and represent an important step since food choices have been shown to be affected by the familiarity with food images, which will inevitably vary across cultures [33].

The second step of the validation process consisted of asking healthy adults (half females and half males) to complete the LFPQ-fr before and after a standardized test meal on two separate occasions. The scores obtained in both fasted and fed states for all LFPQ-fr dimensions were in the ranges previously reported when using both the original [6, 28] and some recently culturally adapted versions [24, 25], supporting the sensitivity to a test meal manipulation. Despite the high degree of experimental control by standardizing dietary and physical activity-related behaviors in the 2 days preceding each test day, some scores were found to be significantly different between the first and the second visit. This might be attribute to myriad environmental factors or other contextual reasons that appetite may be sensitive to and are difficult to control for [1]. However, it important to note that the presence or absence of statistical differences remained consistent between pre- and post-meal values except for Explicit Liking fat bias. It should be further considered that the patterns in appetite feelings (hunger, fullness, prospective food consumption and desire to eat) from to baseline to 90 minutes post-meal were found to be nearly identical between V1 and V2. These observations reinforce the condition and state-related consistency at the participant level between lab visits.

Importantly, due to the high inter-rater variability of appetite-related measures, the obtained concordance coefficients and the Bland & Altman analyses as represented graphically in Figure 2 and the LOA provide better evaluations of the test-re-test reliability of the LFPQ-fr. Moreover, none of the changes in key LFPQ-fr dimension in response to the test meal was significantly different between the first and the second visit. Overall, the evaluation of the LFPQ-fr values across different appetitive states revealed a high reproducibility between the participants' two visits.

In line with previous cultural adaptations of the LFPQ conducted in other countries, the present work produced a culturally appropriate and reliable version of the LFPQ suitable for French populations. While this validation study has been conducted in healthy men and women aged between 20 to 40 years, further studies should be conducted to assess its reliability in other French samples with different age ranges, weight status and health profiles. Additionally, it may be beneficial to conduct further studies in different settings or using different test meals, for example, to elucidate whether the reliability of the LFPQ-fr extends to different research contexts.

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Figures legends

Figure 1. Scatter plot visualising the hierarchical clustering by taste and fat. To validate the classification in four food categories, a hierarchical clustering was made (see Oustric et al 2020). Mean results of the food validation survey for taste and fat have been scaled and the foods have been projected according to their new fat and taste coordinates. Positive ratings represent savoury taste or high-fat, respectively. Smaller points represent the foods and larger points depict the cluster's centre. The smaller the ellipse of the cluster, the more homogenous the cluster (e.g. LFSW). The further the food are from zero, the more separate are the clusters. This scatter plot attests of four distinct groups of food and allows to spot which food are closer to other clusters. Plot performed on R version 3.5.1 (R Core Team, 2013) using factoextra v1.0.5 package and enhanced hierarchical clustering (see Oustric et al. 2020).

Figure 2. Bland & Altman plots for food choice, explicit liking, explicit wanting and implicit wanting pre-post-meal deltas between visit 1 (V1) and visit 2 (V2) for both Taste and Fat. These graphs show the difference between the measures performed on V1 and V2 plotted against the means for each participant. The purple lines=Bias or mean differences between the 2 measures; red lines=95% limits of agreement of the mean difference. The critical difference is "two" times standard deviation of the difference between the 2 measures (half of the limits of agreement). The bias (purple line) should be close to zero and the limit of agreement narrow to support the reliability of the task. Participants should be evenly distributed along the means.

Figure 3. Evolution of Hunger (A), Desire to Eat (B), Fullness (C) and Prospective Food Consumption (D) during the first and second visits.

Figure S1. Food pictures selected in a French version of the Leeds Food Preference Questionnaire.

Table 1. Survey results on the selected food pictures (n=430)

Names	Recognition (%)[a]	Frequency (1-6)	Liking (mm)	Taste (mm)	Fat (mm)	Time of day (%)[b]
Brownie	99.30	3.24	82.76	4.73	85.56	82.41
Butter biscuits	100.00	2.84	73.00	9.88	82.88	74.40
Icecream	99.77	2.97	75.62	4.89	60.06	82.99
Raspberry tart	100.00	2.92	83.42	4.91	64.56	86.68
Apple puree	96.51	4.38	79.15	12.31	15.33	88.61
Banana	99.53	4.30	73.05	12.02	26.48	80.47
Strawberries salad	100.00	3.15	88.19	8.57	14.31	89.76
Fruits salad	100.00	4.29	84.13	12.26	9.77	89.68
Avocado with mayonnaise	99.77	3.14	72.17	80.73	74.66	76.96
Charcuterie	100.00	4.00	76.65	95.52	93.95	75.87
Comté	100.00	4.83	83.88	91.53	80.96	82.85
Quiche Lorraine	98.14	3.55	76.46	90.12	79.76	80.17
Chicken salad	99.30	4.00	71.03	85.68	28.48	82.94
Ratatouille	100.00	4.11	77.71	83.74	27.14	88.77
Shrimp skewer	100.00	3.27	79.28	85.81	29.07	77.94
Tomato salad	100.00	4.53	80.79	73.85	14.11	89.08
mean (sd)	99.52±0.9	3.72±0.65	78.58±5.00	47.28±40.19	49.19±30.97	83.10±5.21

[a]Recognition is expressed as a percentage of the total number of the samples; [b]Percentage of participants who properly identified the appropriate time of day

Table 2. A French version of the Leeds Food Preference Questionnaire results and comparison between Visit 1 and Visit 2, pre- and post-meal.

	Visit 1						Visit 2						Pre vs post		Visit 1 vs Visit 2					
	Pre-meal			Post-meal			Pre-meal			Post-meal			Visit 1	Visit 2	Pre-meal			Post-meal		
	Mean	*SD*	*p50[p25 ; p75]*	*Mean*	*SD*	*p50[p25 ; p75]*	*Mean*	*SD*	*p50[p25 ; p75]*	*Mean*	*SD*	*p50[p25 ; p75]*	*p*	*p*	*Lin [95%CI]*	*95% LOA (Bias)*	*p*	*Lin [95%CI]*	*95% LOA (Bias)*	*p*
Choice																				
Fat	-6,48	8,75	-7,00 [-11,00 ; -1,00]	-5,98	9,20	-5,50 [-13,01 ; 1,00]	-5,26	8,42	-5,00 [-10,00 ; -1,00]	-2,95	10,77	-3,00 [-9,00 ; 2,00]	0,59	0,204	0,94 [0,91 ; 0,97]	-6,01 to 4,35	0,044	0,66 [0,51 ; 0,81]	-18,11 to 12,86	0,015
Taste	-16,00	12,12	-20,01 [-24,00 ; -8,00]	16,70	15,11	23,00 [8,00 ; 27,00]	-18,50	12,38	-21,00 [-26,00 ; -11,40]	18,87	13,16	23,50 [14,00 ; 27,50]	<0,0001	<0,0001	0,93 [0,89 ; 0,97]	-7,40 to 9,25	0,117	0,62 [0,45 ; 0,80]	-23,75 to 22,00	0,437
Explicit Liking																				
Fat	-8,22	17,11	-5,56 [-18,25 ; 3,50]	-5,11	15,15	-1,31 [-11,5,0 ; 3,75]	-5,64	13,60	-6,00 [-11,75 ; 3,18]	-1,45	12,69	-1,87 [-8,62 ; 5,25]	0,086	0,005	0,80 [0,71 ; 0,90]	-19,42 to 16,35	0,191	0,80 [0,70 ; 0,90]	-18,39 to 13,32	0,019
Taste	-17,82	22,16	-19,00 [-32,25 ; -4,37]	19,62	25,08	19,81 [5,25 ; 36,25]	-20,75	23,76	-21,31 [-36,31 ; -2,43]	22,41	18,74	19,75 [9,68 ; 39,43]	<0,0001	<0,0001	0,74 [0,61 ; 0,86]	-27,17 to 35,39	0,093	0,57 [0,38 ; 0,76]	-39,16 to 37,28	0,557
Explicit Wanting																				
Fat	-9,01	16,04	-8,50 [-16,75 ; 0,50]	-4,09	14,20	-1,43 [-7,50 ; 2,12]	-7,57	13,08	-6,68 [-14,75 ; 0,37]	-1,26	11,65	-2,31 [-7,06 ; 1,31]	0,013	<0,0001	0,80 [0,70 ; 0,90]	-17,36 to 16,72	0,687	0,77 [0,66 ; 0,89]	-17,39 to 14,17	0,114
Taste	-19,70	21,51	-18,81 [-37,12 ; -4,50]	18,62	25,05	17,81 [0,62 ; 34,62]	-19,60	22,66	-20,87 [-33,31 ; -6,12]	20,01	17,70	19,81 [5,81 ; 33,37]	<0,0001	<0,0001	0,89 [0,83 ; 0,95]	-17,94 to 21,10	0,366	0,63 [0,47 ; 0,79]	-34,00 to 35,01	0,967
Implicit Wanting																				
Fat	-19,48	28,15	-22,29 [-34,28 ; -4,65]	-16,15	29,58	-11,91 [-36,08 ; 5,80]	-9,04	25,70	-10,67 [-21,99 ; 5,30]	-6,92	31,61	-5,86 [-23,54 ; 7,59]	0,358	0,52	0,76 [0,64 ; 0,87]	-40,65 to 23,54	<0,0001	0,64 [0,48 ; 0,81]	-56,30 to 40,37	0,017
Taste	-41,03	42,61	-47,97 [-69,38 ; -17,02]	47,34	45,86	63,71 [13,83 ; 80,66]	-47,93	38,80	-52,19 [-76,16 ; -26,29]	47,21	42,03	62,93 [35,80 ; 74,44]	<0,0001	<0,0001	0,72 [0,58 ; 0,85]	-52,20 to 65,99	0,107	0,53 [0,32 ; 0,73]	-76,02 to 84,04	0,694

Table 3. LFPQ-fr pre-post-meal deltas comparison between visit 1 and visit 2.

	V1 Delta Pre-Post-meal			V2 Delta Pre-Post-meal			V1 vs V2		
	Mean	***SD***	***p50[p25 ; p75]***	***Mean***	***SD***	***p50[p25 ; p75]***	**p**	**Lin [95%CI]**	***95% LOA (Bias)***
Choice									
Fat	0,57	7,10	1,00 [-3,00 ; 5,00]	1,31	8,98	1,00 [-4,00 ; 9,00]	0,509	0,59 [0,39 ; 0,78]	-15,01 to 13,55
Taste	31,91	17,48	32,00 [19,00 ; 47,00]	36,75	17,40	39,50 [25,00 ; 52,00]	0,204	0,71 [0,56 ; 0,87]	-26,55 to 23,43
Explicit Liking									
Fat	3,11	12,97	3,87 [-4,50 ; 13,12]	4,19	10,49	4,06 [-2,37 ; 8,93]	0,484	0,61 [0,44 ; 0,78]	-21,43 to 19,42
Taste	37,44	26,16	35,56 [16,00 ; 58,37]	43,17	30,18	41,43 [24,18 ; 56,68]	0,124	0,62 [0,45 ; 0,79]	-52,62 to 42,52
Explicit Wanting									
Fat	4,92	14,18	6,81 [-4,12 ; 13,37]	6,31	10,44	4,37 [0,56 ; 10,25]	0,424	0,55 [0,37 ; 0,74]	-24,41 to 21,82
Taste	39,67	27,43	37,06 [21,12 ; 59,50]	38,62	27,11	36,81 [21,06 ; 53,31]	0,877	0,71 [0,56 ; 0,87]	-41,13 to 38,82
Implicit Wanting									
Fat	3,33	25,88	0,05 [-12,53 ; 23,26]	2,11	23,06	-1,39 [-14,01 ; 21,13]	0,797	0,49 [0,27 ; 0,71]	-48,24 to 49,42
Taste	88,37	51,17	86,43 [52,27 ; 134,56]	95,14	45,50	87,58 [65,48 ; 134,10]	0,479	0,55 [0,35 ; 0,75]	-89,48 to 83,72

Table S1 (Supplementary). Nutritional composition of the selected food.

	Food	Kcal/100g	% Pro	% Carb	% Fat	Energy density (kcal/g)
HFSW	Brownie	440.00	5.27	48.58	53.18	4.40
	Icecream	175.59	8.70	49.58	52.22	1.76
	Raspberry tart	451.00	7.89	50.89	54.68	4.51
	Butter biscuits	503.00	4.45	49.20	50.10	5.03
mean± SD		392.4±147.13	6.58±2.04	49.56±0.97	52.54±1.92	3.92±1.47
LFSW	Banana	90.00	4.36	81.67	2.50	0.90
	Strawberries salad	52.24	4.74	76.06	2.95	0.52
	Apple puree	73.00	1.10	87.33	0.00	0.73
	Fruits salad	54.67	5.37	69.51	7.13	0.55
mean± SD		67.48±17.65	3.89±1.91	78.64±7.63	3.15±2.96	0.67±0.18
HFSA	Comté	418.00	25.55	0.00	74.50	4.18
	Avocado with mayonnaise	254.54	2.44	5.12	88.74	2.55
	Quiche Lorraine	274.00	12.99	22.17	70.29	2.74
	Charcuterie	338.48	29.78	1.59	68.59	3.38
mean± SD		321.26±73.8	17.69±12.41	7.22±10.19	75.53±9.15	3.21±0.74
LFSA	Chicken salad	156.00	54.03	3.95	19.95	1.56
	Shrimp skewer	109.00	69.72	15.62	9.58	1.09
	Ratatouille	58.00	8.28	18.75	18.62	0.58
	Salad with tomato	17.70	23.44	42.37	12.06	0.18
mean± SD		85.18±60.21	38.87±28.02	20.17±16.11	15.05±5.02	0.85±0.6
TOTAL mean± SD		216.58±167.04	16.76±19.79	38.9±29.95	36.57±30.31	2.17±1.67

HFSA: high-fat savoury, LFSA: low-fat savoury, HFSW: high-fat sweet, LFSW: low-fat sweet; % Pro: Percentage of total energy from protein, % Carb: percentage of total energy from carbohydrate, % Fat: percentage of total energy from fat.